From:	[redacted]
To:	Manston Airport
Subject:	Climate Change; Need; Viability and Public Interest; Noise; Environmental Impacts
Date:	17 May 2019 19:35:53
Attachments:	SEI-ProjectReport-Whitelegg-TowardsAZeroCarbonVisionForUKTransport-2010.pdf Climate change 2 BBC.rtf 2018_10_Aviation_decarbonisation_paper_final.pdf 2019_02_CE_Delft_Taxing_Aviation_Fuels_EU.pdf EC 2019_05_Tax_report_briefing_web_0.pdf 19-04-04_DL_IR_Ware_Park_Hertford_3178839.pdf study_costs_not_implementing_env_law.pdf TH-AL-18-022-EN-1 Unequal exposure.rtf

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From: Chris Lowe. Interested party: 20014275

Dear Sirs,

In line with your plea for evidence of which you may not be aware, the following may be relevant.

Note that Item 1, refers to to ExA Q3, CC.3.1 and I suggest additional question(s) either for the ISH or ExA Q4.

I hope this is helpful,

best wishes,

Chris

Chris Lowe

Climate Change

1 Committee on Climate Change: Net Zero
This report has already been mentioned in ExA Q3, CC.3.1 but that question seems only to relate to adaptation, rather than asking the rather more important question: How can the proposed 10,000 freight ATMs at Manston airport operate without exceeding the UK's existing Climate Change commitments, let alone the even lower requirements of the Net Zero report?

The main report (Page 205), says: "**New UK policies will therefore be needed to manage growth in demand**. These could include carbon pricing, reforms to Air Passenger Duty, or policies to manage the use of airport capacity"
This new report, in the Technical Report: 'Net Zero - Technical Report', has a Chapter 6 on Aviation and Shipping (so a separate aviation report is not going to be published), and Section 3, page 173, says that the existing core scenario allows 80% increase in demand, but this will need to be reduced to 60% in the revised core scenario.
On page 174, it recognises that: 'Further demand constraint is possible in order to limit growth to less than 60% compared to 2005 levels.'
Page 176 recognises the long lifetimes of aircraft, and the challenges of a technology based solution shows the importance of managing growth in demand.
It goes on to say, Page 176, in 'Measures to manage growth in demand', that: 'Policies to manage demand can therefore be pursued without significant risk of perverse impacts'.

The main report, page 33, Box 6, says that: "If policies are not sufficiently funded or their costs are seen to be unfair, then they will fail".
However demand management by appropriate fuel taxes or carbon taxes, means that the important principle that the "Polluter pays" principle, operates and so are shown to be very fair.

In addition demand management is more rapid and reliable than techology measures, and also reduces non-CO2 emissions which the CCC also require to be managed (Net Zero - Technical Report, Box 6.1, page 169).

It is notable that in 2010, the Stockholm Environment Institute published "**Towards a Zero Carbon Vision for UK Transport"**, by John Whitelegg, Gary Haq, Howard Cambridge and Harry Vallack" (Executive Summary, attached) which formulated a "Maximum Impact" (MI) scenario which would reduce emissions to 26.3 Mt CO2 by 2050 (page ix), which is lower than the CCC 30 Mt (Technical Report, Box 6.4), so is clearly feasible.

With all the current focus on climate change the Government will have to respond, so the operation of Manston would be impossible in that reduced demand situation.

2 Government recognition of the need to reduce aviation emissions

Two reports, (attached as one document) show that UK governments recognise that aviation will need to be curbed to meet climate emissions targets. This means that they accept the importance of the Committee on Climate Change recommendations, and will respond accordingly.

The recognition by the Scottish Government that climate change is more important than encouraging tourists shows the increasing pressure to reduce air transport.

3 The challenges of decarbonising aviation

The “Road map to decarbonising European aviation”, 2018 (attached), provides additional evidence that the expected technology and operations improvements will be insufficient to reduce the expected aviation fuel demand and emissions that are required to meet the Paris Agreement.

Although the Examination is concerned with Manston, the Report shows that the required decarbonisation will increase aviation costs and reduce demand. The implications for Manston are that it will be even less able to compete and thus render the proposals unviable.

The report says that Carbon pricing needs to play a central role reduce fuel demand. Exempt from kerosene taxation and with most European aviation emissions excluded from the EU ETS, much needs to be done. The report shows that introducing fiscal measures that combined represent a carbon price equivalent to €150/tonne can moderate fuel demand growth from the sector through incentivising a combination of design and operational efficiency improvements and modal shift. Other measures highlighted include stricter fuel efficiency standards and incentives to speed up fleet renewal. Combined, these measures could cut fuel demand by some 12 Mtoe, or 16.9% in 2050 compared to a business as usual scenario.

However that still leaves substantial and increased fuel demand in 2050. This report examines how the carbon footprint of the remaining fuel demand can be cut and, where possible, eliminated. With todays' technology this can only be achieved through the use of sustainable alternative fuels, which is no easy task.

To succeed in putting aviation on a pathway to decarbonisation, new types of alternative fuels need to be brought forward.The report focuses on synthetic fuels, namely electrofuels, which would be needed to close the gap.

If produced at scale, electrofuels are likely to cost between three and six times more than untaxed jet fuel. At a cost of €2,100 per tonne in 2050, electrofuel uptake will increase ticket prices by 59%, resulting in a 28% reduction in projected passenger demand compared to a business-as-usual scenario. However, compared to the ticket price with an equivalent CO2 tonne, the ticket price increase would only be 23%. However introducing a progressively more stringent low carbon fuel standard (GHG target) on aviation fuel suppliers will leave all operators flying within or from Europe needing to purchase such fuels. These rising fuel costs will increase operating costs which will inevitably be passed onto consumers, causing a fall in demand for jet fuel compared to forecasts and reducing the volume of alternative fuels that will be required to replace kerosene.

Importantly, the report highlights the enormous demand on renewable electricity if fuel demand remains high and electrofuels are the only way to decarbonise. Using electrofuels to meet the expected remaining fuel demand for aviation in 2050 would require renewable electricity equivalent to some 28% of europe's total electricity generation in 2015 or 95% of the electricity of currently generated using renewables in Europe. It is also important to keep in mind that other sectors will need additional renewable electricity to decarbonise, for example for green hydrogen to be used in industry. However with today's technology, synthetic fuels are the the only technically viable solution that would allow aviation to exist in a world that avoids catastrophic climate change.

Aside from decarbonising aviation fuels, the warming from non-CO2 effects at altitude is considerable and is a challenge that is barely being touched. While the report discusses these effects and identifies possible mitigation approaches, there remains a lack of policy focus on this topic. What is clear is that the European Commission must meet its obligations under the EU ETS Directive to come forward with proposals on measures by the start of 2020.

For Manston this means another negative impact on its potential viability.

Finally, in agreement with the Committee on Climate Change, the report does not recommend offsetting as this is incompatible with the decarbonisation logic of the Paris Agreement.

4 Committee on Climate Change: Managing the Coast in a Changing Climate

This recent report (October 2018), highlights the need for much more work and funding to reduce the risk of severe coastal change and flooding.

Recommendation1: The scale and implications of future coastal change should be acknowledged by those with responsibility for the coast.
They highlight that the risks of coastal flooding and erosion are not fully understood.

Recommendation 3: Defra and MHCLG policy on the management of coastal flooding and erosion risk should specify long-term, evidence based, quantified outcomes that have the buy-ins of the affected communities and stakeholders.
They highlight that the Government Adaptation programme, Management Strategy and Environment Plan have not proposed actions that can be assessed for their impact on exposure or risk.

What this means is that the risk that the Isle of Thanet may be cut off from the mainland due to sea water flooding, is unknown together with a lack of planned action to ensure that connections can be maintained.

As previously submitted (in my Written Representation) there is a known very serious risk of such flooding, as shown by events in 1953, so the CCC Coastal report means that Manston is a very unsuitable place for an airport.

Need

5 Actual Data of Cargo and Total ATMs shows no need for more ATMs

The aviation industry always tries to say we need more activity, but that is not true.

In comparing data between 1998 and 2018, it is notable that Cargo tonnes *increased by 27%* but Cargo Air Transport Movements *decreased by 50%* from 108,000 to 54,000.

Clearly this means there is no need for more cargo air transport movements, especially as there is now more ATM capacity than in 1998, but *Total Air Transport Movements have actually decreased by 8% from 3,334,000 to 3,061,000* since 1998.

Hence there is no need for Manston.

CAA Airport Statistics, Table 1 (Passengers), Table 6 (PATMs & CATMs), Table 15 (Cargo Tonnes) and Table 3.2 (Aircraft Movements):
https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-airport-data/

Viability and Public Interest
6 European Commission Report on Taxing Air Transport

The Final version of the the EC_report_Taxes_in_field_of_aviation_and_their_impact has come out and its conclusions are that the oft-quoted Chicago Convention "does not explicitly prohibit the taxation of jet fuel", only the taxation of fuel already on board an aircraft upon arrival in another state. It makes clear that exemptions from taxing jet fuel largely arise from bilateral air services agreements.

This follows on from previous work by C E Delft, for example their Taxing Aviation Fuels EU, attached, and their Study on Aviation ticket Taxes, submitted with my Written Representation.

In the first model scenario existing ticket taxes are abolished (scenario 1), EU-wide passenger demand, flights and connectivity increases 4%; ticket prices fall 4%; CO_2 emissions increase 4% and those people affected by aircraft noise rise 2%. Member state revenues fall by 74% or €2.6bn, leaving revenue from the only remaining tax in place - domestic VAT. Jobs and value-added rise 4% in the aviation sector matched by an equal fall of 4% in jobs elsewhere. So a net effect of zero on total employment and GDP. This directly contradicts industry-sponsored reports which claim that abolition of existing ticket taxes would result in an increase in GDP and total employment (https://a4e.eu/tax/) .

The other two scenarios - introduction of kerosene taxation and VAT - produce opposite results. The impact of each is modelled separately.

Imposing a fuel tax on all departing flights to all destinations at the 33 cents EU energy tax minimum would cause ticket prices to rise 10%; flights, passengers and CO_2 emissions all fall 11%, people affected by noise drop 8% and fiscal revenues rise from €10 billion to €27 billion. Jobs and aviation value added falls 11% but the overall impact on EU jobs and GDP is zero.

VAT applied at the German rate of 19% on all tickets reduces passenger demand and flights by 19%; direct jobs and value added in aviation fall 18% while the overall effect on EU jobs and GDP is negligible. Member state revenues rise from €10 billion to €40 billion while CO_2 emissions fall 18% and number affected by aircraft noise 12%.

For the UK, introducing taxation of €0.33 per litre raises €7.3 billion, reduces Passenger numbers, number of flights and noise by 12% with no effect on jobs or GDP.

The Income in 2017, from Air Passenger Duty is £3.4 bn (HMRC, Air Passenger Duty ('APD') Bulletin - September 2018, Table 2 – APD receipts Calendar Year 2017: https://www.uktradeinfo.com/Statistics/Pages/TaxAndDutybulletins.aspx), so this would clearly be benefical to the UK in raising treasury income and reducing carbon emissions with no loss of jobs.

Obviously the ExA cannot impose taxes, but bearing in mind that we are bound by EU legislation, and there is a strong support for such taxation in the EU, as well as strong support for reducing emissions, it seems very likely that these taxes will be introduced.

This would mean that Manston would be even less viable, and also it would not be in the public interest to Compulsory Purchase the land for an unnecessary airport.

Noise

7 Flawed baseline noise measurement meant quarry noise unacceptable

Both an Inspector and the Secretary of State agreed that because baseline noise measurements were made in windy, high noise conditions, the actual noise from a quarry would exceed acceptable limits and the character of the operational noise would be distinctive, and thus harm the living conditions nearby occupiers and the amenity of the area.

Noise from Manston airport would be distinctive, as it is tonal, and would certainly harm the living conditions of nearby occupiers, so the Application for the airport should be refused as well.

8 Independent Commission on Civil Aviation Noise (ICCAN)

The ExA has already involved the Head Commissioner of ICCAN and the final technical Commissioner is due to be interviewed on 9 July, 2019.
(See: https://publicappointments.cabinetoffice.gov.uk/appointment/commissioner-for-acoustics-and-aviation-noise/)

Therefore the ExA is not in a position to ask for advice from ICCAN, but I suggest that if the ExA is minded to recommend to support the Application, that it recommends to the Secretary of State (SoS) that ICCAN be asked to review the Noise aspects to ensure that the proposals will indeed meet the SoS's intention that the

Application will:
“

- Increase the public’s confidence in the noise data published by the aviation industry and in the impartiality of the airspace change process;
- Challenge industry to enhance its approach where necessary on assessing and mitigating noise impacts and engaging communities;
- Maintaining independence by testing and challenging all opinions to seek best outcomes and building trusted relationships between all parties involved in Aviation changes;
- Ensure improved relations and trust underpin local decision making on noise controls”

as described in the ICCAN objectives.

Environmental Impacts

9 The Costs of not implementing EU Environmental Law

This Report (attached) shows the costs of not achieving noise limits given by the World Health Organisation (WHO) 1999. As the latest WHO recommendations are even lower than the 1999 ones, this means the costs are even higher, and shows the importance of not allowing Manston Airport which would increase noise in East Kent above recommended WHO levels, both past and present.

The report also highlights that similar costs are involved in the other environmental issues, so those costs are also under-estimated, so the Precautionary Principle means that the Application must be refused,

10 Unequal exposure and Unequal Impacts
A very long (55 Mb) EEA Report No 22/2018: “Unequal exposure and unequal impacts: social vulnerability to air pollution, noise and extreme temperatures in Europe” ISSN 1977-8449, (www.eea.europa.eu/publications/unequal-exposure-and-unequal-impacts) emphasises the greater impact on vulnerable people
of adverse environmental impacts.
In view of the vulnerability of many of Thanet’s residents, this is a further reason to refuse the Application.

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Stockholm Environment Institute, Project Report - 2010

Towards a Zero Carbon Vision for UK Transport

John Whitelegg, Gary Haq,
Howard Cambridge and Harry Vallack

Towards a Zero Carbon Vision for UK Transport

John Whitelegg, Gary Haq, Howard Cambridge and Harry Vallack

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We would like to thank the Greenpeace Environmental Trust for giving us the opportunity to undertake an interesting and timely study. In particular, we are grateful to Doug Parr, Anita Goldsmith, Emma Gibson and Vicky Wyatt at Greenpeace for all their feedback and support. A number of transport experts reviewed our scenario assumptions and provided advice. We thank Jillian Anable, Kieth Buchan, Simon Davies, Phil Goodwin, Steve Norris, Simon Reddy and John Stewart for their expert insights.

Finally, we are grateful to Richard Clay and Erik Willis for producing this final report.

LIST OF ACRONYMS AND ABBREVIATIONS

ACS	Air cavity system
APU	Auxiliary power unit
AQMA	Air Quality Management Areas
ATM	Air transport movements
ATOC	Association of Train Operating Companies
BAU	Business-as-usual
BERR	Department for Business, Enterprise and Regulatory Reform
CAA	Civil Aviation Authority
CAEP	Committee on Aviation and Environmental Protection
CCC	UK Committee on Climate Change
CCS	Carbon capture and storage
CCT	Company car tax
CH_4	Methane
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalents
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EC	European Commission
EST	Environmentally sustainable transport
ETS	Emission Trading System
EU	European Union
EV	Electric vehicle
FPE	Fuel price escalator
FTK	Freight tonne kilometres
GDP	Gross domestic product
GHG	Greenhouse gas
Gt	Gigatonnes
Gt CO_2	Gigatonnes of carbon dioxide
GTP	Global temperature potential
GWP	Global warming potential
HGV	Heavy goods vehicle
HOV	High occupancy vehicle
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICE	Internal combustion engine
ICT	Information and communication technologies
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
ITIF	Information Technology and Innovation Foundation
LDV	Light goods vehicle
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
LTP	Local transport plan
MARPOL	International Convention for the Prevention of Pollution from Ships
MI	Maximum Impact
Mppa	Million passengers per annum
mph	Miles per hour
Mt CO_2	Megatonnes (millions of tonnes) of carbon dioxide
NICE	National Institute for Clinical Excellence
OECD	Organisation for Economic Cooperation and Development
NO_X	Nitrogen oxides ($NO + NO_2$)
N_2O	Nitrous oxide
NAIGT	New Automotive Innovation Growth Team
NETCEN	National Atmospheric Emission Inventory
NHS	National Health Service
NTM	National Transport Model
OECD	Organisation for Economic Cooperation and Development
pa	Per annum
PEV	Plug-in electric vehicles
PM	Particulate matter
RF	Radiative forcing
RFI	Radiative forcing index
RTFO	Renewable Transport Fuel Obligation
SARS	Severe acute respiratory syndrome
SEI	Stockholm Environment Institute
TEU	Twenty-foot equivalent units
TSGB	Transport Statistics Great Britain
UK	United Kingdom
UKERC	UK Energy Research Centre
UNFCC	United Nations Framework on Climate Change
VA	Voluntary agreement
VED	Vehicle excise duty
VKT	Vehicle kilometres travelled
WBCSD	World Business Council for Sustainable Development

EXECUTIVE SUMMARY

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level. The dominant factor in the warming of the climate in the industrial era is the increasing concentration of various greenhouse gases (GHG) in the atmosphere.

In 2006, the transport sector accounted for approximately 24 per cent (130 million tonnes) of the UK's domestic emissions of carbon dioxide (CO_2) the majority of these emissions (92 per cent) coming from road transport. The 2008 Climate Change Act, commits the UK to reducing GHG emissions across the economy by at least 80 per cent (in comparison to 1990 levels) by 2050.

In its recently published Carbon Reduction Strategy for Transport, the Department of Transport (DfT) recognises that effective decarbonisation of the transport sector will play a large role in achieving this goal. This DfT strategy document also recognises that complete decarbonisation is unlikely to be possible for aviation and shipping due to the greater technical challenges although by 2050 "these modes will have seen a transformative improvement in efficiency".

Despite the difficulties envisaged by the DfT study in decarbonising the UK transport sector, it is possible to make significant progress towards the desirable future of a zero carbon transport system by 2050. There are no technical, financial, organisational or other obstacles that would put this objective out of reach though a willingness to move boldly and decisively in this direction has yet to be demonstrated.

A zero carbon road transport system has enormous potential to deliver post-Kyoto GHG reductions and to embed the transport sector firmly within a wider process of societal change that can move beyond rhetoric and target setting and deliver a decarbonised future. Indeed, without a clear and robust low carbon transport system in place reinforcing all other sectoral and lifestyle contributions to carbon reduction, it is highly unlikely that CO_2 emission reductions of the scale required across the UK or the European Union (EU) can actually be achieved.

A zero carbon transport future will provide better access for more people to more things than is currently the case. Traffic congestion and time wasted stuck in jams will be a thing of the past and time currently wasted on commuter trips will be spent on rewarding and enriching activities.

By 2050 all urban and rural areas will have significantly enhanced public transport and cycling facilities bringing high quality and low-cost transport choices within everyone's reach. Those who opt not to use a car will save thousands of pounds a year by avoiding the fixed and variable costs of car ownership and use, and will also avoid the uncertainties and potential disruption of oil price shocks as the world adjusts to shortages of supply and increased demand from developing countries. Individuals and families will have much improved air quality, reduced noise and stress from traffic and much improved community life stimulated by reduced levels of motorised traffic and reduced traffic on streets and through villages.

The aim of this study is to quantify and assess the contributions that different CO_2 emission reduction measures can make in assisting the UK to move towards a zero carbon transport sector by 2050. Existing published reports, academic papers and official statistical data have been used to estimate CO_2 emissions from the transport sector in 2050 according to two scenarios: a Business-as-usual (BAU) scenario and a Maximum Impact (MI) Scenario in which all feasible interventions for achieving a 'near zero carbon' UK transport sector are applied.

Much of the baseline and trend data used are derived from other modelling initiatives such as the DfT's National Transport Model (NTM). Therefore, the BAU Scenario estimates are necessarily constrained by these assumptions (e.g. the NTM's future fuel price increase assumptions).

In addition to reducing GHG emissions, moving towards a zero carbon transport system will lead to a number of social, environmental and economic benefits. These co-benefits will improve the quality of life for social groups of widely differing lifestyles and transport needs. The measures outlined in the MI Scenario will deliver the transition towards a zero carbon transport system which in turn, will produce knock-on beneficial effects in the following key areas: environmental quality, social exclusion, mobility and accessibility.

Moving towards a zero carbon transport Britain will affect diverse lifestyle groups in different ways. By 2050 Britain is expected a have an older population, where people aged over 50 will represent 30 per cent of the population. Many older people will remain fit and active into later life where mobility will be a key factor in determining their quality of life. The study compares the current lifestyles of typical families with those likely to be led by their equivalent counterparts in 2050 under assumptions made in the MI Scenario.

The study focuses solely on 'tailpipe' CO_2 emissions. It should be noted that in the future, the carbon intensity of fossil fuels (the 'well-to-wheel' emissions) is likely to increase as fossil fuels become more difficult to locate and extract. An exception to this general approach applies when the role of plug-in electric vehicles (PEV) is considered in the MI Scenario as clearly the concept of 'tailpipe emissions' becomes meaningless for these vehicles. Also, it is beyond the scope of this study to enter into cost-benefit analyses of the various CO_2 emissions reduction measures which have been included in the MI Scenario.

There are two key future challenges which necessitate the reduction of oil use within transport, and the consequent CO_2 emissions, to an absolute minimum. Firstly, transport is extremely dependent on oil and there is a likelihood that there will not be much oil left in 2050, compared with today. Gilbert and Perl (2008) argue that we have to embrace a new transport revolution based on "moving people and freight without oil". It is clear, therefore, that transport systems have to change. Secondly, climate change raises important issues around re-engineering transport systems so that they are less vulnerable to the damaging consequences of climate change and play a full proportionate role in mitigation i.e. reducing GHG emissions.

The climate change problem has a strong ethical dimension through its differentially serious impacts on the poor and the vulnerable. Transport developments based on year-on-year growth in GHG emissions actively contribute to the generation of unethical outcomes. Transport is also the fastest growing source of GHG emissions and shows little sign of seriously addressing the need for carbon reduction.

The BAU Scenario is an estimate of a particular end-state in a chosen year based on the continuation of present trends and policies to 2050. The BAU is one of two scenarios examined in this study to explore future scenarios for a zero carbon transport sector in the UK. The base year for each mode may differ due to the availability of studies and projects using different data.

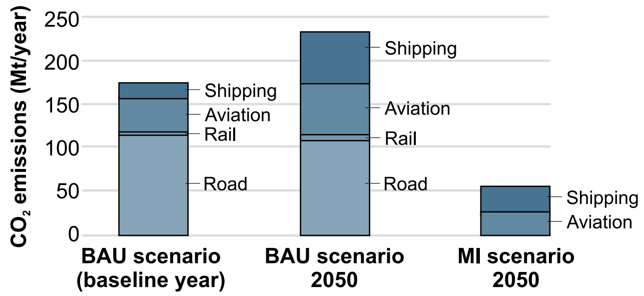
The baseline BAU CO_2 emission estimates are compared with a number of recent UK studies on low carbon transport. The estimates for road and rail transport are generally in line with these studies. Estimates for aviation vary depending on whether or not international aviation is included. Emissions from shipping include those from domestic and international shipping and are considerably higher than reported elsewhere because of the methodology used to allocate emissions to countries. For shipping this is based on freight tonne kilometres as this better represents UK economic activity.

The MI Scenario represents a radically different Britain by 2050, where the UK transport sector emits close to zero CO_2. A wide range of measures known to reduce CO_2 emissions from transport were examined to see the extent to which these measures can have a maximum impact on the transport sector and realise the vision of a zero carbon transport sector in the UK.

These measures are grouped into in four categories (Spatial planning, Fiscal, Behavioural and Technology) and the impacts of each assessed separately in order to allow their relative efficacy to be assessed. For passenger and freight railways, a single technological intervention only is applied: complete electrification of the UK rail network. Biofuels are assumed to have only a minimal role given they are usually considered to be far from 'carbon neutral' and have been associated with adverse land-use issues and other drawbacks identified in the Gallagher review (Renewable Fuels Agency, 2008).

Under the MI Scenario assumptions, road transport will be completely carbon neutral by 2050 due to a combination of reduced demand (approximately 75 per cent from spatial, fiscal and behavioural measures) and a whole-scale shift in technology to PEVs and hydrogen fuel cell vehicles, both of which will utilise decarbonised UK electricity supply. Clearly, a carbon neutral electricity supply would be much more likely to be able meet the increased needs of a road transport sector almost entirely composed of PEVs and/or hydrogen fuel cell vehicles if total demand is also drastically reduced. The measure causing the greatest reduction in demand is the annual increase in fuel costs due to the re-introduction of a fuel price escalator.

Emissions of CO_2 from aviation have been reduced by 56 per cent when the 2050 MI Scenario is compared with the 2050 BAU. CO_2 emissions in 2050 under the MI Scenario are also 11.2 million tonnes less than the baseline 2005 figure. This represents significant progress in bringing aviation into line with the implications of the UK national commitment to an 80 per cent reduction by 2050 on a 1990 base. The



Summary of CO_2 emissions for BAU and Maximum Impact (MI) Scenarios

scale of reduction achieved is still not enough but it has been produced by the full application of all available measures. It is clear that a combination of those measures that reduce demand such as air fare increases, no additional runways, modal shift to railways (including High Speed Rail) and video substitution would deliver a considerably greater reduction than could be achieved by advances in aircraft technology and air traffic management alone. It follows that a reduction in CO_2 emissions from aviation of this scale could not be delivered by a policy that encouraged technological solutions alone whilst allowing demand to continue o grow. Any expansion of airport capacity through building new runways would have the effect of supporting year-on-year increases in demand and therefore does not form part of this MI Scenario. Indeed, there would be no need for any new runways under a policy designed to maximise CO_2 emissions reductions from aviation through a demand-led reduction strategy as assumed in this MI Scenario.

Published evidence that CO_2 emissions from shipping can be reduced by 49 per cent through changes in ship size, routeing, fuel, speed and a number of other promising technologies have been assumed. No change in prices for shipping bulk products or 'twenty-foot equivalent units' (TEUs) have been factored in the analysis because of the lack of published information on robust relationships between shipping prices and the physical quantity of goods shipped or the distance over which they have been moved.

Although road and rail transport could both achieve the zero CO_2 emission target by 2050, emissions from aviation and shipping are problematic. For the 2050 MI Scenario, the net result for the entire UK transport sector is a 76 per cent reduction in CO_2 emissions compared with the 2050 BAU Scenario (or a 68 per cent reduction on the BAU baseline year emissions). While this reduction is a considerable achievement in the transport sector it still falls short of the zero carbon target. The 24 per cent short-fall is entirely due to the remaining CO_2 emissions from aviation and shipping. To improve on this 76 per cent CO_2 emissions reduction would require much more radical interventions or technological innovations for these two sectors than those envisaged

Summary of BAU versus Maximum Impact (MI) Scenario

Category	Baseline emissions (Mt CO_2) [and Year]	BAU emissions (Mt CO_2) 2050	MI emissions – Combined measures (Mt CO_2) 2050	Reduction in CO_2 emissions relative to 2050 BAU
Road	116.2 [2003]	110.2	0	100%
Rail	3.4 [2006/7]	4.6	0	100%
Aviation	37.5 [2005]	59.9	26.3	56%
Shipping	18.9 [2005]	59.9	30.4	49%
All transport	176.0 [composite year]	234.6	56.7	76%

in the present study. This will require fundamental changes in globalisation and patterns of international trade and mobility if aviation and shipping is to make a larger contribution to the zero carbon target.

It must also be emphasised the MI Scenario for road and rail transport depends on the decarbonisation of the electricity supply system. A detailed analysis of policy pathways leading to such a decarbonised electricity supply in the UK is outside the scope of this study. However, if the electrical power sector decarbonisation by 2050 is less than 100 per cent, CO_2 emissions from road and rail transport will be substantially higher than projected for the MI Scenario.

Cycle hire scheme, La Rochelle, France - © Spixey/flickr

1 INTRODUCTION

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level (IPPC, 2007). The dominant factor in the warming of climate in the industrial era is the increasing concentration of various greenhouse gases (GHG) in the atmosphere (Soloman *et al.*, 2007). Several of the major GHG, including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) occur naturally. However, current concentrations of atmospheric CO_2 and CH_4 far exceed pre-industrial values found in Polar ice-core records of atmospheric composition dating back 650,000 years, and multiple lines of evidence confirm that increases in their atmospheric concentrations over the last 250 years are due largely to human activities (Soloman *et al.*, 2007).

The GHG contributing most to human-induced climate change is CO_2, global average atmospheric CO_2 concentrations having risen from 280 ppm at the start of the industrial revolution (ca. 1750) to a global monthly mean of 386 ppm in 2009 (Tans, 2009). Anthropogenic CO_2 emissions come mainly from fossil fuel combustion and globally, amounted to 26.1 Gigatonnes of CO_2 (Gt CO_2) in 2004 (Sims *et al.*, 2007) of which the transport sector was responsible for 6.3 Gt CO_2 (Kahn Ribeiro *et al.*, 2007). Over the past decade, global transport GHG emissions have increased at a faster rate than any other energy using sector and will continue to increase in the future as economic growth fuels transport demand and the availability of transport drives development (Kahn Ribeiro, 2007).

Global anthropogenic CO_2 emissions are growing and, according to the International Energy Agency's "Business-as-usual" scenario, are set to rise by 130 per cent by 2050 (IEA, 2008). The Intergovernmental Panel on Climate Change (IPCC) considers a rise of this magnitude could raise global temperatures by 6°C (eventual stabilisation level), perhaps more. This would lead to many adverse consequences including impacts on freshwater resources (increased droughts and flooding, less water stored in glaciers and snow), ecosystems (increased species extinction, reduced biodiversity), increased coastal erosion and flooding (due to sea level rise and increased storm frequency) and negative effects on human health, especially in developing countries (Parry *et al.*, 2007). Mankind faces an urgent need to reduce GHG emissions in order to avert dangerous levels of climate warming.

In 2006, the transport sector accounted for approximately 24 per cent (130 million tonnes) of the UK's domestic emissions of CO_2 the majority of these emissions (92 per cent) coming from road transport (DfT, 2008a). The 2008 Climate Change Act, commits the UK to a reduction in GHG emissions across the economy by at least 80 per cent (in comparison to 1990 levels) by 2050. In its Carbon Reduction Strategy for Transport, the Department of Transport (DfT) recognises that effective decarbonisation[1] of the transport sector will play a large role in achieving this goal (DfT, 2009a). This DfT strategy document also recognises that complete decarbonisation is unlikely to be possible for aviation and shipping due to the greater technical challenges although by 2050 "these modes will have seen a transformative improvement in efficiency".

Despite the difficulties envisaged by the DfT study in decarbonising the UK transport sector, it is possible to make significant progress towards the desirable future of a zero carbon transport system by 2050. There are no technical, financial, organisational or other obstacles that would put this objective out of reach though a willingness to move boldly and decisively in this direction has yet to be demonstrated. A zero carbon road transport system has enormous potential to deliver post-Kyoto GHG reductions and to embed the transport sector firmly within a wider process of societal change that can move beyond rhetoric and target setting and deliver a decarbonised future. Indeed, without a clear and robust low carbon transport system in place reinforcing all other sectoral and lifestyle contributions to carbon reduction, it is highly unlikely that CO_2 emission reductions of the scale required across the UK or the European Union (EU) can actually be achieved.

There is an urgent need to reduce CO_2 emissions and to act now to implement the necessary measures to move the UK transport towards zero emissions. Elements of a zero-carbon road transport system already exists in the sense that enormous progress has been made in different places and at different times to re-shape the transport system so that it delivers societal objectives at a much lower carbon penalty than is currently the case in the United Kingdom (UK). If it were possible to combine

1 The word 'carbon' within commonly used terms such as 'decarbonisation', 'low-carbon' and 'zero-carbon' and 'reduced carbon' is short hand for, and synonymous with, 'carbon dioxide (CO_2) emissions'.

just a small number of elements from UK and European Union (EU) best practice (see box 1.1) and introduce them into the UK planning and transport system with the necessary funding, decisions on transport infrastructure, business and governmental delivery systems and supporting fiscal and taxation regimes then the UK would be well on the way towards the zero carbon transport target over the next forty years.

1.1 AIM OF THE STUDY

The aim of this study is to quantify and assess the contributions that different CO_2 emission reduction measures can make in assisting the UK to move towards a zero carbon transport sector by 2050. Existing published reports, academic papers and official statistical data have been used to estimate CO_2 emissions from the transport sector in 2050 according to two scenarios: a Business-as-usual (BAU) scenario and a Maximum Impact (MI) Scenario in which all feasible interventions for achieving a 'near zero carbon' UK transport sector are applied. Much of the baseline and trend data are derived from other modelling initiatives such as the DfT's National Transport Model (NTM). Therefore, the BAU Scenario estimates are necessarily constrained by these assumptions (e.g. the NTM's future fuel price increase assumptions).

Transport-related CO_2 emissions are not restricted to vehicle exhaust emissions. Emissions of CO_2 are also produced by the energy consumed in the extraction, processing and distribution of fuels (i.e. 'well-to-wheel' emissions) as well as 'embodied energy' CO_2 emissions from the manufacture of vehicles, and construction of roads and other components of the transport infrastructure. However, it is beyond the scope of this study to include 'embodied energy' and 'well-to-wheel' GHG emissions. The study focuses solely on 'tailpipe' CO_2 emissions. It should be noted that in the future, the carbon intensity of fossil fuels (the 'well-to-wheel' emissions) is likely to increase as fossil fuels become more difficult to find and extract. An exception to this general approach applies when the role of plug-in electric vehicles is considered in the MI Scenario as clearly the concept of 'tailpipe emissions' becomes meaningless for these vehicles. Also, it is beyond the scope of this study to enter into cost-benefit analyses of the various CO_2 emissions reduction measures which have been included in the MI Scenario.

Box 1.1: Towards a zero carbon transport system

If the UK is to move towards a zero carbon transport system then every urban area with a population of more than 50,000 would develop and implement a:

- Cycle network similar to Copenhagen (Denmark), Groningen (The Netherlands) and Muenster (Germany) where each day 30 per cent of all trips are undertaken by bike compared the two per cent in large British cities.
- Travel plans similar to the one adopted by York University (UK) where 25 per cent of all trips to the site are by bicycle. This would apply to all major businesses which have over 500 employees.
- Integrated public transport and cycling system similar to that in Basel (Switzerland) which has achieved a modal split of 17 per cent for car use (i.e. only 17 per cent of all trips made every day are by car and 83 per cent by foot, bike and public transport).
- Urban logistics similar to those used in German cities which reduce the number of lorries in urban areas by 60 per cent. This is already in place at the Broadmeads shopping centre in Bristol and Heathrow Airport.

Every rural area in the UK would develop and implement:

- A Swiss style rural transport solution with highly connected and integrated public transport services (bus and rail) to small villages, seven days a week including holidays.
- The German style "citizen's bus" adopted in North Rhine Westphalia to serve rural areas not well connected to the already high quality public transport services available in rural area.
- The Friesland (Netherlands) fully integrated rural public transport network which relates directly to local population sizes.
- The switch to local management and control of some rural railway lines e.g. the Durener Kreisbahn and Regiobahn in North Rhine Westphalia (Germany) which has produced dramatic increases in passenger numbers.
- High quality fully segregated cycle paths besides main roads connecting villages and regional centres in Denmark.
- Anytime, anywhere demand-responsive transport in Limburg and North Brabant, the Netherlands.

2 A VISION OF A ZERO CARBON TRANSPORT FUTURE

Visioning desirable futures has been examined in studies such as The Great Transitions (Raskin *et al.*, 2002), which envisions sustainable and desirable futures emerging from new values, a revised model of development and the active engagement of civil society. Also, the OECD's Environmentally Sustainable Transport (EST) project examines how desirable futures can be attained. It demonstrates what strategies might look like to achieve EST, as well as considering their economic, environmental and social impacts. The present study provides a vision of a desirable future for one important sector of the economy. It provides an examination of how we might deliver the desirable future of a zero carbon transport system in the UK by 2050.

2.1 THE VISION

A zero carbon transport future will provide better access for more people to more things than is currently the case. Traffic congestion and time wasted stuck in jams will be a thing of the past and time currently wasted on commuter trips will be spent on rewarding and enriching activities. By 2050 all urban and rural areas will have significantly enhanced public transport and cycling facilities bringing high quality and low-cost transport choices within everyone's reach. Those who opt not to use a car will save thousands of pounds a year by avoiding the fixed and variable costs of car ownership and use, and will also avoid the uncertainties and potential disruption of oil price shocks as the world adjusts to shortages of supply and increased demand from developing countries and the rapidly growing economies of China and India. Individuals and families will have much improved air quality, reduced noise and stress from traffic and much improved community life stimulated by reduced levels of motorised traffic and reduced traffic on streets and through villages.

The shift to bike, foot and public transport will increase the spending of people in their local areas. This will result in a local renaissance with shops and newly created jobs in local communities serving the increased level of local spending that previously leaked out to global oil and car-making sectors of the economy. Those that have given up individual car ownership will benefit by an average of £4,000 per annum which will be available to spend on local goods and services giving a further boost to local economies (AA, 2010).

The passenger car will still exist and be used by those who have limited transport alternatives but fuel prices will rise to cover the full costs of supporting motorisation (the polluter pays principle) and parking will be recognised as a valuable asset that must be charged for at market rates. Speeds will be limited to a maximum of 20mph/30kph in all residential areas and through villages to support the rapid take up of walking and cycling and to create high quality living environments. Speeds on motorways and dual carriageways will be limited to 60mph to reduce CO_2 emissions and to encourage the take-up of eco-driving techniques. Cars will be either plug-in electric vehicles (PEVs) or powered by hydrogen fuel cells. The electricity required, both for re-charging the PEVs and for producing the hydrogen, will come from a decarbonised electricity supply system largely based on renewable energy and micro-generation in all businesses, homes, schools and health care facilities.

Businesses of all kinds will find ways to introduce flexible working, videoconferencing, more family and child friendly working practices and will actively promote the end of the long commute. Links between businesses, businesses and customers and workers at home or in local "area offices" will be facilitated by a large number of electronic methods. Deliveries of raw materials and goods to manufacturing sites will exploit the advantages of canals, inland waterways, estuaries and the UK's excellent network of 300 ports as well as making better use of the rail network e.g. as in the German "Rollende Landstrasse" system where whole lorries go on trains for sections of their journeys. Lorries will operate in ways that avoid cities, avoid long trunk-haul routes on motorways and are powered by alternatives to diesel that significantly reduce CO_2 emissions.

Tourism in 2050 will still be important but a combination of higher fares and air traffic delays will reduce the demand for flying and increase the number of holidays taken in the UK. There is evidence that holidays involving personal development, child-centred activities, outdoor activities and artistic activities are already on the increase and this process will accelerate putting more emphasis on what is done rather than on where it is done. Holidays in the EU will still be popular and will be accessible by much improved train services, including overnight trains, which provide a journey experience that is also part of the holiday and will steadily supplant air travel.

The aviation industry will still be important but no larger than in 2005 and airlines and companies owning airports will be far more profitable and successful as they diversify into all kinds of communication and mobility activities and services. There will be significant job gains across all sectors of the aviation, rail and bus industries.

The health of all citizens will improve in a low carbon transport future. There will be more lively local economies making jobs available in the community. There will be more social interaction giving everyone the health generating social context of living in a supportive community. There will be less noise and air pollution with attendant health benefits and much more physical activity contributing to a reduction in rates of obesity and heart disease.

The demands on public finance and spending will be reduced. There will be no need for new roads, bypasses and motorway widening at current prices. A healthier and more supportive population and community will reduce National Health Service (NHS) costs e.g. the predicted £50 billion per annum costs of obesity by 2050 (Foresight, 2007).

Local communities will be far more resilient in the sense that a larger proportion of jobs, food and other items of consumption will be sourced locally. This will reduce the risks of disruption that are likely to be associated with long distance sourcing in the future such as oil price hikes, interruption in supply as transport infrastructure succumbs to damage from extreme weather events and shortfalls in fuel availability.

Cities will change so that there is far more green space and woodland and a higher number of homes and employment opportunities than is currently the case in low density developments. Land for eco-efficient, car-free housing can be released from car parks that will now be surplus to requirements and the projected need for new homes therefore, can be met without taking away valuable rural land that will be needed for increased food production.

Cities will be far more friendly and supportive of children and the elderly with calmer environments, reduced traffic and increased feelings of confidence and security. The shift away from the car will increase the amount of walking and cycling and the degree of mutual, friendly "surveillance" making everyone feel safer. Children will rediscover the delights of independent mobility, the joys of getting to and from school and visiting friends and local swimming pools under their own steam. The elderly will find it much easier to cross roads, hold conversations on the street and engage with neighbours in ways that ends social isolation and its related health damaging consequences

Urban and rural residents alike will be happier in this zero carbon future. Layard (2006) has shown that happiness can be measured and that the objective of public policy is to increase the amount of happiness and/or the number of people reporting that they are happy. He shows that in many societies happiness has declined as indices of material welfare have gone up raising the intriguing possibility that a society or culture moving at a slightly slower pace with more opportunities for social, interaction and less noise and pollution might be warmly welcomed. A low carbon future delivers such a society.

A much improved local environmental quality linked to higher levels of integration with local food production, heightened involvement with neighbours and community activities and a greater feeling of security and comfort from a more resilient society will all contribute to increased happiness and to higher levels of social cohesion.

The transformation of society from having a rather one-dimensional emphasis on economic growth to one based on community growth, increased happiness, reduced pollution, improved health and the creation of jobs that are far more evenly distributed and resilient to potential shocks, will bring enormous benefits to all. Examples of community growth would include more social interaction as people meet each other in a much more pleasant public realm as they walk and cycle. A decline in traffic levels is associated with more friends and acquaintances at the level of an individual street (Appleyard, 1981) and more friends and acquaintances are associated with higher self-reported happiness.

This transformed society, combined with increases in transport choice and improvement in safety and security, all point to the absence of "losers" in the zero carbon world. Society will be much fairer with much improved access for everyone, much fewer demands on those with constrained budgets through the elimination of the need to own a car as a default option and the availability of many more transport choices.

2.2 MOVING TOWARDS A ZERO CARBON TRANSPORT FUTURE

There are two key future challenges which necessitate the need to reduce fossil fuel use by the transport system down to an absolute minimum. Firstly, transport is extremely dependent on oil and there is a likelihood that there will not be much oil left in 2050, compared with today. Gilbert and Perl (2008) point out that we have to embrace a new transport revolution based on "moving people and freight without oil". Secondly, climate change raises important issues around transforming transport systems so that they play a full and proportionate role in mitigating GHG emissions as well as becoming less vulnerable to the damaging consequences of climate change in the future. The climate change problem also has a strong ethical dimension through its differentially serious impact on the poor and the vulnerable. Transport developments based on year-on-year growth in GHG emissions actively contribute to the generation of unethical outcomes. Transport is also the fastest growing source of GHG emissions and shows little sign of seriously addressing the need for carbon reduction

Figure 2.1 presents the actual and estimated consumption and production of petroleum liquids for the period 1990 to 2030 based on International Energy Agency data (Gilbert and Perl, 2008). By 2030 production will be considerably less than forecast demand. It would therefore be prudent to reduce the size of this gap and implement a low carbon transport system. The decline of oil availability and the rise in global demand is referred to as the "peak oil" problem and, whilst there is a debate about the exact timing of the tipping point when oil availability declines (and the rate of that decline), there is a considerable measure of

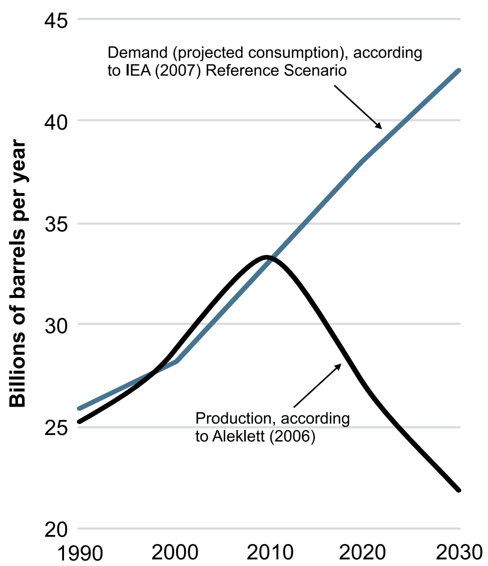


Figure 2.1: Actual and estimated consumption and production of petroleum liquids, 1990-2030
Source: Gilbert and Perl (2008)

agreement that the phenomenon itself is real and has to be dealt with.

The peak oil problem is acknowledged by the oil industry, for example, in the Shell (2008) energy scenarios to 2050. Administrations as widely spread as the Swedish government and the city of San Francisco have examined the peak oil issue, found it to be real and designed policies to cope with the lack of availability of cheap oil. The San Francisco report on peak oil (San Francisco Peak Oil Preparedness Task Force, 2009) has adopted many of the recommendations that are included in this report and these are now under discussion by the city and the State of California. At the national level Sweden has committed to an oil free policy by 2020 (Commission on Oil Independence, 2006) which is much sooner than the present study's target year of 2050. Transport figures strongly in their vision and the policy document makes seven recommendations relating to this sector:

- Encourage a more energy efficient fleet of cars.
- Improve the efficiency of goods transport and reduce its share on the roads.
- Increase the share of fuels from agriculture and forestry.
- Make public transport cheaper and more attractive.
- Strengthen the role of the train.
- Promote alternatives to air travel especially information and communication technologies (ICT) and high speed rail.
- Use ICT and flexible working to encourage different forms of working that reduce work commuter trips.

In terms of climate change the urgency of dealing with GHG emissions is recognised by the UK government's commitment to reduce these by 80 per cent by 2050. However, this target is considered not to go far enough and a generalised target does not deal with the importance of transport and the potential of transport emissions to de-rail an overall target. The Tällberg Declaration sets a more demanding target saying that atmospheric levels of CO_2 must be brought down to 350 parts per million (ppm). This cannot be done unless transport is restructured to play its full proportionate role in a wider community of interest delivering carbon reduction.

The Tällberg declaration sets out the case for an urgent return to 350 ppm from the current 387 ppm. The ethics are clear and the morality is compelling. Significant changes in the current way of life are necessary if the aim for less than 350 ppm within a century is to be achieved. Future generations will benefit for the efforts made today (Ekman *et al.*, 2008). Moving towards a zero carbon transport future makes a significant contribution to those objectives.

Electric car - Lotus Elise - © Harry nl/flickr

3 BUSINESS-AS-USUAL SCENARIO

In line with other major scenario exercises the BAU Scenario can be seen as an estimate of a particular end-state in a chosen year based on the continuation of present trends and policies. The World Business Council on Sustainable Development (WBCSD) (2004) defines BAU as the continuation of present trends which implies:

- "mainstream" projects of economic and population growth are realised;
- the general trajectory of technological development and its incorporation into transportation systems and services continues much as it has over the past several decades; and
- policies currently in place continue to be implemented but no major new initiatives are launched.

This chapter outlines the methodology and assumptions in developing the BAU Scenario to calculate CO_2 emissions from the UK transport sector to 2050. The BAU is one of two scenarios examined here to explore future scenarios for a zero carbon transport sector in the UK. The base year for each mode may differ due to the availability of studies and projects using different data.

3.1 ROAD TRANSPORT

Figure 3.1 summarises the methodology used to estimate the BAU Scenario CO_2 emissions for road transport. The CO_2 emissions were estimated by major vehicle category as used in the National Atmospheric Emissions Inventory NETCEN UK Fleet Composition Projections (NETCEN, 2003) but with the addition of motorcycles:

- petrol car
- diesel car
- petrol Light Duty Vehicle (LDVs)
- diesel LDV
- rigid Heavy Duty Vehicles (HDVs)
- artic HGVs
- buses
- motorcycles.

These categories were further subdivided by Euro emission standard (e.g. for cars: Pre-Euro I, Euro I, Euro II, Euro III, Euro IV) and road type (urban, rural and motorway).

Vehicle kilometres travelled (VKT) for the base year (2003) for the major vehicle categories (cars, LDVs, HGVs, buses and motorcycles) were taken from the DfT Traffic Statistics Great Britain (TSGB) (DfT, 2008b). These distances travelled were further subdivided by fuel type and Euro standard (according to NETCEN, 2003) and road category (DfT, 2004). For motorcycles, CO_2 emissions were then calculated from the total fuel consumption for 2003 reported by DfT (2008c) multiplied by an emission factor of 3,180 g CO_2 kg-1 fuel. For all other vehicle categories, speed dependent CO_2 (ultimate) emission factors (in g/km) for Euro standards up to Euro II were derived from NETCEN (2003) and, for post-Euro II, from DfT (2005).

For the BAU Scenarios projections to 2010, 2015 and 2025, the percentage change (over baseline 2003 levels) of VKT by major vehicle category for England from the DfT's National Transport Model (NTM) were used (presented in DfT, 2008d) and it was assumed these applied to the UK as a whole. Projected changes in distribution of these kilometres travelled between road type (rural, urban or motorway) were derived from the percentage changes given in the DfT's Road Transport Forecasts 2008 (DfT, 2008e).

BAU assumptions

Transport measures incorporated into the NTM forecasts include graduated vehicle excise duty (VED), company car tax (CCT), fuel duty, the Renewable Transport Fuels Obligation (RTFO), the voluntary agreements on new car fuel economy (VAs) (DfT, 2008e). The bulk of these (VED, CCT, fuel duty

2 The validity of some of these assumptions, especially when applied to our 2050 BAU Scenario, may be open to question. In particular, it might be argued that these fuel cost projections are unrealistically low, especially given that 'peak oil' production may have already been exceeded. However, the methodology used in this study has been to produce an analysis based on existing published forecasts rather than undertaking new modelling.

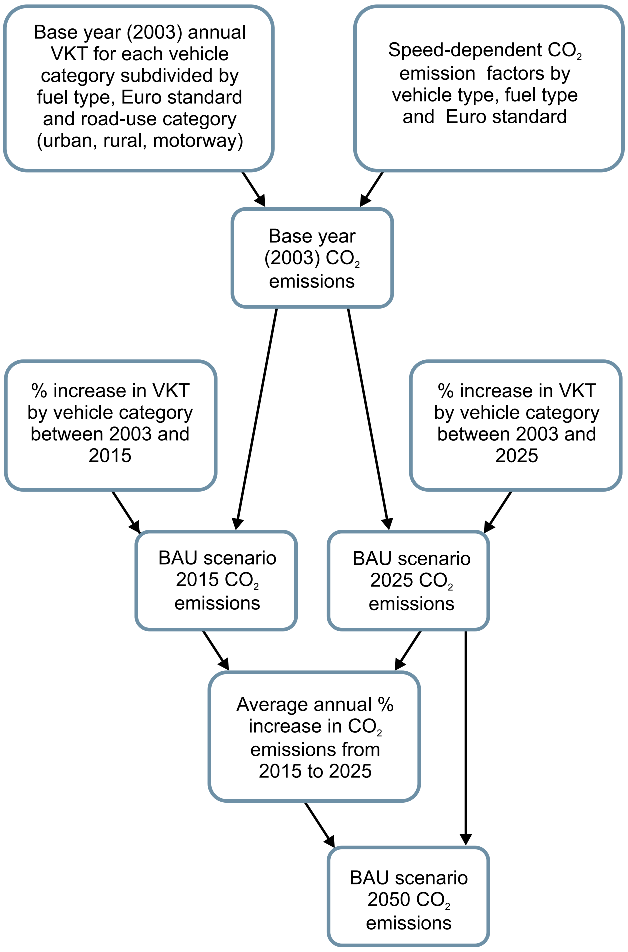


Figure 3.1: Flow chart of methodology used for BAU Scenario CO_2 estimates for road transport

and the VAs) all work to reduce road transport CO_2 by encouraging improvements in fuel economy. The other measure aimed at cutting CO_2 emissions is the RTFO which places an obligation on fuel suppliers to ensure that a certain percentage of their aggregate sales are made up of biofuels.

The key drivers of traffic growth in the NTM are changes in income, employment, population and falling running or travel costs, as a result of fuel economy improvements. Unfortunately, detailed traffic growth forecasts (by vehicle and road type) are only provided for England and Wales and only up to 2025. It was therefore assumed that rates of change for England also apply to the UK as whole and that the annual percentage increases in traffic for each vehicle category between 2015 and 2025 continue unchanged to 2050. The NTM assumptions for motorcycles and LPG-fuelled vehicles are not stated and are therefore kept constant in the BAU Scenario (2015, 2025 and 2050). The changes in traffic volume adopted in the BAU Scenario are taken from DfT (2008d) and include the assumptions used within the NTM (see box 3.1). For the 2050 BAU Scenario, annual average rates of change in traffic volume between 2015 and 2025 were assumed to continue unchanged up to 2050. Thus, continuation of the above assumptions up to 2050 is implicit in the BAU projections.

Fuel Economy - Improved fuel economy lowers CO_2 emissions. Following the EU negotiations on compulsory targets for new car emissions, the NTM assumes average new car CO_2 emissions reach 130 g/km by 2015 and assumes that improvements in new car fuel economy will continue at an average rate for the recent past of 1.15 per cent per annum for gasoline and 1.35 per cent for diesel through to 2025 (DfT, 2008a). It has been assumed these same rates of improvement apply to LDVs but from an EU agreed target of 160 g/km by 2015 whilst for HGVs the improvement is only 0.8 per cent per annum (DfT, 2008a). For the BAU 2050 scenario, it is assumed the same annual rate of improvement in fuel economy is maintained.

Renewable Transport Fuels Obligation (RTFO) - From April 2008, the RTFO places an obligation on fuel suppliers to ensure that a specified percentage of their aggregate sales are made up of biofuels. The specified amount was 2.56 per cent in 2008/09 and rises each year to a maximum of 5.26 per cent by 2013/14 (Renewable Fuels Agency, 2008).

In addition, the European Commission's (EC) Renewable Energy Directive (RED), which came into force in June 2009, obliges all member states to ensure that 10 per cent of final consumption of energy in all forms of transport is renewable by 2020. This includes renewable energy used to produce electricity used in electric vehicles, including trains, weighted at 2.5 x the energy content of the renewable energy input. Thus the actual per cent biofuel required by 2020 under this directive depends on the extent of electricity supply decarbonisation and, to meet the target, there may need to be an increase in biofuel use above five per cent by 2020. However, for the purposes of the BAU Scenario the NTM assumption of a five per cent biofuel component of all road fuel in 2025 and 2050 has been adopted. Following the NTM methodology, the impact of the RTFO is calculated on an IPPC inventory basis. That is, road transport hydrocarbon fuel sales will fall by five per cent and so total CO_2 emissions will also reduce by five per cent compared with what they would have been. In reality, biofuels production, processing and transport will add to CO_2 (and other GHGs) emissions but these are not included. The actual CO_2 emissions saved depends on the source and type of biofuel and can be estimated by use of for example, the Renewable Fuels Agency carbon calculator.[3]

Box 3.1: NTM Assumptions on population, demographic change, economic growth and fuel costs for road transport

- Population is assumed to rise by 14.5 per cent between 2003 and 2025.
- The over 65 population is forecast to grow from around 20 per cent of the population in 2000 to over 25 per cent by 2025.
- Employment is projected to increase by around 10 per cent over the same period.
- Economic trend growth is assumed to be around 2.5 per cent per annum over the forecast period with Gross Domestic Product (GDP) per capita growing by 2.1 per cent per annum;
- Fuel costs: central projection for 2025 of $72.5 per barrel in 2007 prices. (The projections also include scenarios with a 'high' being $100 and 'low' $45.)[2]
- Constant real prices of cars and non-fuel operating costs.

BAU CO_2 emissions estimates for road transport

Table 3.1 presents CO_2 emissions estimates for UK road transport in the baseline year (2003) and the scenario years (2015, 2025 and 2050). The baseline year emissions of 116 Mt CO_2 compares with the official National Atmospheric Emissions Inventory (NAEI) value of 118 Mt for 2003 (reported in DfT, 2008b). The reasons for the small difference may relate to the use of different CO_2 emission factors or different average speeds assumed for urban, rural and motorway driving. The BAU 2050 scenario estimate of 110 Mt CO_2 is 5.2 per cent lower than the baseline estimate for 2003 (see table 3.1). This is in spite of the increase in traffic projected by 2050 (e.g. 76 per cent increase in passenger car VKT) and is largely a result of the continuous year-on-year improvement in average fuel economy assumed in the BAU Scenario.

3.2 RAIL TRANSPORT

For CO_2 emissions from rail transport, data on diesel and electricity consumed by both passenger and freight rail transport published by Association of Train Operating Companies (ATOC, 2007) were used for a 2006/07 baseline. Due to differences between the ATOC and the DfT's Carbon Pathways Analysis baseline emissions estimates (DfT, 2008a), especially for rail freight, it was decided to use the more detailed ATOC data. Emissions were then estimated according to the percentage increases in CO_2 given by DfT's 'Business as planned scenario', minimum up-take projections (see table 3.2). BAU projections to 2025 and 2050 (see table 3.3) assume a continuation of the average annual percentage increases in CO_2 emissions given in the DfT Carbon Pathways Analysis for the period 2020 to 2022 (i.e. 0.39, 0.65 and 0.85 per cent for diesel passenger, electric passenger and diesel freight respectively).

The DfT's 'Business as planned scenario' takes account of CO_2 saving initiatives that are either planned or that are expected to take place. Projections are expressed as a range bounded by maximum and minimum anticipated levels of saving. The BAU

3 See: www.renewablefuelsagency.org/carboncalculator.cfm

Table 3.1: Business-as-usual baseline (2003) and scenario (2015, 2025, 2050) CO_2 emissions estimates for road transport

Vehicle Type	Baseline (2003) CO_2 emissions (Mt)	CO_2 emissions in 2015 (Mt)	CO_2 emissions in 2025 (Mt)	CO_2 emissions in 2050 (Mt)	Annual % increase in VKT from 2015 to 2025, and applied to 2025 to 2050	Total % change in CO_2 emissions by 2050 over 2003 emissions
Passenger cars	66.4	58.1	57.9	59.6	1.23%	-10.2
Light Duty Vehicles	14.0	14.7	15.5	18.8	2.13%	34.4
Rigid HGVs	9.9	9.1	8.5	7.6	0.37%	-22.7
Artic HGVs	20.8	18.4	18.9	20.6	1.17%	-0.8
Buses and coaches	4.3	3.6	3.2	2.6	0.00%	-38.6
Motorcycles	0.5	0.5	0.5	0.5	0.00%	-5.0
LPG vehicles	0.3	0.3	0.3	0.3	0.00%	0.0
Total:	**116.2**	**104.6**	**104.8**	**110.2**		**-5.2**

projections are based on the minimum values (see box 3.2).

BAU CO_2 emissions estimates for rail transport

Table 3.3 presents BAU emissions estimates for UK rail transport in the baseline year (2006/7) and the scenario years (2015, 2025 and 2050). The baseline year emissions are 3.44 Mt. For the BAU 2050 scenario, the estimate is 34.3 per cent higher than CO_2 emissions in 2006/7).

3.3 AVIATION

The DfT's CO_2 passenger demand and CO_2 forecasts were used to develop the BAU Scenario for aviation (DfT, 2009b). The DfT forecasts passenger demand and CO_2 emissions over two time-periods (2005–2030 and 2030–2050) and use detailed models related to passenger airport choice and projections of economic growth, trade, exchange rates and fares, for the period 2005-2030. It then uses a 'central case' trend in passenger demand and fuel efficiency as well as available airport capacity to project CO_2 emissions for 2050.

In general, the DfT model forecasts the number air transport movements (ATMs) at each airport depending on available capacity which are then combined with projections of average flight distance (depending on type of flight e.g. long-haul, short-haul, domestic etc.) to obtain seat-kilometre projections by airport. These are then combined with a projection of the fleet fuel efficiency taking into account different aircraft type and configurations. There are a number of assumptions made within the DfT forecasts. Box 3.3 highlights the key assumptions in the BAU Scenario.

Under the assumption that airport capacity is not constrained, the DfT forcast that air travel demand at UK airports will grow strongly (under their central case scenario), from 241 million passengers per annum (mppa) in 2007 to 465 mppa in 2030 (within the range 415-500 mppa). This will lead to a growth in UK aviation CO_2 emissions (covering both domestic and international aviation) from 37.5 Mt CO_2 in 2005 to 58.4 Mt CO_2 in 2030, within the range 51.8 Mt CO_2 to 61.6 Mt CO_2. After 2030, the growth in aviation emissions is projected to slow, partly due to market maturity, limits to improvements in aircraft efficiency and capacity constraints slowing demand growth. By 2050 aviation emissions are projected to have stabilised, at 59.9 Mt CO_2 within the range 53.0 Mt CO_2 to 65.0 Mt CO_2 (see table 3.4).

These DfT figures have been used in the BAU Scenario however, it is important to mention that aviation emissions contribute more to climate change than do

Box 3.2: Assumptions of the DfT's 'Business as planned scenario' for rail transport

- Rail growth occurs in line with the High Level Output specification (HLOS)/Freight Route Utilisation Strategy estimates and is accommodated through additional trains to maintain crowding at constant levels and running additional freight services;
- the electricity generating mix becomes cleaner over time based on the Department for Business, Enterprise and Regulatory Reform (BERR) projections;
- regenerative braking is in place across the electrified network;
- new trains coming into service reflect an increased emphasis on energy efficiency compared with recent designs;
- rail uses a five per cent biofuel mix from 2010; and
- introduction of a range of energy saving initiatives e.g.: driver training, improved idling and stabling policies.

Table 3.2: UK CO_2 emissions (tonnes, '000) under a 'business as planned' maximum and minimum take up of measures. source: dft

Year	2008		2014		2020		2022	
	Max	Min	Max	Min	Max	Min	Max	Min
Passenger Rail	2,696	2,704	2,730	2,895	2,988	3,136	3,018	3,168
Of which –Electric trains	1,425	1,432	1,450	1,540	1,584	1,665	1,596	1,678
Diesel trains	1,271	1,273	1,280	1,355	1,404	1,472	1,422	1,491
Freight rail (all diesel)	644	644	569	600	607	640	618	651
Total rail:	**3,340**	**3,349**	**3,298**	**3,495**	**3,594**	**3,776**	**3,636**	**3,819**

Table 3.3: Business-as-usual baseline (2006/7) and scenario (2025 and 2050) CO_2 emissions for rail transport

Vehicle Type	Baseline (2006/7) CO_2 emissions (Mt)	CO_2 emissions in 2022 (Mt)	CO_2 emissions in 2025 (Mt)	CO_2 emissions in 2050 (Mt)	Annual % increase in CO_2 emissions used for 2025 and 2050 estimates	Total % change in CO_2 emissions by 2050 over 2006/7 emissions
Diesel passenger rail	**1.24**	**1.45**	**1.47**	**1.62**	**0.39%**	**30.6**
Diesel freigh rail	**0.76**	**0.77**	**0.49**	**0.98**	**0.86%**	**28.5**
Electric passenger rail	**1.44**	**1.69**	**1.73**	**2.03**	**0.65%**	**40.5**
Electric freight rail	**0.0**	**0.0**	**0.0**	**0.0**	**0.0%**	
Total:	**3.44**	**3.91**	**3.98**	**4.62**		**34.3**

Box 3.3: Assumptions of the DfT BAU Scenario for aviation

Financial

Oil Price: under the BAU there a number of financial assumptions which affect ticket price. Regarding fuel cost, there is an assumption about the relationship between aviation fuel consumption and oil prices. The price of oil is assumed to move in line with the BERR central oil price projection (2007 prices \$73 - \$68 per barrel in 2015) however in 2008 oil prices were around \$100 per barrel. This could be a continuing trend if the current economic situation continues. Also in the future the price of oil may be much higher as stocks are depleted and extraction gets harder. This will affect demand as the cost could be passed on to the passenger through higher ticket prices. DfT predictions show that using a slightly higher 2030 oil price of just \$80 a barrel in its forecasts would lower demand by 15 million passengers a year. Higher oil prices could even lead to air services ceasing as the cost of running air fleets becomes too expensive for some airlines.

Air Passenger Duty/Carbon cost: the BAU assumes that Air Passenger Duty (APD) will increase in 2009 and 2010 and will continue in real terms thereafter. An Carbon Tax may also be applied in addition to the APD. Whilst this tax has only been mooted at the moment it is probable that ticket prices will include a component attributable to the carbon impact of flying. This tax will also reflect both direct carbon emissions and other warming-effects of non-carbon emissions into the atmosphere.

European Emission Trading Scheme (EU ETS) starting in 2012 aviation will be included in the EU Emission Trading Scheme. This means that the industry will be allocated a certain number of carbon credits based on average emission figures for (2004-2006) otherwise know as the 'cap'. Under the operating rules of the ETS, if passenger numbers (air traffic movements) increase then the aviation industry would either have to reduce emissions through improvement in efficiency (engine technology, airspace management etc.) or purchase carbon credits from other airline companies if the ETS is operating under a 'closed' system or with companies in other sectors if operating in an 'open' system. If they have to buy more credits then this cost could be passed onto the passengers. If the price per tonne of carbon rises significantly because of the need to buy the additional credits then the ticket price becomes too expensive for passengers and this leads to a reduction in demand.

Exchange rate: one further factor affecting demand for air travel, especially in leisure and tourism markets, is fluctuating exchange rates. In terms of European travel, there might be a shift towards more domestic vacations. A shift in people's decision to visit long haul destinations to take advantage of better exchange rates may also occur. However, the DfT methodology assumes this remains constant over the period.

Technology

Engine Efficiency: under the BAU there will be an overall improvement in the fuel efficiency of the aircraft fleet. More efficient aircraft types will replace older aircraft and those not replaced will be retro-fitted with new technology. The model assumes the industry will make technological gains consistent with the manufacturers' ACARE target for fuel efficiency such that a proportion of aircraft coming into service in 2020 are 40 per cent more fuel efficient than those in service in 2000. These targets are voluntary and therefore there is no guarantee that they will be attained. Also, there is a long product life-cycle involved in designing and implementing new technology in aviation. Under more stringent economic conditions existing fleets may be used for longer. Fuel efficiency improvements within both the BAU and the MI Scenarios do not include biofuels/hydrogen as their uptake is too uncertain.

Behavioural: under the BAU it is not foreseen that there will be a significant shift away from air travel through direct behaviour change. The air-ticket price will be the deciding factor on which most people choose to fly. However, the cost of businesses travel will have little effect on demand.

emissions from other transport modes due to non-CO_2 warming effects. An 'uplift factor' or multiplier is often applied to CO_2 from aviation to account for the fact the aircraft emit other greenhouse gases into the stratosphere, mainly nitrogen oxide and water vapour which have the potential for causing global warming (there is also the potential for some cooling as well, but to a lesser extent). The value used for the multiplier is based on the Radiative Forcing Index (RFI) which is the ratio of total radiative forcing (RF) of all GHGs to RF from CO_2 emissions alone (IPCC, 1999). The extent to which these contribute to climate change is much debated and a range of values is given in the literature, typically between one and four. For example, the IPCC report (1999) Aviation and the Global Atmosphere estimated it to be 2.7 (with an uncertainty of ± 1.5). However, following work by Sausen *et al.* (2006), this has been revised to take into account the uncertainty in

Table 3.4: DfT Business-as-usual baseline (2005) and scenario (2030 and 2050) CO_2 emissions estimates for aviation

Scenario	Baseline (2005) CO_2 emissions (Mt)	CO_2 emissions in 2030 (Mt)	CO_2 emissions in 2050 (Mt)	Total % increase by 2050 over 2005 emissions
Low	37.5	51.8	53	41%
Central	37.5	58.4	59.9	60%
High	37.5	61.6	65	73%

Source: DfT (2009)

the global warming effect from cirrus clouds and the DfT report (DfT, 2009b) uses an uplift factor of 1.9. Also, the Stockholm Environment Institute (SEI, 2009) suggest that a multiplier of "at least 2" is required to capture aviation's climate change impact. Therefore, in light of the uplift factor used by DfT and that suggested by SEI, a reasonable estimate of the full total CO_2 emissions including non-CO_2 warming impacts from UK aviation would be effectively doubled (74 Mt CO_2eq) in 2005.[4]

No attempt has been made to develop an alternative model for aviation. The BAU Scenario assumptions are designed to be in agreement with those of the DfT. However, Stanton and Ackerman (2008) have commented on the assumptions used by the DfT and suggest that the net economic benefits that can be gained from the increase in passenger numbers following the introduction of a third runway at Heathrow are over-inflated. A similar view is adopted in this study. The case made by government for the growth of aviation, or its role in supporting the national economy or its presumed benefits in terms of jobs created or international competitiveness is not accepted. These are wider issues than estimating the end-point for the growth of aviation on BAU assumptions and the DfT view of this end point is accepted.

BAU CO_2 emissions estimates for aviation

Table 3.4 presents the DfT's BAU emissions estimates for UK aviation in the baseline year (2005) and the scenario years (2030 and 2050). The baseline year (2005) emissions are 37.5 Mt. For our BAU 2050 scenario, we have chosen the central DfT estimate of 59.9 Mt CO_2 which is 60 per cent higher than CO_2 emissions for aviation in 2005.

4 For a more detailed review of the use of the 'uplift factor' see http://www.CO$_2$offsetresearch.org/aviation/index.html

3.4 SHIPPING

Shipping is an international activity responsible for the mass movement of cargo and freight over long distances. It is largely controlled by the International Maritime Organisation (IMO) which has the responsibility for controlling and regulating air pollution from shipping under the MARPOL ("MARine POLlution") convention 73/78. One hundred and fifty countries are signatories to the convention which covers 98.7 per cent of all shipping.

An IMO GHG Study found that in 1996, shipping accounted for 1.8 per cent of world's total CO_2 emissions. However, a more recent estimate undertaken in 2007 put this figure at 2.7 per cent or 843 Mt CO_2. This difference is explained by improvements in a more detailed methodology which takes into account shipping activity rates and fuel consumption. The study also forecasted future global emissions using IPCC scenarios and by 2050, in the absence of any regulations, emissions were predicted to rise by 2.4 to 3.0 times (MEPC, 2008). Emissions in 2050 could be between 2.4 and 3.6 Gt CO_2 representing 10 - 15 per cent of global CO_2 emissions according to the UK Committee on Climate Change (CCC) scenarios.

Global emissions from shipping are greater than those from aviation and global growth rates are reflected in UK growth rates. Since the early 1990s, UK port container traffic has increased from approximately 3.5 million twenty-foot equivalent units (TEU) in 1990 to nearly nine million TEU in 2007 (DfT, 2007). Such levels of growth are clearly at odds with other emission reduction targets.

The calculation of emissions from shipping is relatively easy where energy consumption is directly proportional to the quantity of fuel that is used which in turn is proportional to CO_2 emissions. The allocation of global shipping emissions to the UK is problematic due to a number of different methodologies that could be used. This is partly due to ship ownership and operational differences but also governance overseeing legislation and emission controls. With regard to adjusting UK GHG targets the CCC states: "It is not clear what methodology for estimating the UK's international shipping emissions should be used as the basis for such an adjustment." (CCC, p 329). The four main emission allocation options are those based on:

- bunkers sales/bunker consumption;
- freight tonne kilometres;
- country of departure/destination;
- zone of emissions within radius of coastline (12 miles/200 miles).

Shipping has been left out of the Kyoto Protocol due to the difficulties of estimating emissions and the methodology by which they are assigned to different nations. Under the United Nations Framework Convention on Climate Change (UNFCCC), countries are not required to produce a GHG emissions inventory for shipping as they do for other sectors. However, they do have to provide an inventory for fuel bunker sales which is reported as a footnote. This reported figure does not give an accurate picture of the fuel consumed by UK ship operators. Since 1998 there has been a decrease of 23 per cent in emissions from UK shipping bunkers, although there was a 1.5 per cent increase from 2006 to 2007. This is related to the fact that UK operators purchase most of their fuel outside the UK either because it is cheaper or for operational reasons. When ships stop en-route to refuel in other countries, these bunker fuel sales, and associated CO_2 emissions, are then attributable to the host country where fuel is uploaded not to the country where the ship is registered or to the country where the ships cargo is off-loaded. The other confounding issue is the use of flags of convenience or 'flagging out' of ship fleets. This practice switches the ship's registration to another country, with the purpose of minimising operational costs as well as a way to avoid regulatory requirements. The implication is that it is difficult to identify who is the legal authority required to regulate for pollution or environmental damage. Furthermore, if emissions are allocated on the basis of freight tonnes kilometres then there is a problem as the vessel may stop-off at a number of ports en-route dropping-off/picking up cargo. It is difficult to calculate the emissions on freight moved and to keep track of who should be responsible on the basis of territory/ship owner for the emissions along each segment of the journey.

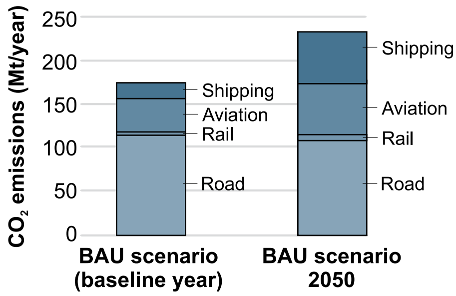


Figure 3.2: Baseline and BAU 2050 scenario estimates of UK transport CO_2 emissions used for this study (as Mt CO_2 yr^{-1})

A wide range of published estimates for current baseline levels of CO_2 emissions exist. Future projections are then based on a set of key drivers for growth:

- economic activity (GDP and value of imports and exports);
- trade activity (tonnes and tonne / kilometres);
- fuel usage (sales and estimates); and
- installed power.

However, uncertainties in these estimates increase significantly when projecting emissions to future years.

The BAU shipping scenario is based on the annual growth rate of 2.6 per cent per annum as suggested by Entec (2008). Entec project emissions between 2000 and 2020 and these are assumed to continue up to 2050 at a 2.6 per cent per annum increase. This growth rate can be applied for any of the allocation methods. However, we are only considering emissions allocated to freight tonne kilometres (FTK) as this avoids the problem of ships refuelling elsewhere or operating under countries' flags. FTK is a measure of economic activity and so essentially this is an allocation of responsibility, i.e. who is making the economic returns from the transport of the cargo.

BAU CO_2 emissions estimates for shipping

Table 3.5 presents BAU emissions estimates for UK shipping in the baseline year (2005) and the scenario years (2030 and 2050). By 2050, CO_2 emissions from shipping are projected to increase by over 200 per cent.

Table 3.5: Business-as-usual baseline (2005) and CO_2 emissions estimates (2030 and 2050) for shipping based on freight tonne kilometres

Baseline (2005) CO_2 emissions (Mt)	CO_2 emissions in 2030 (Mt)	CO_2 emissions in 2050 (Mt)	Total % increase by 2050 over 2005 emissions
18.87	35.85	59.91	217%

3.5 SUMMARY OF BAU EMISSION ESTIMATES

Table 3.6 compares the baseline BAU CO_2 emission estimates with those reported in a number of recent UK studies on low carbon transport. The estimates for road and rail transport are generally in line with these studies. Estimates for aviation vary depending on whether or not international aviation is included. Emissions from shipping include those from domestic and international shipping and are considerably higher than reported elsewhere because of the methodology used to allocate emissions to countries. For shipping this is based on FTKs as this better represents UK economic activity.

Freiburg - Vauban © kaffeeeinstein/flickr

Table 3.6: Baseline and BAU Scenario estimates of UK transport CO_2 emissions (as Mt CO_2 yr-1) compared to other studies

This Study	Category	Baseline value (year)	2020	2025	2030	2050	Per cent increase (+ve) or decrease (-ve) in 2050 compared with baseline
Towards a Zero Carbon Vision for UK Transport	Total transport	176 (composite year)		199		235	+34%
	Road	116 (2003)		105		110	-5.2%
	Rail	3.4 (2006/7)		4.0		4.6	+34%
	Aviation (Dom and Intern)	38 (2005)			58	60	+60%
	Shipping (Dom and Intern)	19 (2005)			36	60	+217%
Other Studies							
COCC - Committee on Climate Change Building a Low-carbon Economy (2008)	Total transport	169 (2006)					
	Domestic transport	130 (2006)					
	Aviation (Dom and Intern)	38 (2006)					
	Shipping	9 (2000)					
DfT - Carbon Pathway Analysis: Informing Development of a Carbon Reduction Strategy for the Transport Sector (2008)	Total transport	131 (2006)	129				
	Road	120 (2006)	116				
	Rail	3.3 (2006/07)	3.6 - 3.8				
	Aviation (Dom)	2.3 (2006)	2.9				
	Shipping (Dom)	5.5 (2006)	6.2				
VIBAT - Visioning and Backcasting for UK Transport Policy (2007) [Note: these values have been converted from values originally expressed in MtC rounded to the nearest whole number.	Total transport	150 (2000)			191		
	Road	139 (2000)			180		
	Railways	7 (2000)			4		
	Aviation (Dom)	4 (2000)			4		
	Shipping	4 (2000)			4		

4 MAXIMUM IMPACT SCENARIO

The Maximum Impact (MI) Scenario outlines different policy pathways that will move the UK towards achieving a zero carbon transport system by 2050. There are three precursors to the MI Scenario:

- the OECD Environmentally Sustainable Transport (EST) study (OECD, 2002);
- the Visioning and Backcasting for UK Transport Policy (VIBAT) (Hickman and Banister, 2007);
- the Campaign for Better Transport study on A Low Carbon Transport Policy for the UK (Buchan, 2008).

4.1 PREVIOUS LOW CARBON TRANSPORT STUDIES

OECD EST study

The OECD's EST study used a backcasting exercise to define a desirable future for transport that looked beyond just CO_2 emissions. It demonstrated the feasibility of reductions in transport activity by the year 2030 compared to a BAU Scenario in 2030. In a backcasting exercise, goals are set and there is a working backwards – backcasting - to determine what must be done to reach them. Policy development is based on forecasting results in an attempt to change projected trends to avoid an undesirable future. Policy development based on backcasting results in doing what is necessary to achieve a desired future (See figure 4.1). The EST study proposed a range of policy instruments which included regulations (emission and CO_2 standards and limit values), economic instruments (such as fuel and road pricing and fiscal incentives and disincentives) and changes in infrastructure investment policies and land-use planning. Information dissemination and education to raise public awareness about the problems and possible solutions and alternatives also play key roles in the proposed strategies. The study concluded that although environmentally sustainable transport is attainable, this will only be achieved with a broad-based and concerted commitment. Key challenges lie in the acceptability of the strategies and their component instruments rather than in the effectiveness of the instruments themselves. The study recommends that issues of acceptability are best addressed by careful phasing of the application of instruments across the whole implementation period until 2030. Issues of effectiveness are best addressed by careful monitoring of the effects of instruments and appropriate adjustment of the vigour of their implementation (OECD, 2002).

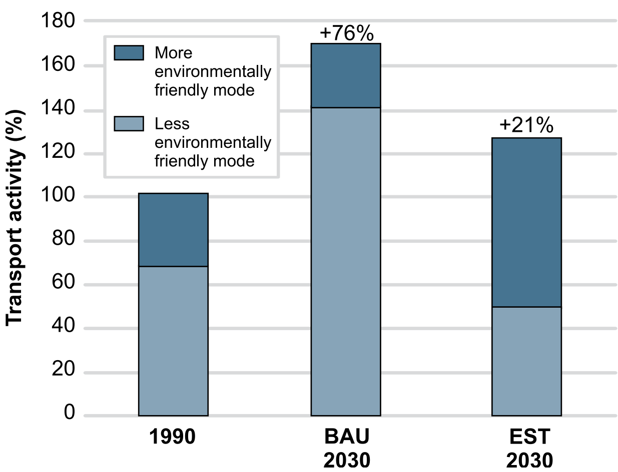


Figure 4.1: OECD Environmentally Sustainable Transport (EST) project results comparing the baseline situation (1990) with the BAU (2030) and the preferred scenario in 2030 (aviation excluded)

VIBAT study

The VIBAT study, funded by the DfT Horizons Research programme, does not include international aviation or shipping. This study produced 123 individual "measures" that would produce a 60 per cent reduction in CO_2 emissions by 2030 and these were assembled into eleven policy packages. It concludes that a 60 per cent reduction in domestic transport by 2030 is possible with some important qualifications:

> *"But it is travel behaviour that the real change must take place, and this should be implemented at the earliest possible occasion. Changes in the built environment will be effective in the medium term (over 10-15 years), whilst the major contribution of technological innovation will be effective after 2020. However, it is not possible to achieve the 60% CO_2 reduction target (in 2030), with the expected growth in travel, as the increase in CO_2 emissions from the growth outweighs many of the possible savings from behavioural change and technological innovation. "*

Low Carbon Transport Policy study

The 'Low Carbon Transport Policy for the UK' study, produced for the Campaign for Better Transport (Buchan, 2008), undertook an analysis and made policy recommendations to show that it is possible to reduce:

- overall CO_2 emissions from transport by 26 per cent by 2020 compared to 2006 figures;
- passenger travel emissions by 32 per cent;
- freight emissions by up to 19 per cent;
- fuel use by 25 per cent by making cars more fuel efficient;
- car traffic by 15 per cent;
- domestic aviation emissions by 30 per cent.

The policy package outlined includes a range of quick-win measures on business travel, including commuting and freight, and funding to switch local car journeys to walking and cycling. Longer-term measures include a new national travel card, parking controls in new developments, changes in planning guidance and tax changes to reward low-carbon travel. The study identifies a number of different policy packages that will reduce CO_2 emissions in aviation, freight and passenger transport. It demonstrates that a 26 per cent reduction in CO_2 is possible by 2020 and that:

> *"These reductions would be in line with those required for the UK generally to achieve 80 per cent reduction in emissions by 2050."*

Towards a Zero Carbon Vision for UK Transport study

The approach used in developing the MI Scenario for the present study takes the form of a backcasting exercise similar to that used in the OECD and VIBAT studies and examines future scenarios for CO_2 emissions from the transport sector in the UK (see figure 4.2). This MI Scenario envisions a radically different Britain by 2050, where the UK transport sector emits close to zero CO_2. A wide range of measures known to reduce CO_2 emissions from transport were examined to see the extent to which these measures can have a maximum impact on the transport sector and realise the vision of a zero carbon transport sector in the UK. These measures are grouped into in four categories (Spatial planning, Fiscal, Behavioural and Technology) and the impacts of each assessed separately in order to allow their relative efficacy to be assessed. For passenger and freight railways, a single technological intervention only is applied: complete electrification of the UK rail network. Biofuels are assumed to have only a minimal role given they are usually considered to be far from 'carbon neutral' and have been associated with adverse land-use issues and other drawbacks identified in the Gallagher review (Renewable Fuels Agency, 2008).

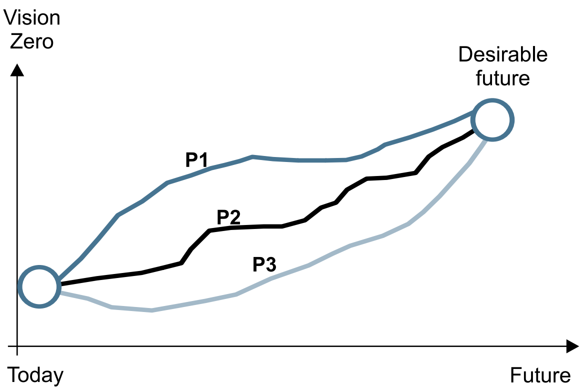


Figure 4.2: A backcasting approach

A transport system in which plug-in electric vehicles (PEVs) or hydrogen (H) fuel cell vehicles predominate, combined with a carbon-neutral electricity supply, is seen as probably the only way that a near zero CO_2 emission transport sector can be achieved in 2050. This was also the view of the King review (HM Treasury, 2007) in which it is stated that:

> *"In the long-term (possibly by 2050 in the developed world), almost complete decarbonisation of road transport is a possibility. If substantial progress can be made in solving electric vehicle technology challenges and critically, the power-sector can be decarbonised and expanded to supply a large proportion of road transport demand, around 90 per cent reduction per kilometre emissions would be achieved across the fleet."*

This is also a view reflected in the DfT's Carbon Reduction Strategy for Transport (DfT, 2009a) which envisages that by 2050, road and rail transport will be largely decarbonised and powered by clean electricity. The UK Energy Research Centre (UKERC) has explored scenarios for the possible development of the UK energy system to achieve the UK Government's Climate Change Act target of 80 per cent CO_2 reduction by 2050 (UKERC, 2009). Under UKERC's low-carbon core scenario, electricity generation would undergo progressive decarbonisation to produce a 93 per cent reduction in CO_2 emissions by 2050 compared with their reference scenario. Under the UKERC 'super ambition' (CSAM) scenario, almost complete decarbonisation of UK electricity supply is envisaged by 2050. It has therefore been assumed that, for the purposes of the present analysis, a carbon-neutral UK electrical power supply could be achieved by 2050, although undoubtedly this would represent a huge challenge.

For aviation and shipping, the options for reducing emissions are more limited but nevertheless a full range of technology and operational measures that can be implemented over the next forty years have been applied. Biofuels are also not considered a viable fuel replacement for aviation or shipping. There is also the assumption that the EU emissions trading system (ETS) will lead to efficiency improvements in both sectors as well as possible price effects in the case of aviation.

The following methodology was used to avoid overestimating the combined effect of more than one measure applied to the same category. Clearly, two measures each reducing CO_2 emissions by 50 per cent when applied separately, would not give 100 per cent emissions reduction in combination. The 50 per cent reduction of the second measure would only apply to the 50 per cent remaining after the first measure, the total reduction being 75 per cent. The same logic applies to combining the effect of any number of measures. For example, if there are three measures to be combined and measure M1 alone reduces CO_2 emissions by x%, measure M2 alone reduces emissions by y% and measure M3 alone reduces emissions by z%, the combined effect of all three (Mcomb) is calculated as:

$$M_{Comb} = 100 - (1-x/100) \times (1-y/100) \times (1-z/100) \times 100\%$$

(Equation 1)

The order in which the measures are arranged in the equation is irrelevant as the result is the same. The same approach is used when applying a particular reduction measure annually over several years as we have done for air fare increases and the road fuel price escalator (FPE). If the annual decrease in emissions is x % and the period of time over which it takes place is T years then the total reduction M is calculated as:

$$M = 100 - (1 - x/100)^T \times 100\%$$

(Equation 2)

The following sections outline the assumptions used and CO_2 reduction achieved from different transport modes when a range of spatial planning, fiscal, behavioural and technology measures are applied.

4.2 ROAD TRANSPORT

Spatial planning

This category covers aspects of spatial planning that are known to support sustainable transport. It mainly focuses on urban planning, encouraging walking by pedestrian-oriented design (ease of access to shops and other amenities), reallocating road space (to pedestrian only streets, cycle tracks, bus lanes, grass verges etc.) and high occupancy only vehicle (HOV) lanes. There is clear evidence that high density cities that avoid urban sprawl, and have good quality accessibility policies to deliver services locally, produce significant reductions in VKT (e.g. Kenworthy and Laube, 1999). Also, it is easier to serve more densely populated areas with attractive and efficient public transport systems compared with lightly populated areas. Thus the development of compact cities could significantly reduce urban CO_2 emissions. This category also includes the effect of implementing a 'Regional co-operation model for HGVs'. The regional co-operation model for reducing road freight transport has been advanced by Holzapfel (1995) and is based on an analysis of the potential for substituting regional supply chain linkages for longer distance linkages and reducing the kilometres driven by HGVs by up to 67 per cent.

MI Scenario assumptions for spatial planning:

- **Pedestrian-oriented design**: urban car VKT reduced by 10 per cent (Dierker *et al.*, 2005).
- **Road space reallocation**: urban car CO_2 emissions reduced by 11 per cent (Cairns *et al.*, 1998).
- **High occupancy only vehicle (HOV) lanes**: urban car VKT reduced by 1.4 per cent (VTPI/TDM 2008).
- **Compact development**: for cities >100K population, all traffic VKT reduced by 30 per cent (Reid Ewing, 2008).[5]
- **Regional co-operation model for HGVs**: assume 50 per cent reduction in total VKT (Holzapfel, 1995).

Table 4.1 presents the reduction in CO_2 emissions in 2050 from spatial planning measures used in the MI Scenario.

5 In order to avoid double-counting, the 30 per cent value is assumed to include the impacts of the first three assumptions (Pedestrian-oriented design, Road space reallocation and HOV lanes) which, therefore, are not applied to urban traffic in cities with a population > 100,000 in addition to the 30 per cent.

Fiscal

Financial incentives and disincentives in the form of charges, tax increases, fare subsidies (for public transport) can have a powerful effect on people's transport choices from the type of car they purchase (if at all) through to choice of transport mode for each individual journey. This category covers road user charges and charging for parking spaces which can also shift car users to other, more sustainable, forms of transport.

The Fuel Price Escalator (FPE) is the practice of automatically increasing hydrocarbon oil duty (i.e. 'fuel tax') in the UK by more than inflation. It was first introduced by a Conservative government in 1993 when it was set at an annual increase of three per cent, later rising to five per cent, and then continued by the Labour government in 1997 at a higher rate of six per cent per year. The FPE was abandoned after the UK fuel protests of 2000. For fuel price, it is assumed there will be a re-introduction of the FPE at five per cent per annum above inflation in 2010 and maintained through to 2050. This will result in a seven-fold (i.e. 600 per cent) increase in the cost of fossil-fuel derived hydrocarbons (e.g. gasoline, diesel, LPG) for all road vehicles by the end of the 40 year period. The escalator would not apply to electricity used to charge PEVs or to produce hydrogen for hydrogen fuel cell vehicles and hence produce a progressively stronger incentive to choose these cleaner alternatives.

The vehicle excise duty (VED), sometimes termed a 'circulation tax', is a recurrent charge levied by the government on vehicles used on the public road. It can be linked to fuel efficiency or engine size and so influence CO_2 emissions through altered vehicle purchase choice.

Vehicle purchase taxes are levied when vehicles are purchased and can be specifically aimed at reducing CO_2 emissions as, for example, in so-called 'feebate' tax structures that offer buyers rebates for choosing low CO_2 emitting vehicles and penalties for buying high CO_2 emitting vehicles. Other financial incentives include subsidising public transport fares to encourage up-take of these more CO_2 efficient modes.

MI Scenario assumptions for Fiscal:

- Road user charges: three per cent reduction in all traffic (Kollamthodi, 2005).
- Workplace car parking charges: CO_2 emissions from commuting by car reduced by 12 per cent (Shoup, 2007). Thus, assuming 25 per cent of total car CO_2 emissions are due to commuting (DfT, 2008a; 2008e) this equates to a three per cent reduction in total passenger car CO_2 emissions.

Table 4.1: The impact of the MI Scenario 'spatial planning' measures on CO_2 emissions in 2050

Vehcile Type	Baseline (2003) CO_2 emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions due to MI Spatial measures (%)
Passenger cars	66.4	59.6	48.2	-19+-
Light Duty Vehicles	14.0	18.8	17.8	-5
Rigid HGVs	9.9	7.6	3.7	-52
Artic HGVs	20.8	20.6	10.2	-51
Buses and coaches	4.3	2.6	2.4	-9
Motorcycles	0.5	0.5	0.4	-14
LPG vehicles	0.3	0.3	0.3	0
Total:	**116.2**	**110.2**	**83.0**	**-25**

- Urban, non-commuting car parking charges: A 13 per cent reduction in urban car VKT assuming: (a) VKT elasticity factor of -0.07 (average quoted for predominantly urban areas by Litman (2009); (b) 75 per cent of car CO_2 emissions are for non-commuting purposes (DfT, 2008a; 2008e) assuming that this also applies to urban car use; and (c) average parking charges increase in real terms by 10 per cent per annum from 2010 to 2030, to give a 570 per cent final increase.

- Fuel price: A five per cent per annum fuel price escalator is introduced from 2010 onwards producing a 600 per cent fuel price increase by 2050 for all road vehicles. A short-term elasticity factor of -0.25 for fuel consumption (Goodwin *et al.*, 2004) applied annually results in a 40 per cent reduction in CO_2 emissions for all fossil fuel powered road vehicles by 2050. (An implicit assumption here is that there will be progressive availability of non-CO_2 emitting alternatives such as electric vehicles powered by carbon neutral electricity, and carbon neutral public transport systems).

- VED circulation tax: Increased differentiation reduces VKT for all cars by 4.8 per cent (COWI, 2002).

- Car purchase tax and 'Feebate' systems based on fuel consumption: Reduces VKT for all cars by four per cent (Anable and Bristow citing Van den Brink and Van Wee, 2001).

- Public transport fares subsidy: a 30 per cent reduction in fares will reduce CO_2 emissions for all cars by two per cent (UKERC, 2009b).

Table 4.2 presents reduction in CO_2 emissions in 2050 from fiscal measures used in the MI Scenario.

Behavioural change

Although fiscal measures and spatial planning will usually reduce transport related CO_2 emissions through their effect on peoples' behaviour, some measures can be regarded as 'purely' behavioural and these are included here. 'Ecological driving' can reduce fuel use by means of information campaigns, better vehicle maintenance (including correct tyre pressures), in-car information systems and courses on driving style (smoother driving etc.). Vehicle CO_2 emissions vary with speed and can be minimised if the vehicles are made to keep to lower speeds, especially on motorways. Car sharing increases vehicle occupancy and reduces the number of vehicle journeys needed so reducing CO_2 emissions. Much freight that is currently hauled by road could be transported by rail, inland waterways and coastal shipping, all these alternatives being much less carbon intensive per tonne-kilometre moved. There is also a variety of mainly behavioural measures, termed 'Smarter choices' by

Table 4.2: The impact of the MI Scenario fiscal measures on CO_2 emissions in 2050

Vehcile Type	Baseline (2003) CO_2 emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions due to MI Fiscal measures (%)
Passenger cars	66.4	59.6	19.9	-67
Light Duty Vehicles	14.0	18.8	8.9	-53
Rigid HGVs	9.9	7.6	3.6	-53
Artic HGVs	20.8	20.6	9.8	-53
Buses and coaches	4.3	2.6	1.5	-41
Motorcycles	0.5	0.5	0.3	-41
LPG vehicles	0.3	0.3	0.3	0
Total:	**116.2**	**110.2**	**44.3**	**-60**

Cairns *et al.* (2004), including workplace travel plans, home working and teleworking, travel awareness and education, public transport information and marketing, personal travel plans, local collection points, school travel plans, home shopping and car clubs. Although these measures can make an important contribution to CO_2 emission reduction from road transport, there is considerable overlap with both spatial measures (e.g. compact development) and fiscal measures (e.g. parking charges) already dealt with above. Therefore, to avoid the danger of double-counting, 'Smarter choices' have been omitted for the purposes of the current analysis. Thus estimates of the emissions reduction potential of the 'behavioural change' category used here can be considered to be conservative estimates.

MI Scenario assumptions for behavioural:

- Ecological driving: eight per cent reduction in car CO_2 emissions (DEFRA, 2007; King 2008).
- Reducing motorway speed limit to 60 mph and enforcing it: 10 per cent reduction in motorway CO_2 emissions (Commission for Integrated Transport, 2005).
- Car share: reduction in car VKT for urban (8.3 per cent) and rural (3.6 per cent) driving (VTPI/TDM 2008).
- Modal shift for road freight: 20 per cent reduction in CO_2 emissions from HGVs (Whitelegg, 1995).

Table 4.3 presents reduction in CO_2 emissions in 2050 from behavioural measures used in the MI Scenario.

Technology

The internal combustion engine (ICE) has been the predominant form of propulsion for road vehicles for over 100 years and continued increases in ICE engine efficiency, as assumed for the BAU Scenario, will deliver substantial CO_2 emission savings. Further savings could be achieved through a large-scale shift to highly efficient, smaller diesel engines. However, in the likely absence of large-scale availability of sustainable biofuel substitutes for all fossil fuels currently used in transport, a radical shift to other technologies will be required in order to achieve a near zero carbon emission target for this sector by 2050. The New Automotive Innovation and Growth Team (NAIGT) has set out a roadmap, agreed by UK industry, that shows how automotive technology will need to develop to 2050 in order to tackle the CO_2 challenge (See figure 4.3). Although innovations in ICE vehicles and different types of electric hybrids will play a role in the intervening years, by 2050 road transport will have to be largely made up of some combination of PEVs and hydrogen fuel cell vehicles, depending on technology breakthroughs. Of course this technology shift would only deliver a low carbon future if the electricity required to charge the PEVs, or to produce the hydrogen for the fuel cells, comes from carbon-neutral sources such as renewables, fossil fuel combustion with carbon capture and storage (CCS), or nuclear energy. ICE passenger cars, vans and motorcycles would become obsolete in this low carbon future. Lighter HGVs up to 12 tonnes would also be fully electric (DfT, 2009a) although heavier HGVs would need to be powered by hydrogen fuel cells or sustainable biofuels (as described by Baker *et al.*, 2009) in order to achieve carbon neutrality.

MI Scenario assumptions for Technology:

- All passenger cars, LDVs, motorcycles and HGVs/buses less than 12 tonnes in weight to be PEV using 100 per cent renewable electricity or hydrogen fuel cell powered (using carbon neutral sourced hydrogen).
- Heavier HGVs and buses/coaches (>12 tonnes) to be powered by either H fuel cells (with carbon neutral sourced hydrogen) or sustainable biofuel.
- Liquefied petroleum gas (LPG) vehicles completely phased out.

The assumptions in the MI Technology package are different from the first three in that they comprise desired technology end-points rather than a set of policy interventions per se. These technology end-points could arise simply as a result of the spatial, fiscal and behavioural measures described earlier. In particular, the fiscal measures alone may render petrol/diesel powered vehicles prohibitively expensive compared with say, PEVs. Alternatively, a society being adversely affected by climate change in forty years time may reasonably decide to ban any remaining petrol/diesel vehicles completely. In this case the technology assumptions would in a sense, also represent policy interventions. Of course, significant policy interventions would be required to produce the carbon neutral UK electricity power generation sector on which the above assumptions are based, but a detailed analysis of these is beyond the scope of this study.

Table 4.4 presents reduction in CO_2 emissions in 2050 from technology assumptions used in the MI Scenario. Clearly, with 100 per cent carbon neutral electricity, the CO_2 emissions from road transport are also reduced by 100 per cent under these assumptions.

Table 4.3: The impact of the MI Scenario behavioural measures on CO_2 emissions in 2050

Vehcile Type	Baseline (2003) CO_2 emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions due to MI Behavioural measures (%)
Passenger cars	66.4	59.6	48.4	-18.7
Light Duty Vehicles	14.0	18.8	18.1	-3.8
Rigid HGVs	9.9	7.6	5.8	-23.5
Artic HGVs	20.8	20.6	15.3	-25.7
Buses and coaches	4.3	2.6	2.6	-2.2
Motorcycles	0.5	0.5	0.5	-1.5
LPG vehicles	0.3	0.3	0.3	0.0
Total:	**116.2**	**110.2**	**91.1**	**-17.3**

Combined measures

Table 4.5 presents reductions in CO_2 emissions in 2050 from all four categories of road transport measures used in the MI Scenario, both when applied separately and when combined. Each package of measures is first of all considered in isolation so, for example, Spatial planning alone reduces the BAU 2050 total from 110.2 Mt CO_2 to 83.0 Mt CO_2, a reduction of 27.2 Mt CO_2 or 25 per cent. This same calculation is then repeated for each other package of measures so that each row shows their impact on CO_2 emissions in isolation. The final row uses the methodology described in Section 4.1 (using Equation 1 extended to four

Table 4.4: The impact of the MI Scenario technology measures on CO_2 emissions in 2050

Vehcile Type	Baseline (2003) CO_2 emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions due to MI Technology measures (%)
Passenger cars	66.4	59.6	0.0	-100
Light Duty Vehicles	14.0	18.8	0.0	-100
Rigid HGVs	9.9	7.6	0.0	-100
Artic HGVs	20.8	20.6	0.0	-100
Buses and coaches	4.3	2.6	0.0	-100
Motorcycles	0.5	0.5	0.0	-100
LPG vehicles	0.3	0.3	0.0	-100
Total:	**116.2**	**110.2**	**0.0**	**-100**

Note: The effect of measures when combined is somewhat less that the sum of the effects of each separate measure due to the use of a method (explained fully in Section 4.1) that avoids overestimating the effect of combining measures.

Table 4.5: The impact on road transport CO_2 emissions by 2050 of all MI Scenario measures applied both in isolation and when combined

	2005	2050	Reduction in CO_2 emissions (Mt CO_2) relative to	Per cent change in CO_2 emissions relative to
	Emissions (Mt CO_2)		2050 BAU	2050 BAU
BAU Total	**116.2**	**110.2**		
MI measures separately: **Spatial planning**		83.0	27.2	-25%
Fiscal		44.3	65.9	-60%
Behavioural		91.1	19.1	-17%
Technical		0.0	110.2	-100%
The three non-technical MI measures combined		28.0	82.2	-75%
All four MI measures combined		**0.0**	**110.2**	**-100**

terms) to combine all four packages (spatial, fiscal, behavioural and technology); the final result being a 100 per cent reduction in CO_2 emissions due to the fact that technology alone produces 100 per cent reduction. However, as referred to above, the technology assumptions run in parallel with the others so that, for example, the 40 per cent reduction in fuel consumption by 2050 due to the FPE would most likely depend on non-CO_2 emitting transport alternatives such as PEVs being available. For this reason, the combined impact of the three non-technology MI categories only (also calculated using Equation 1) are also shown in table 4.5 in order to indicate what their total effect on CO_2 emissions would be in the absence of a complete switch to carbon neutral technologies. It can be seen

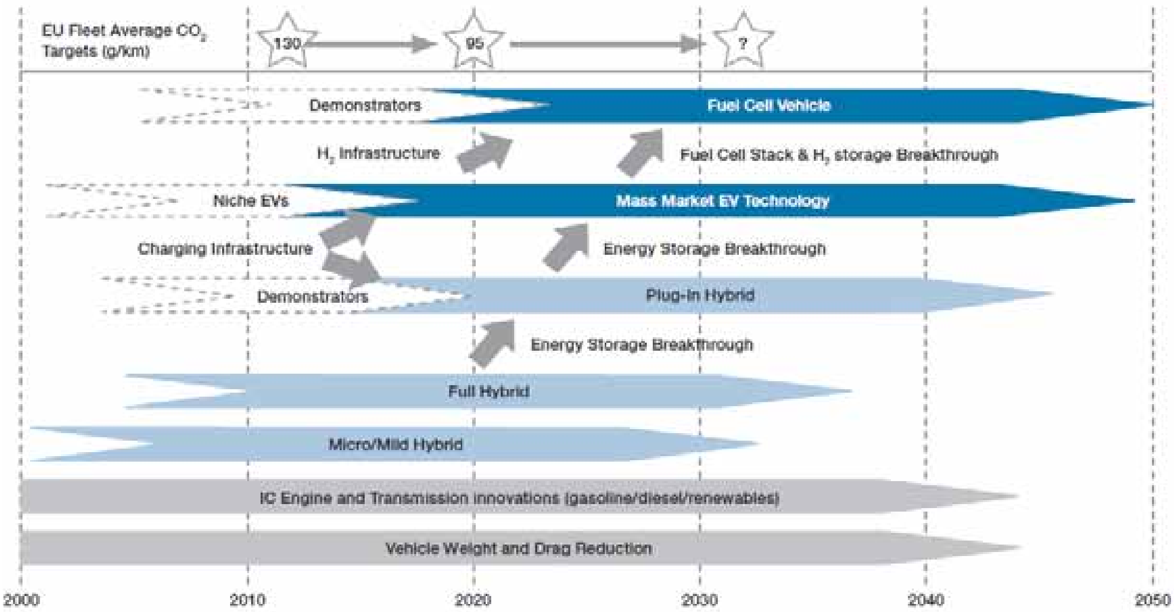


Figure 4.3: High-level technology roadmap for the UK's decarbonisation of road transport

Source: NAIGT (2009)

that together, these non-technical measures would achieve a 75 per cent reduction in CO_2 emissions relative to the BAU 2050 scenario.

In addition to the impact of technology changes, reducing the demand for road transport is also clearly very important. Spatial re-engineering interventions and behavioural change can help to do this but the largest impact on demand comes from fiscal interventions, in particular the FPE. Any remaining demand for private motorised transport can then be met by PEVs or other technologies based on electric power and storage. In assessing the effect of these technological changes, it is assumed that an electricity supply system that is 100 per cent decarbonised will be in place by 2050. The final result is a road transport system that is 100 per cent decarbonised

4.3 RAIL TRANSPORT

Electric trains emit 20 to 35 per cent less carbon per seat-kilometre than diesel equivalents on the basis of the current electricity generation mix (Rail Safety and Standards Board, 2007). This advantage will increase over time as our electricity generation mix becomes less carbon intensive. It is therefore assumed the railway network will be completely electrified by 2050 and that the electricity used will be carbon neutral (i.e. from renewable sources, fossil fuel with carbon capture and storage or nuclear). This is in line with the DfT's Carbon Reduction Strategy for Transport (DfT, 2009a) which envisages that by 2050, rail transport will be largely decarbonised and powered by clean electricity. Hence the MI Scenario assumes that CO_2 emissions from both passenger and freight rail will be zero by 2050.

MI Scenario assumption for railways:

- All passenger and freight rail to be powered by electricity that is 100 per cent carbon neutral.

4.4 AVIATION

The aviation BAU Scenario included changes expected over the next 40-50 years. The DfT's (2009) Low Carbon Transport report recognises that, even in the longer-term, the decarbonisation of aviation (and shipping) and the use of alternative fuel sources will be more challenging than for road and rail modes.

The International Air Transport Association (IATA) (2009) has developed a roadmap towards carbon neutral growth (no increase in emissions as demand continues to grow). The IATA roadmap includes setting emissions standards, use of biofuel and improvement in air traffic management. In the short to mid-term (to 2020) a 1.5 per cent per annum improvement in fuel efficiency is expected. Within this timeframe, the industry is also expected to achieve carbon neutral growth. By 2050, emissions will have reduced by 50 per cent compared to 2005 according to the IATA roadmap; clearly a long way off from zero carbon transport.

The Sustainable Aviation Group (2008) presents a more optimistic future where demand increases threefold by 2050 but emissions from aircraft manage to return to 2000 levels. They suggest that this can be achieved through a combination of new technologies and operational efficiency gains and with ten per cent reduction by using biofuels.

The main way to reduce aviation emissions which is considered in our MI Scenario, is a reduction in flying activity and distance travelled. The MI Scenario sees the need for people to adapt their lifestyles by taking fewer long-haul holidays, international business trips and overall travelling less by air. UK internal flights could be eradicated through substitution of transportation modes that are less GHG intensive than aircraft. In particular, information technology plays a key role in reducing domestic and international air travel in the business sector.

In terms of fiscal measures, the BAU Scenario already incorporates the introduction of the EU ETS which will affect ticket prices and thereby demand. In the MI Scenario there will be higher ticket prices due to a rise in the price of oil and with the introduction of some form of carbon tax. Aviation growth will continue, albeit at an increasingly slower rate, and a general "greening" of attitudes and behaviour will gradually smooth out growth rates in the latter half of the projection. In the MI Scenario no major institutional changes in the aviation industry over the next 40 years are expected. Improvements in airspace management will mean there is a coordinated approach to flight planning and this will be augmented by better communication due to technological developments.

Constraining capacity

The BAU Scenario is based on DfT forecasts for aviation emissions in 2050. These forecasts are based on a scenario[6] which includes additional capacity at Stansted and a third runway at Heathrow. Due to some of the other measures in the MI Scenario, additional capacity will not be required as there will be fewer domestic and international air traffic movements. Therefore, in the MI Scenario the policy that sanctioned the additional runways has been reversed (as subsequently occurred under the 2010 Con-Lib government with respect to the third runway at Heathrow airport). However, growth at airports in terms of air traffic movements and passenger numbers will continue at expected rates using existing airport capacity. This is modelled in the DfT CO_2 forecasts (table G15, pg 148) and shows that in 2050 CO_2 emissions reduce from 59.9 Mt CO_2 under their 's12s2' scenario to 54 Mt CO_2 under their s02 - "maximum use" scenario. Therefore, as a consequence of this intervention measure to constrain demand, we will see a 10 per cent reduction in aviation emissions under our MI Scenario (see table 4.6).

Technology

In this section we evaluate opportunities for technological change that go beyond the technology assumptions already considered in the BAU Scenario. The MI Scenario does not foresee a radical shift in aircraft design or major switch to alternative fuel. It is assumed aircraft manufacturers meet their ACARE objectives to improve fuel efficiency in new aircraft by 2030. After this, additional improvements to the design of existing aircraft, making smaller improvements in efficiency, will be retrofitted in the current fleet. ACARE suggests that from 2021, 0.5 per cent per annum increase in efficiency is feasible with further developments in lightweight materials and turbomachinery (e.g. turbines and compressors) efficiencies. Whilst the technology exists conceptually to produce more efficient aircraft, such as use of blended wing bodied aircraft, airlines retain their existing aircraft fleets for longer (20-30 years) so that even by 2050 the aircraft fleets are based on current designs. In the MI Scenario there will be a replacement of the whole fleet of aircraft by 2050 by scrapping or re-engineering the oldest and most fuel intensive aircraft.

However, one significant development in engine design in the future could be the use of the propfan (or open-rotor/inducted jet) which is a hybrid between a turbofan and a turboprop engine. This type of engine has an open rotor (like a turboprop) with thin, highly swept blades which improves aerodynamic performance at higher speeds. The advantages of this type of engine are speeds comparable to turbojets and reduction in fuel intensity between 51 and 55 per cent compared with conventional engines (Peeters Advies, 2000). These aircraft could be used on short haul flights.

Biofuels will only replace a small proportion of fossil fuel as there is only limited production capacity and it certainly will not be able to be used as a substitute for the whole fleet. Also, there are complex issues and uncertainties regarding using biofuel including the amount of land required to produce feedstock, issues relate to food security and the potential loss of biodiversity that could occur through deforestation and other land-use change.

Predominantly, aviation will still use carbon-based fuels as hydrogen-based propulsion systems are not yet technically feasible. For long-haul flights, there is a design problem with hydrogen because of its low density and therefore to store enough fuel on board would require a much larger aircraft. Once again, this carries with it a number of issues including airport infrastructure requirements. The second and more environmentally sensitive aspect is the need for these aircraft to fly at lower altitudes and releasing water vapour (a greenhouse gas) into the atmosphere. Therefore, a precautionary approach for using hydrogen is taken so as not to detract from the potential for reducing carbon emissions made elsewhere. Finally, synthetic kerosene is another potential substitute fuel which could be produced. However, the production process for synthetic kerosene could lead to even more GHG emissions (CAEP, 2007).

Airlines could also optimise load factors and aircraft configurations especially as in the MI Scenario there will be fewer business passengers. Carriers with large business class cabins have higher emission levels per passenger than those that carry a larger number of economy passengers in the same aircraft type. According to EUROCONTROL (2008) scenarios, the number of seats per aircraft is expected to increase by approximately one per cent per year until 2030.

As a result of the technological improvements but not including radical new technology such as blended-wing aircraft, CO_2 emissions from aviation in the MI Scenario are reduced by 14 per cent in 2050 (table 4.7). This is consistent with the scale of reduction suggested by the Sustainable Aviation Group (2008).

6 In the DfT forecasts this is called the s12s2 scenario

Table 4.6: Reduction in CO_2 emissions in 2050 from constraining demand (no new runways at Heathrow and Stansted) used in the MI Scenario

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Constrained Demand	37.5	59.9	54.0	-10%

Note of Explanation
DfT forecasts for air travel include a new runway at Heathrow. The definition of constrained demand used in this study is no additional runway capacity at any London airport and the effect of removing additional runway capacity is a 10 per cent reduction in demand when the Maximum Impact Scenario is compared with the Business-as-usual Scenario

Operational efficiencies

With regard to air transport management (ATM), there is the potential for reducing aircraft emissions in the air through efficient management of airspace and optimised flight-planning and on the ground through better aircraft handling procedures. The Civil Air Navigation Services Organisation (CANSO) has assessed the long-term potential for efficiency improvements in global air traffic management. They foresee only an additional four per cent improvement above what has been achieved up until 2005 (Stollery, 2008). However, inefficiencies in European airspace enable far greater reductions in CO_2. For example the UK National Air Traffic Service (NATS) plans to cut by an average of 10 per cent of ATM-related CO_2 emitted per flight by aircraft in UK controlled airspace by 2020 (NATS, 2008).

Air traffic control can ensure that emissions are minimised by creating flight plans which have more direct routes and with flexibility to take advantage of tailwinds. These plans will also see aircraft flying at those altitudes that cause the least climate change in relation to global warming potential (GWP). Each GHG has a different capacity to cause global warming depending on its radiative forcing properties, its molecular weight and its lifetime in the atmosphere which taken together determine its GWP. (GWP is defined as the warming influence over a set time period of a gas relative to that of CO_2).

In addition to CO_2, GHGs such as water vapour and nitric oxide, together with nitrogen oxides which are major precursors of ozone (another GHG), are released by aircraft at high altitude (6 - 10 km). Also released are other ozone precursors such as hydrocarbons and carbon monoxide as well as particulate matter (soot, nitrate and sulphate particles), some of which reduce and some of which increase aviation's total climate impacts.

Contrails formed when water vapour freezes at high altitudes, can lead to the formation of cirrus clouds. These are considered to contribute to global warming however their overall effect is highly uncertain (IPPC, 1999). Nonetheless by taking into account weather conditions at high altitudes then aircraft could fly at lower altitudes where appropriate to minimise contrail formation.

Telematics can play an important role in improving operational efficiencies especially through improved

Table 4.7: The impact of the MI Scenario aircraft technology measures on CO_2 emissions in 2050

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Aircraft Technology	37.5	59.9	51.8	-14%

Note of Explanation
The BAU Scenario includes technology changes that were anticipated by the DfT in its scenario work. The technology impacts that have been included in the MI calculations in this table are additional to any BAU technology assumptions.

communication between the aircraft and the ground. Satellite technology such as the European EGNOS/ GALILEO system (a global navigation satellite system or GNSS) can assist navigation and re-routing to avoid difficult or dangerous weather. These can be used for all flight phases (take off/cruise/landing) and mean that the stacking of aircraft over certain parts of the country can be avoided. This arises as aircraft are usually allocated a particular time-slot to land and when they miss their slot by arriving late or because there is congestion on the ground then they need to fly in a holding pattern until a slot becomes available. This extra fuel used leads to increased carbon emissions.

Another area where improvements in airspace management can lead to reduced amounts of fuel consumption and lower carbon emissions is the utilisation of airspace restricted to military operations. This would see greater co-operation between military and civil air traffic control such as proposed under the SESAR programme (EC, 2009) and would see the abolition of fixed military airspace.

There is also the potential for ground-based reductions in carbon emissions associated with aviation. The assumption in the MI Scenario is that electric vehicles (using a renewable energy supply) will be used on all airside operations. Better communication between aircraft, ground vehicles and terminal facilities such as baggage handling will reduce delays. The use of Auxiliary Power Units on-board aircraft for air-conditioning and lighting whilst at departure gates can also be replaced by ensuring aircraft plug-in to a renewable energy supply. The overall effect of improving air transport management both in the air and on the ground including the use of military airspace will reduce CO_2 emissions by 13 per cent in 2050 (see table 4.8).

Fiscal

The price of air fares plays an important role in the demand for aviation, the net effect depending on the price elasticity of demand. Several factors contribute to the price of air fares such as route, distance flown, seat availability and class of seat. Also, additional expenses of the airlines related to CO_2 emissions, noise and security charges and price of oil will be passed onto the customers by increased fares. Changes in fares generally have an inverse effect on the demand (e.g. higher prices lead to less demand) the scale of the effect determined by its price elasticity.

An analysis by Cairns and Newson (2006) of studies on price elasticities for air travel suggest that they ranged between -0.5 and -1.5. Therefore, a 10 per cent increase in fares would yield a demand reduction in 5 - 15 per cent. However, this tends only to be the case for short-haul and budget flights. Elasticities for business flying and long haul flights tend to be lower. The DfT (DfT, 2008a) concludes that while the price elasticity for leisure travel was -0.3, no significant price effect is found for business travel. Cairns and Newson (2006) also highlight the fact the business flights and long haul are generally not affected by price increases.

Some key fiscal policy interventions, such as the inclusion of aviation in the EU ETS in 2012, are already take into account under the BAU Scenario (see box 3.3). However,there are other factors that will affect ticket prices including:

- taxation of aviation fuel (a massive subsidy enjoyed by the industry, see next section);
- VAT on air tickets;
- airport slot auctions;

Table 4.8: The reduction in CO_2 emissions in 2050 from air traffic management measures used in the MI Scenario

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Air Traffic Management	37.5	59.9	52.4	-13%

Note of Explanation
It is assumed that the contribution of de-militarised air space is 3% and the remaining 10 % refers to all the other measures. The DfT has reported that four per cent of the delays in EU air space are the result of military activity. Three per cent has been selected as a conservative estimate on the basis that it is unlikely that all delays attributable to military activity can be stripped out of the system (DfT, 2001).

Boeing 787 Dreamliner © Dave Sizer

- raising airport landing charges;
- emissions charging.

These differ in the way they are applied. In general, they cannot be done unilaterally by the UK Government and some, such as aviation fuel taxation, can only be done through lengthy international processes.

The option used in the MI Scenario (also considered feasible at the EU level) is en-route emission charging of flights within and between European countries. Here the emission charge would include the full climate change effect of aircraft emissions taking into account the 'uplift factor' based on the RF potential of emissions at high altitude (see Section 3.3).

In addition to these price effects, the MI Scenario includes an assessment of the impact on air fares if the industry was not subsidised by the Government in the form of zero fuel tax, VAT exemption and other measures. The Aviation Environment Federation (Sewill, 2005) calculates the revenue lost by the Treasury as a result of the exemption from fuel tax and VAT, and tax free sales, amounted to £9.2 billion when income from air passenger duty of £0.9 billion is factored in. If air travel was taxed the same as car travel then:

- the rate of growth would be halved;
- the climate change impact would be much reduced;
- an extra £9 billion a year would be available for improving public services or cutting taxes.

Fuel taxation is one of the most cited examples of how the aviation industry benefits significantly compared to other industries. Due to international agreement (the Chicago Convention of 1944) aviation fuel is tax exempt. ICAO, the industry body responsible for international agreements including fuel tax, is strongly against countries imposing taxes unilaterally. There would be major legal hurdles to face if the UK Government imposes a tax itself. Even if it managed to implement such a tax, airlines would simply refuel in countries where the tax was exempt.

For the MI Scenario it is assumed that a package of fiscal measures which increase ticket prices may include emission charging based on full climate change impact applied at the European level as well as including external costs such as noise and local air pollution. The MI Scenario also includes the removal of any domestically applied subsidies but not a fuel tax. In the scenario, UK aviation Air Passenger Duty is assumed to remain at current levels from 2012 onwards.

As a consequence of these fiscal measures in the MI Scenario, air fares will increase by six per cent per annum over the next 40 years (2010-2050) to produce a nine-fold final price increase. These annual increases represent a strong enough price signal over a long time period to bring about a change in behaviour that is large enough to make a contribution to demand reduction and carbon reduction without economic disruption. An increase in the cost of carbon from £80 to £200 per tonne in 2050 as suggested by the Committee on Climate Change (2009) is unlikely to have a significant effect on demand as the carbon cost is only a small fraction of the overall ticket price. The discussion around price signals and their application over a long time period has been advanced by (amongst others) Weizsaecker and Jesinghaus (1992) and Kohlhaas (2000). Both authors argue that the rate of taxation should not be so great as to create perturbations in the economy that cause difficult problems of adjustment. They take the view that the exact value of the initial rate of taxation is not as important as the year-on-year cumulative effect and its impact on behaviour. That is also our view.

In the MI Scenario, we have used the mean price elasticity value of -1.146 derived by Brons *et al.* (2002) from a meta-analysis of elasticities based on a set of 204 observations. Short haul flights account for approximately 30 per cent of air traffic movements in the UK (including domestic flights). Therefore using the elasticity value of -1.146, it is estimated (using Equation 2 in Section 4.1) that an increase in fares due to emission charging and other fiscal measure reduces CO_2 emissions from short haul flights by 94 per cent by 2050. Table 4.9 shows that the effect of increasing prices alone could reduce total (short haul plus long haul) aircraft CO_2 emissions by 27 per cent by 2050.

In this report a direct increase in fares charged to passengers has been selected. There are several ways this can be achieved through regulation and governmental intervention and a carbon tax as recommended in CCC (2009) is one of them. Another method would be to assess the full range of externalities associated with aviation including nose and air quality and use conventional methods of evaluation to put a monetary value on the externalities and through government regulation internalise them (i.e. fully recoup the costs through a charge related to emissions or noise and directly impacting on the actual fare paid by the passenger). The feasibility, practicality and effectiveness of different methods of “making the polluter pay” have not investigated . It is noted that it is EU and UK government policy to make the polluter pay and to internalise external costs. It is also noted that the aviation industry is complex and has many strategies available to it to minimise or mitigate a carbon tax or an emissions charge and ensure that the full weight of the monetary value of that charge or tax does not bear down on the passenger. This will reduce the impact of the tax or charge on passenger demand so that demand reduction does not take place or is much lower than it could be. A direct and transparent method is preferred whereby the fares rise in the way we have specified in the MI Scenario and cannot be diluted or mitigated by industry strategies to fuel extra demand through lower fares.

Creaton (2005) shows how one low cost airline (Ryanair) produces low fares by very impressive cost cutting and by robust negotiation to produce, for example, a 50 per cent reduction in landing charges at Stansted. Any carbon taxation or emissions charging regime would be severely compromised by the ability and willingness of local authorities and airports to grow the demand for flying by finding ways of delivering financial inducements to airlines which then negate wholly or partially the impact of the tax or charge. This study has set out to avoid this.

Behaviour

In terms of behavioural change, the MI Scenario assumes that there is a continued drive by the Government towards a low-carbon economy and that this is reflected in changes in behaviour of businesses, tourists and the ways in which business to business contacts and family contacts are initiated and maintained. Stringent regulation of behaviour in the form of carbon rationing or personal carbon allowances is not envisaged in the MI Scenario. However, people will tend to travel shorter distances and there will be greater use of railways for domestic travel as a result of improved services and lower fares. People will still take long haul flights but less frequently.

Other factors may also lead to a change in travel behaviour patterns. For instance, the global impact of climate change will affect leisure and tourism travel. Under IPCC climate change predictions many destinations face risks from climate change in the form of coastal inundation, erosion, saline contamination and loss of beach. Some small island states will be submerged in water due to rising sea-level (Mimura *et al.*, 2007). Increases in sea surface temperature of approximately one to three degrees C are expected to result in more frequent coral bleaching events and widespread coral mortality. Southern Europe will simply become too hot for holidaymakers and there will be a shift in demand for tourism to countries in more northern latitudes including the UK. This is

Table 4.9: The impact of fiscal measures on CO_2 emissions in the MI Scenario

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Fiscal Measures	37.5	59.9	43.5	-27%

highlighted in Eurocontrol's "Challenges for Growth" report (2008):

"Within 10-20 years parts of the Mediterranean are forecast to become so hot during mid summer that this could cause a decline in the tourism economy during July and August."

Therefore, more domestic holidays could be taken in the UK which would also mean an increase in road traffic and domestic aviation. The UK may become a more popular holiday destination taking holidaymakers away from Mediterranean resorts.

Climate-sensitive diseases, including morbidity and mortality from extreme weather events, certain vector-borne diseases, and food- and water-borne diseases could increase under a warming climate. The perception of the risk to human health to diseases such as swine flu and severe acute respiratory syndrome (SARS) could result in changes in demand for air travel and flight patterns. The Mexican swine flu pandemic of 2009 saw airlines reducing services at least over the short-term. These events are difficult to predict and not explicitly modelled here but rather highlighted as potenetial consequences of climate change which will affect demand.

Substitution of information technology

Technology will play an important role in reducing air travel and in particular business travel which accounts for 14 per cent of the market (UK and Foreign together). The extent to which this situation will actually materialise is difficult to predict as it will require both a shift in organisational behaviour as well as significant investment in infrastructure to provide high quality video-conferencing and associated secure electronic data transfer. The next generation of broadband and more extensive wireless connectivity could mean both business and households will require less travel. There is a body of evidence to show that companies are beginning to substitute technology for travel. Joint research by ETNO and WWF (Pamlin and Szomolányi, 2008) suggests that (see figure 4.4):

> *"If all European companies were to cut their business travel by 20% and use video or audio-conferencing instead, we would save 22 million tonnes of CO_2 each year, equivalent to taking one third of the UK's cars off the road."*

Myoshi and Mason (2009) suggest that 10 to 20 per cent of business travel could be saved by either replacing the travel with alternative forms of communication or by simply stopping unnecessary travel. Therefore, if this 20 per cent saving in business related air travel can be achieved then this will lead to a significant reduction in carbon emissions.

A report from the WWF-UK (Pamlin and Szomolányi, 2008) entitled 'Travelling Light' suggests that many UK businesses have a "green" corporate policy which aims to reduce their carbon emissions and that they are willing to use technology to replace travel. However, they also point out that the quality of the experience needs to be better and the equipment has to be user-friendly with good inter-operability across different systems. This relates to the provision of high quality broadband to replace current broadband provision which is of much lower

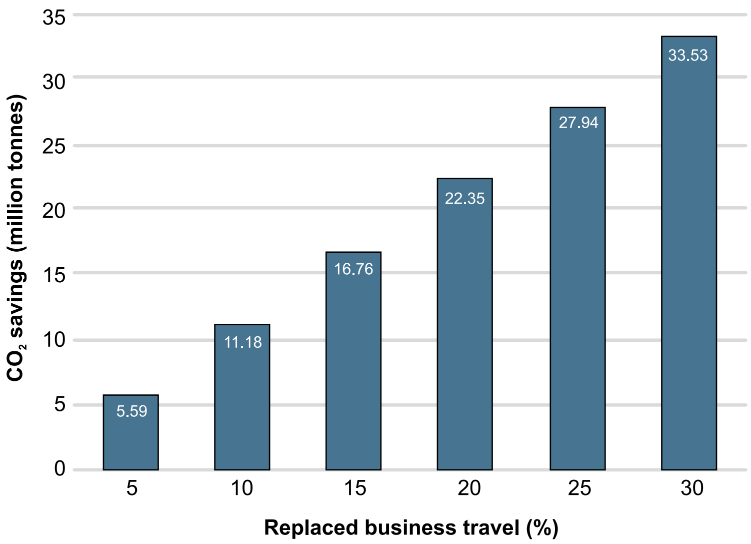


Figure 4.4: CO_2 Savings in Europe from use of video-conferencing
Source: Pamlin and Szomolányi (2008)

quality (speed, performance and availability). Most of the companies surveyed believe that investment in videoconferencing should be encouraged by the government. This could have additional benefits to the UK economy. However, there needs to be willingness on both the business community and the Government to achieve this. This will require incentives and other policy interventions to change current business travel behaviour

Ackerman (2005) presented a range of different scenarios for aviation up to 2050 and sees information technology as one of the key driving forces for reducing emissions though substitution. The reduction in short haul flights has also been driven by the availability and relative cost of quality high-speed rail links within Europe.

In the MI Scenario, aviation business travel activity is assumed to have fallen by 20 per cent by 2050. This has the potential to reduce emissions by 1.7 Mt CO_2 (2.8 per cent). Table 4.10 shows the reduction in CO_2 emissions in 2050 from video conferencing assumed for the MI Scenario.

Substitution of air travel by rail travel

In the absence of a national plan aimed at re-localising economic activity, it is assumed that high speed rail will be the preferred option for replacing physical travel in order to reduce domestic and short haul aviation in UK. This will require four strands of intervention:

- Government subsidy to reduce the price of rail travel. This would be affordable if revenue from Air Passenger Duty was used.
- Upgrade of existing rail lines to accommodate high speed trains as well as improvements in service (networks and schedules) and e-ticketing.
- Investment in rail termini. These are needed to connect both major urban areas and main points of international embarkation/disembarkation (sea ports and airports).
- High speed rail links to Europe extended.

Within Europe it is foreseen that the expansion of the network of high-speed rail will attract more passengers travelling shorter distances. This development will reduce aviation passenger demand by 0.3-0.5 million flights in 2030 in particular those short-haul fights within Europe for which the train can be time-competitive (up to approximately 500 km) (EUROCONTROL, 2008). However, if the UK's high-speed rail network connects with mainland Europe then there is even more potential for replacing short-haul flights especially within Northern Europe (Belgium, Holland, France and Germany). This accounts for approximately 10 per cent of UK arrivals and departures in 2007. The MI Scenario applies a 50 per cent reduction to statistics for France and Germany to recognise the size of the country and that high-speed train substitution is less likely (DfT, TSGB, 2008b).

Under the MI Scenario there will be complete rail substitution for domestic air travel by 2030 (given a 10 year high-speed train investment plan). This means there is a potential saving of approximately 3.5 Mt CO_2 per year. It is assumed this substitution is made by rail transport powered by renewable energy sources. It is also assumed a feasible reduction in short haul flights from nearby Europe by 10 per cent. This would mean a further 1.4 Mt CO_2 (approximately one per cent aviation emissions) by 2050. This represents approximately eight per cent of total aviation emissions (see table 4.11).

Summary of all measures

Table 4.12 shows the impact of each of the measures used in the MI Scenario for aviation. Each measure is first of all considered in isolation so, for example, 'constrained demand' reduces the BAU 2050 total from 59.9 Mt CO_2 to 54.0 Mt CO_2, a reduction of 5.9 Mt CO_2 or 10 per cent. This same calculation is then repeated for each measure so that each row shows the

Table 4.10: The impact of the MI Scenario video conferencing measures on CO_2 emissions

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Video Conferencing	37.5	59.9	58.2	-2.8%

impact in isolation of each of measure in reducing the BAU total. The final row uses the methodology described in Section 4.1 (using an extended version of Equation 1) to combine all six measures so that the final result is a reduction of 33.6 Mt CO_2 which brings down the BAU 2050 total of 59.9 Mt CO_2 to a new total of 26.3 Mt CO_2. This is a reduction of 56 per cent. It can be seen that the combined reduction is somewhat lower than the value obtained by adding up the six separate reductions (whether as Mt CO_2 or percentage). This is because the combined reduction was calculated using a methodology (see Section 4.1) that avoids erroneously overestimating the combined effect of more than one measure.

It is clear that by 2050, aviation is a long way from decarbonising under the MI Scenario. The MI Scenario has taken into account the fact that there are already a number of policies assumed within the BAU Scenario including fuel efficiency improvements related to aircraft engine technology and air traffic management. It also includes the participation of aviation in the EU ETS. However, it can be seen from table 4.12 that fiscal measures (27 per cent) and aircraft technology (14 per cent) make the largest reductions in emissions. Railway and video substitution have a smaller impact largely because the measures do not affect the whole market. For example, railways substitution only affects the domestic market which is only a relatively small percentage of total emissions. It is can be seen that taken together, those measures that reduce demand (constrained demand, fiscal measures, railway substitution and video substitution) would deliver considerably greater reductions than could be achieved by simply focussing on improvements in aircraft technology and air traffic management.

Table 4.11: The impact of rail substitution on aviation CO_2 emissions assumed in the MI Scenario

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Rail Substitution	37.5	59.9	55.0	-8.2%

Table 4.12: Summary of all measures taken in the aviation industry in the MI Scenario

	2005	2050	Reduction in CO_2 emissions (Mt CO_2) relative to 2050 BAU	Per cent change in CO_2 emissions relative to 2050 BAU
	Emissions (Mt CO_2)			
BAU Total	**37.5**	**59.9**		
MI measures separately:				
Constrained Demand		54.0	5.9	-10%
Aircraft Technology		51.8	8.1	-14%
Air Traffic Management		52.1	7.8	-13%
Fiscal Measures		43.5	16.4	-27%
Railway Substitution		55.0	4.9	-8.2%
Video Substitution		58.2	1.7	-2.8%
All MI measures combined		**26.3**	**33.6**	**-56%**

Note of Explanation. The effect of all measures combined is somewhat less that the sum of the effects of each measure implemented separately. This is intentional because the method used is designed to avoid overestimating the combined effect of measures for which information is only available concerning their effects when applied individually. (See text for more details.)

4.5 SHIPPING

The Government has outlined its options for dealing with shipping emissions in its "Low Carbon Transport: A Greener Future" report (DfT, 2009a) although shipping was left out of the 2006 Climate Change Bill. The UK Government does not foresee that shipping, like aviation, can be fully decarbonised. However, it suggests there will be major step changes in efficiency through technology and operations (DfT, 2009a). In addition, it considers the International Maritime Organisation (IMO) as the main body to enforce regulation for emissions at global levels. However, the Government envisages that the implementation of such regulation, or setting a cap on emissions, will be a very slow process and suggests instead that shipping be included within an EU Emissions Trading System. Shipping emissions could be offset by reductions in other sectors operating in the scheme. However, this has a number of potential problems related to the allocation of carbon permits. If this is done on the basis of a freight-tonne kilometres (FTK) then there needs to be some kind of apportionment according to journey segment. Secondly, if it is done on bunker sales a certain amount of carbon is not accounted for as ship operators will bunker fuel where it is cheapest or where it most convenient on route.

In the MI Scenario, emissions for shipping are derived from the allocation method based on FTK as this is a better reflection of UK economic activity and methods are also fairly well-established for allocating emissions on journey segment. It is apparent that using bunker fuel sales would severely under-estimate UK shipping emissions.

An AEA Technology study (AEA Technology, 2008) examined the possibilities of reducing CO_2 from shipping including technological, operational, fuel technology and global carbon price. The implications of their study are that, under a high carbon price scenario, emissions from shipping in 2050 could be double current levels. A number of assumptions about the likely operational, technological and design improvements in ships over the next forty years are included within their scenario. These are summarised as follows:

Operational

- a shift to larger ships, or operating ships at slower speeds;
- optimal hull maintenance and upgrades to propellers and engines;
- improved on-board operations such as better energy management and voyage optimisation.

Technological and design

- improved hull and propeller designs to reduce resistance and increase propulsive efficiency;
- propellers designed to recover energy;
- improvement in the overall body design to reduce air and wind resistance.

The CCC sees the potential for carbon reductions as follows:

- potential to reduce CO_2 emissions from existing ships by approximately 10 per cent through operational measures and by retrofitting various technical measures, while a state-of-the-art ship built in 2008 could emit 27-32 per cent fewer emissions compared to a baseline 2008 typical in-service ship;
- a 2022 state-of-the-art ship might emit 32–35 per cent fewer emissions than a 2008 typical in-service ship.

The European Technology Platform, "Waterborne" in its "Vision 2020" considers different technological improvements in ship design which will contribute to carbon reductions. This will be through the development of clean propulsion systems and economic retrofit-packages for existing ships as well as non-fossil based propulsion solutions for economic application on large ships and highly sophisticated ICT as well as improved ports handling and operations. Improved engine efficiency could reduce fuel consumption by up to 30 per cent.

The MI Scenario assumes there will be a number of operational, technological and design improvements in ships over the next forty years which could lead to a reduction in shipping emissions.

Speed

Ships travelling at slow speeds have been found to be far more efficient and less polluting (Harrould-Kolieb, 2008). The IMO suggests that slower speeds applied across the whole fleet could reduce emissions by 23 per cent. Further measures through voyage optimisation can also lead to improved fuel efficiency. Voyage optimisation is where ship operators take various measures to reduce fuel consumption. These are made by operating within the constraints that are imposed by logistics, scheduling, contractual arrangements and other constraints. These measures include (IMO, 2009):

Table 4.13: The impact of the speed reduction and voyage optimisation measures on CO_2

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Slower Speeds / Voyage Optimisation	18.9	59.9	46.1	-23%

- selection of optimal routes with respect to weather and currents in order to minimize energy consumption (weather routeing);
- just-in-time arrival, considering tides, queues, and arrival windows taking into account penalties and safety;
- ballast optimization – avoiding unnecessary ballast;
- trim optimization – finding and operating at the correct trim.

Table 4.13 presents reduction in CO_2 emissions from speed reduction and voyage optimisation. The MI Scenario uses value suggested by the IMO to reduce carbon emissions by 23 per cent and amounts to approximately 14 Mt CO_2 in 2050.

New technology

In the past ships used sails to harness the power of wind and kite sails are now being suggested as a novel means of reducing fuel costs and also for reducing carbon emissions. A kite's shape is aerodynamically more efficient than a standard spinnaker on traditional ships; the kites fly up to 1,000 feet above the sea surface where winds are much stronger. Using sails under optimal wind conditions, fuel consumption can be reduced by up to 50 per cent. However, these conditions are usually only temporary. According to Skysails (2009) 10-35 per cent fuel savings are likely but only for 30-50 per cent of the time the vessel is at sea. Improved weather-tracking using satellite and radar systems could enable the ships to alter its route to seek out the stronger winds. The technology is being used on cargo vessels already and there are no real barriers to retro-fitting the whole fleet.

Another more radical ship design uses technology known as an Air Cavity System (ACS). This development by the DK Group[7] could reduce emissions by 15 per cent. This technology is still a prototype and involves injecting air into specially designed hulls which reduces the frictional resistance of the hull surface against the water. This means that the ship requires less engine power and consequently less fuel and as a result, carbon emissions are reduced.

As in the case of aircraft, the speed of implementing this technology is again, fairly slow. Therefore, carbon reductions will be constrained by the ability of shipyards to meet demand and by the rate of fleet turnover. Ships have a long service life and so replacement of ships may take some time. There can be accelerated development in new technology possibly through incentives scheme by building new fleets and retrofitting.

In the MI Scenario the introduction of new technology will lead to an average 30 per cent reduction in ship emissions by 2050 with the assumption that the fleet is either replaced with new ships or retrofitted (see table 4.14).

Cleaner fuels

Ships can reduce CO_2 emissions by 4-5 per cent by switching to "cleaner" fuels where marine diesel oil is used instead of residual oil. Residual (heavy) oil is much cheaper for shipping lines but requires more processing on board. A by-product of this is sludge which is then burnt on-board releasing a variety of particles (sulphates, black carbon). Cleaner fuels are processed at refineries and so there are potentially life-cycle carbon emissions to consider and the net effect might only be two to five per cent reduction. Therefore, in the MI Scenario a conservative four per cent reduction in emissions is used.

As in the case of aviation, the use of biofuels is not considered an option. The IMO's (2009) summation of the potential of using first or second generation biofuels is given below:

"In summary, the present potential for reducing emissions of CO_2 from shipping through the use of biofuels is limited. This is caused not only by technology issues but by cost, by lack of availability and by other factors related to the production of

7 See: www.dkgroup.eu

Modern ship - MV Emma Maersk © tidewater muse/flickr

biofuels and their use. Additionally, the biofuels are, at present, significantly more expensive than petroleum fuels." (IMO, 2009)

An alternative to biofuels is Liquefied Natural Gas (LNG) which has a number of additional benefits such as low levels of emissions of nitrogen oxides, sulphur oxides and particulate matter. Unfortunately, there are associated increases in emissions of methane, a more powerful GHG than CO_2. Another option for shipping is to use nuclear reactors onboard although this is not likely for obvious environmental, political and security reasons. Table 4.15 presents the reduction in CO_2 emissions from ships using cleaner fuels.

Shore-side measures

Other measures within the MI Scenario include portside measures such as cold-ironing. This is where ships, whilst docked in port, shut off their propulsion engines and use auxiliary engines to power on-board

Table 4.14: The impact emissions of CO_2 from shipping using new technology

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Technology	18.9	59.9	41.9	-30%

refrigeration, lights, pumps and other equipment. These auxiliary engines tend to be powered by high-sulphur marine heavy fuel oil or in some cases by low-sulphur marine gas oil, resulting in significant emissions of air pollutants. Therefore, an alternative measure to reduce emissions from the ships whilst docked is to connect to shore-side electricity generated from renewable sources. It is often possible to reduce energy consumption on board ships by using equipment more efficiently and using optimal settings for heating ventilation and air conditioning. The IMO states that up to a two per cent reduction in fuel consumption could be made. This figure is used in the MI Scenario and shown in table 4.16. Solar panels on-board the ship could also be used although only as a source of complementary energy and it use therefore will have little overall effect on emissions.

Summary of all measures

Table 4.17 presents reductions in CO_2 emissions in 2050 from all shipping measures used in the MI Scenario, both when applied separately and when combined. Each measure is first of all considered in isolation so, for example, new technology reduces the BAU 2050 total from 59.9 Mt CO_2 to 41.9 Mt CO_2, a reduction of 18 Mt CO_2 or 30 per cent. This same calculation is then repeated for each measure so that each row shows the impact in isolation of other measures in reducing the BAU total. The final row uses the methodology described in Section 4.1 to combine all the measures so that the final result is a reduction of 29.5 Mt CO_2 which brings down the BAU 2050 total of 59.9 Mt CO_2 to a new total of 30.4 Mt CO_2. This is a reduction of 49 per cent. Unlike the situation for aviation, it can be seen that emissions in the 2050 MI Scenario are still significantly higher than those in the BAU baseline year of 2005. This is due to the overall growth in shipping expected in the next forty years.

4.6 SUMMARY OF MI EMISSION ESTIMATES

Table 4.18 and figure 4.5 provide a summary of the CO_2 emission reductions achieved by implementing the package of measured discussed in the MI Scenario. Road transport will be completely carbon neutral by 2050 due to a combination of reduced demand (approximately 75 per cent from spatial, fiscal and behavioural measures) and a whole-scale shift in technology to PEVs and H-fuel cell vehicles, both of which will utilise decarbonised UK electricity supply. Clearly, a carbon neutral electricity supply would be much more likely to be able meet the increased needs of a road transport sector almost entirely composed of PEVs and/or H-fuel cell vehicles if total demand is also drastically reduced. As for road transport, rail passenger and rail freight CO_2 emissions will be cut to zero due to being 100 per cent powered by a decarbonised electricity supply.

Emissions of CO_2 from aviation in the 2050 MI Scenario have been reduced by 56 per cent when compared with the 2050 BAU emission as well as being 11.2 Mt less than the baseline 2005 figure. This represents significant progress in bringing aviation into line with the implications of the UK national commitment to an 80 per cent reduction by 2050 on a 1990 base. The scale of reduction achieved

Table 4.15: The impact on emissions of CO_2 from shipping using cleaner fuels

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Cleaner Fuels	18.9	59.9	57.5	-4%

Table 4.16: The impact on emissions of CO_2 from shipping following the implementation of shore-side measures

Measure	Baseline (2005) CO_2 Emissions (Mt)	BAU CO_2 emissions in 2050 (Mt)	MI CO_2 emissions in 2050 (Mt)	Change in CO_2 emissions over 2050 BAU emissions
Shore Side Measures	18.9	59.9	58.7	-2%

Table 4.17: The impact of all shipping measures on CO_2 emissions in the MI Scenario

	2005	2050	Reduction in CO_2 emissions (Mt CO_2) relative to	Per cent change in CO_2 emissions relative to
	Emissions (Mt CO_2)		2050 BAU	2050 BAU
BAU Total	18.9	59.9		
MI measures separately:				
New technology		41.9	18.0	-30%
Speed /Voyage Optimisation		46.1	13.8	-23%
Cleaner Fuels		57.5	2.2	-4%
Shore Side Measures		58.7	1.2	-2%
All MI measures combined		**30.4**	**29.5**	**-49%**

Note: As in table 4.12, the effect of all measures combined is somewhat less that the sum of the effects of each separate measure due to the use of a method (explained fully in Section 4.1) that avoids overestimating the effect of combining measures.

is still not enough but it has been produced by the full application of all available measures. It is clear that a combination of those measures that reduce demand such as air fare increases, no additional runways, modal shift to railways (including High Speed Rail) and video substitution would deliver a considerably greater reduction than could be achieved by advances in aircraft technology and air traffic management alone. It follows that a reduction in CO_2 emissions from aviation of this scale could not be delivered by a policy that encouraged technological solutions but allowed demand to continue to grow. As in road transport, technology alone cannot solve these problems and first and foremost, measures are required that substantially reduce demand. Any expansion of airport capacity through building new runways would have the effect of supporting year-on-year increases in demand and therefore does not form part of this MI Scenario. Indeed, there would be no need for any new runways under a policy designed to maximise CO_2 emissions reductions from aviation through a demand-led reduction strategy as assumed in this MI Scenario.

Published evidence leads to the conclusion that CO_2 emissions from shipping can be reduced by 49 per cent through changes in ship size, routeing, fuel, speed and a number of other promising technologies. No change in prices for shipping bulk products or ‘twenty-foot equivalent units’ (TEUs) have been factored in the analysis because of the lack of published information on robust relationships between shipping prices and the physical quantity of goods shipped or the distance over which they have been moved.

Although road and rail transport could both achieve the zero CO_2 emission target by 2050, emissions from aviation and shipping are problematic. For the 2050 MI Scenario, the net result for the entire UK transport sector is a 76 per cent reduction in CO_2 emissions compared with the 2050 BAU Scenario (or a 68 per cent reduction on the BAU baseline year emissions). This falls short of the zero carbon target for UK transport as a whole by 2050. The 24 per cent shortfall is entirely due to the remaining CO_2 emissions from aviation and shipping. However, the reductions achieved in this study are still significantly greater than other studies examined and reflects a 100 per cent decarbonisation of road transport which is responsible

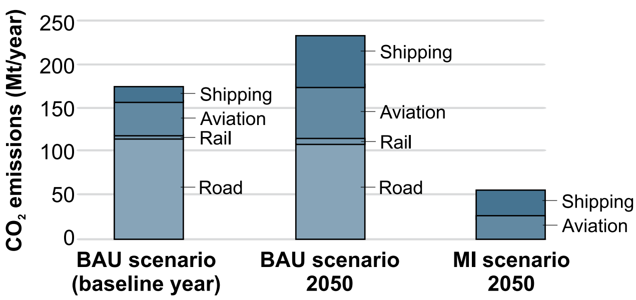


Figure 4.5: Summary of CO_2 emissions for BAU and Maximum Impact (MI) Scenarios

Table 4.18: Summary of BAU versus MI Scenario

Category	Baseline emissions ($Mt\ CO_2$) [and Year]	BAU emissions ($Mt\ CO_2$) 2050	MI emissions – Combined measures ($Mt\ CO_2$) 2050	Reduction in CO_2 emissions relative to 2050 BAU
Road	116.2 [2003]	110.2	0	100%
Rail	3.4 [2006/7]	4.6	0	100%
Aviation	37.5 [2005]	59.9	26.3	56%
Shipping	18.9 [2005]	59.9	30.4	49%
All transport	**176.0 [composite year]**	**234.6**	**56.7**	**76%**

for 66 per cent of baseline transport CO_2 emissions. In addition, it achieves a 49 per cent reduction in CO_2 from shipping and a 56 per cent reduction for aviation. To improve on the overall CO_2 emissions reduction for transport would require much more radical interventions or technological innovations for these two sectors than those envisaged in the present study.

Panorama in Freiburg-Vauban - © Matthew Wyneken

5 LIFE IN A ZERO CARBON TRANSPORT BRITAIN

In addition to reducing GHG emissions, moving towards a zero carbon transport system will lead to a number of social, environmental and economic benefits. These co-benefits will improve the quality of life for social groups of widely differing lifestyles and transport needs. The measures outlined in the MI Scenario will deliver the transition towards a zero carbon transport system which in turn, will produce knock-on beneficial effects in the following key areas:

- environmental quality;
- social exclusion and mobility;
- accessibility.

Environmental quality

Motor vehicles are an important source of nitrogen oxide and particulate matter (PM) pollutant emissions. Nitrogen oxides are acidic gases and ozone precursors and can affect human health and vegetation. Airborne particulate matter (usually measured as PM10) consists of fine particles that can be carried into the lungs and have been linked to premature deaths among those with pre-existing lung and heart disease. Annual average particulate matter levels have been steadily decreasing. However, there has been an upward trend in background urban ozone levels due to the reduction in urban emissions of nitrogen oxides, which destroy ozone close to their emission source. Ground level ozone occurs naturally but levels can be increased as a result of reactions between nitrogen oxides, oxygen and volatile organic compounds in the presence of sunlight. Once formed, ozone can persist for several days and can be transported long distances. In addition to being a powerful greenhouse gas, ozone can cause irritation to the eyes and nose and exceptionally the airway lining (when levels are very high), and can also damage plants and crops.

The UK has a serious air quality problem in its cities with over 150 declared Air Quality Management Areas (AQMA) where air quality exceeds thresholds designed to protect human health. Most of the AQMAs are traffic related and are the subject of Air Quality Action Plans that are largely ineffective. AQMAs have been in place for over 10 years and very few have been "signed off" in the sense that an Air Quality Action Plan has been successful and air quality problems have been resolved. Over 16,000 people die in the UK each year as a result of vehicle-related poor air quality. The phasing-in of PEVs to replace petrol fuelled vehicles and an increase in the use of public transport, cycling and walking will eliminate traffic-related air quality problems bringing a significant public health gain as a co-benefit of reducing CO_2 emissions

In addition, there will be a reduction in vehicle related noise pollution due to a decrease in the number of vehicles used and the gradual substitution of electric vehicles for internal combustion engines produces less noise. Transport noise can cause sleep disturbance, cardiovascular disease, elevated hormone levels, psychological problems and even premature death. Studies on children have identified cognitive impairment, worsened behaviour and diminished quality of life (EEA, 2009).

Social exclusion and mobility

Transport provision in the UK has evolved in a way that excludes many groups from playing a full role in a modern society. They exhibit a lack of mobility often compounded by a lack of accessibility that excludes them from work, leisure, educational and other opportunities (Solomon, 2003). Four main types of transport social exclusion have been identified by the UK government and discussed in Solomon (2003). They are:

- spatial - where people simply cannot get to the location they wish to access (e.g. there is no transport to or from a particular settlement, for example the home of a relative);
- temporal - where they cannot get there at an appropriate time (for example no buses catering for shift working patterns no transport available for young people to return from town in the evening);
- financial - where they cannot afford to get there (when the sacrifice of, for example, food for fares, is not realistic);
- personal - when they lack the mental or physical equipment to handle the available means of mobility (they cannot comprehend the system, or they cannot physically use what transport is available).

Problems of social exclusion and lack of mobility have a differential impact on key identifiable groups and sub-groups in society:

- the unemployed;

- families with young children;
- the young;
- those on low income;
- the elderly;
- those living in rural areas.

Moving towards a zero carbon transport system is associated with the reduction of the need to travel, much improved levels of service and quality for bus, bike and pedestrian journeys and the closer physical proximity of destinations that are routinely accessed. The quality of life for all those without access to a car will improve as the transport system adjusts to prioritise the needs of those who rely on alternatives to the car. These groups are dominated by women, the elderly, those on low income and young people. A zero carbon transport system provides a remedy for the long-standing problem of transport, social exclusion and mobility.

Reduced traffic levels also contribute to improved road safety, the reduction of death and injury and the attractiveness of walking and cycling as transport choices especially for women and children. This improvement in road safety is of direct benefit to low income groups and ethnic minorities who experience a higher level of death and injury on the roads than other groups.

Accessibility

Accessibility is indivisible from the consideration of social exclusion and creating a transport system that rewards all users rather than those relying on private car ownership. The distinctive dimension of accessibility is its emphasis on the ways in which society provides destinations that can be easily accessed for routine everyday purposes. To give a very clear example, a policy that seeks to close 3,000 post offices in urban England is a policy aimed at reducing accessibility and depriving socially excluded groups of easy access to a basic service and ensuring that more car trips are made to the remaining post offices which are now fewer and hence on average further away than they used to be. Post offices are important in a consideration of accessibility but the principle applies to local shops, dentists, doctor's surgeries, workplaces and a large number of leisure and education facilities. A prioritisation of accessibility in public policy would seek to enrich the density of provision of these facilities within a given range of where people live e.g. provide more local swimming pools. This is exactly the policy objective adopted in the MI Scenario where spatial planning and "densification" have been used to reduce the need to travel and put many more destinations within easy reach of homes. A zero carbon transport system is a system that maximizes accessibility.

Lifestyles

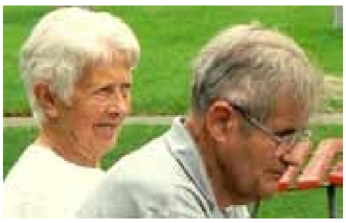
Moving towards a zero carbon transport Britain will affect diverse lifestyle groups in different ways. By 2050 Britain is expected a have an older population, where people aged over 50 will represent 30 per cent of the population compared to approximately 20 per cent in 2006 (See table 5.1) (GAD, 2007) . Many older people will remain fit and active into later life where mobility will be a key factor in determining their quality of life. The following narratives compare the current lifestyles of typical families with those likely to be led by their equivalent counterparts in 2050 under assumptions made in the MI Scenario.

Table 5.1: Population forecasts

	2006	2051
Percentages		
0-14	17.6	16.3
15-29	19.6	17.1
30-44	22.0	19.1
45-59	19.4	17.2
60-74	13.7	15.7
75 and over	7.7	14.5
All ages	**100.0**	**100.0**

NARRATIVES

Retired couple



Ron and Mary's transport needs involve using rail and coach to visit family and distant relations and friends. They use public transport mainly for city centre shopping, medical visits and leisure activities. They take a couple of major holidays a year and enjoy the advantages of off-peak European package holidays and cruises.

In 2050 Britain older people like Ron and Mary will enjoy the benefits of much improved public transport services. They will notice this through increased frequencies of bus services, bus services that run from early in the morning until late at night and at weekends and on bank holidays. These services will link residential areas with a range of important destinations and the rural retired will notice a dramatic increase in bus service provision and frequency. Bus use will continue to be free for this group as is currently the case but car ownership will be rendered almost totally unnecessary as a result of the dramatic increase in bus service density.

Rural areas will also benefit from so-called "demand responsive transport" where buses, given enough notice, will deviate from a set route and call at the home of the person requesting the service. Transport options will also include car share clubs where retired people can access cars for any journey that would still be difficult by the much-improved public transport.

Retired people will still have the option of taking holidays abroad but air travel will be more expensive so less frequently used and sea transport will figure much more as a transport choice.

Young family

Nick has a company car and works from home one day a week. Claire runs a small car and drives to her clients after dropping their child at the child-minder. They are located just outside the main urban area on a new estate built on a green field site which has a bus service every 20 minutes. However, neither Nick nor Claire has ever used it. They go to the out-of-town shopping centre at the weekends for the weekly supermarket shop and for leisure activities (cinema/ten-pin bowling). Nick plays sport twice a week and Claire goes to the gym three times a week. Both of these take place in the city. They also socialise with friends in the city rather than on their estate. They go on a package holiday once a year and take day-trips to the seaside at other times of the year. They visit grandparents on an alternate weekly basis. They usually go out for a pub lunch in the countryside.

In 2050 Nick's company have upgraded their fleet of hybrids with electric vehicles. Claire's counterpart works in her own salon on a new eco-development serving the surrounding estates. This development encourages people to walk or cycle through a local incentive scheme so she does not need a car. Doing without a second car saves a great deal of money and increases their disposable income.

The new eco-development is powered by micro-generated renewable energy. The development also includes gym and sports fields meaning the Nick and Claire's 2050 counterparts travel less into the city by themselves. However, at the weekend they go into the city as a family for cultural activities and to meet friends and family. This is now much easier and cheaper because there are more buses and buses have a "family day ticket" which produces an 80 per cent reduction in fares compared to the old system of charging every adult and child for the bus trip.

Nick and Claire's counterparts also holiday with their family in the UK however they take the train rather than drive. Trains now include on-board entertainment, generous space, windows you can see out of, child compartments, high quality food and drink and ample luggage space including a luggage van on routes that could benefit from this service. This is important with a family with three small children.

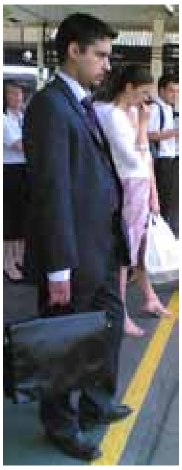
Trains are cheaper and they can purchase a family ticket in advance so there is guaranteed seats for all the family. These trains are state-of the-art. Journey times are quick, toilets are clean and do not malfunction and taxi services at the destination are built in as part of the service and meet the family for the final leg of the trip by road.

Married professionals with children

Greg and Deidre have cars and use them for commuting to work, the school-run and for ferrying children to after-school activities. They also take part in local community activities including the parent-teacher association and church. They tend to eat out as a family at the weekend. They have at least two holidays a year usually a package holiday destination in the summer and a camping trip in the spring

In 2050, overall changes in logistics for families like Greg and Deidre's have helped create more quality time which is spent locally. Greg's 2050 counterpart runs an electric vehicle purchased under a Government car scrappage scheme. He has reduced his business mileage through using technology – he uses video-conferencing from his office to speak to clients he has already met and uses software for more efficient meeting and journey planning. Deidre's 2050 counterpart does not have her own car but car shares to work with her colleague. This saves a great deal of money and boosts the family budget. As active members of the church they help to operate an electrically-powered mini-bus which picks up parishioners who are either too old or less mobile. They invite friends and relatives for lunch or dinner at the weekend instead of going out to eat. They have an allotment and make their own bread. They still take two, sometimes three holidays a year however, these are usually activity holidays in the UK. They take their children on weekend breaks to European cities (Paris, Berlin, Bruges) by rail as they can check-in from their local underground station all the way to their destination due to standardised ticketing which operates across Europe.

Semi-rural professionals



Richard commutes to London by train during the week – Monday and Thursday. He also travels abroad frequently for business purposes. Richard uses a computer/internet for work i.e. logging onto the company intranet. However, he relies on the IT support desk to ensure his equipment works. His wife, Valerie does a lot of outside activities including golf (twice a week) and riding (once a week) and she also drives a relatively new 4 x 4 Volvo X90 which she needs for driving to the stables. Richard does not do any other exercise and suffers from diabetes and hyper-tension due to his stressful lifestyle.

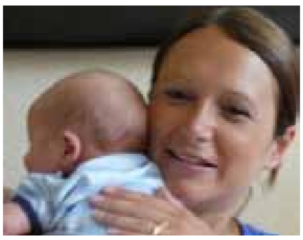
Richard's 2050 counterpart spends less time flying and so has more time to spend playing golf and being with his wife. He is also able to spend more time in the region where he lives as his company has installed a fast broadband home office enabling him to conduct his business at home. He also drives less than his 2010 counterpart as he also uses video-conferencing office suites at a number of locations across the UK. This means he can rent a fully-equipped tele-presence office suite (including fair-trade tea and coffee) by the hour. Valerie's 2050 counterpart plays golf four times a week, is able to go out horse-riding more often and drives a much smaller, plug-in electric vehicle. At the weekend they cycle to the local pubs for lunch. Richard's 2050 counterpart lives a much less stressful life and his blood-pressure is within the normal range.

Young couple

Danny and Stacy own one car which is nine years old. They are reliant on this for going to work Danny drops Stacy at her work and usually picks her up. They also use it for driving out to the shopping mall. They use public transport and taxis during the evening. They go on self-catering holidays in the UK. They go by car to a caravan at the coast. Except for a local convenience store, the estate where they live is too far from the main shopping centre and poorly served by public transport and so they drive out to the local retail park. Danny watches his local football team regularly and also plays for his local pub football team. Stacy visits her mum every Sunday for lunch – she takes the bus there and taxi back. She goes out night-clubbing with her work colleagues every Friday and either takes the night bus home or shares a lift.

Danny and Stacy's 2050 counterparts have a small but stylish plug-in electric car which they share with friends. They enjoy the freedom of not having children and so also have a hectic social life. However, they do all their shopping on the internet so that they can maximise their socialising time at the weekends. They use the much improved bus service for most of their non-work related travel and still mainly go on self-catering holidays in the UK.

Single parent



Mary relies on the bus for all her travel. Her estate is a long way from the city centre and cannot afford a car or taxis. However, due to poor lighting, and poor access and other anti-social problems buses do not stop near her estate anymore. The most direct route for her to walk passes through an unlit recreation park and so she avoids this making her journey times longer. She uses local services for all her needs apart from the local health centre which was recently set on fire and so has to take her son who is asthmatic to the District Hospital on the other side of the city. She also has to go into the city to go to the Job Centre. Mary has not had a holiday or left her home city for about 10 years. She had a bike but it was stolen.

Mary's 2050 counterpart is also unemployed but her quality of life is much better. Her son has no health problems with his lungs as air quality is much improved due to the fact that all vehicles in the city are either electric or have very low air pollutant emissions. Due to a healthy routes initiative based on smarter choices which incorporates a pedestrian/ cycleway, the local authority has invested in street lighting with a text and web-based 'lights-out' reporting facility. Each street-light location is recorded spatially and given a unique code identification number. Residents are able to text or email and also locate on an on-line map the position of the street light that has gone out. This is the chosen route for Mary's counterpart to go to local shops and school.

Public transport is now much cheaper than it used to be and connects Mary's counterpart with most destinations she needs to reach. This has saved money and also made her access to training and education much easier so she is improving her skill levels and qualifications which she expects will lead to a well-paid job.

A Community Regeneration scheme has led to a number of improvements to the local facilities and services. The local streets have also been made safer through improvements in the road layout and other traffic-calming measure. As a consequence bus services actually stop nearby. The money she has saved has meant she has been able to go on several day trips during the school holiday.

Cycling - Holland © Dietmut Teijgeman-Hansen

6 POLICY PATHWAYS

In this Chapter, the policy changes and pathways that need to be introduced into the UK to deliver the carbon reductions reported for road, rail, shipping and aviation will be examined. These will be described and located within a delivery timetable so that all the measures and interventions work synergistically to move towards the desirable future of a zero carbon transport system in 2050. Before examining the policy components in more detail we first of all discuss the rebound effect.

The rebound effect

A rebound effect takes place when an environmental policy designed to reduce fossil fuel consumption (for example) produces an effect that is less than predicted because of changes in consumer or producer behaviour that consume some of the "gain" in more consumption. A frequently quoted example is that of a driver who benefits from more fuel efficient vehicles through a reduction in fuel costs and chooses to drive more miles each year because he/she can do so as a result of lower costs. Another example is energy efficiency in the home and the observation that loft insulation or double glazing produces reductions in energy costs which are then (partly) consumed by turning up the thermostat and enjoying a warmer environment. Recent research (UKERC, 2007) has confirmed that the rebound effect is real and can account for 30 per cent of the savings i.e. it can eliminate 30 per cent of the benefits of the energy efficiency measure. The research also confirms that the rebound effect is complex and difficult to predict in practice. The rebound effect is not evaluated in the context of this report. The existence of the effect has influenced the identification and selection of measures so that (for example) the internalisation of external costs and fiscal measures generally are designed to make sure that price signals reinforce physical measures and avoid the car-driver rebound effect identified above. The approach adopted has been to construct multiple, synergistic reinforcing measures around demand reduction, spatial re-engineering and fiscal measures so that the result in terms of travel choices and behaviour are "locked-in" and not diluted by rebound effects of any kind.

Spatial planning

Most of the policy framework for spatial planning is already in place in the UK Planning Policy Guidance 13 (PPG13)[8] and in Regional Spatial Strategies and policy pronouncements on accessibility. The problem is that on the ground things move in the opposite direction e.g. closure of 3,000 post offices and loss of small shops/local retailing. The following measures/interventions are needed:

A clear duty has to be imposed on local authorities by central government to increase the number of local facilities so that people are nearer to the things that they need to travel to. This would be associated with a similar duty imposed on all NHS, education and other public services and also Post Office Services.

- A clear duty should be imposed on every local authority to double the urban density from approximately 40 people per hectare to 80 people per hectare. This doubling of density would reduce urban car travel measured in VKT by 37 per cent (pers. comm. Kenworthy, 15 June 2009).

- Local Transport Plan (LTP) funding (LTP3 and LTP4) should be linked directly to outcomes especially the reduction of VKT and reduction of CO_2. The current system of funding capital and revenue bids and funding roads, trams etc, should be scrapped. Local authorities would be able to draw down funds in direct proportion to the degree to which those funds would reduce distance travelled and emissions. This would then shift funding into high quality cycle routes, improved bus services and much improved pedestrian environment.

- Changes need to be made to the planning system to require independent verification of the impact of the proposed development on CO_2 emissions. The independent verification body would work along similar lines to the National Institute for Clinical Excellence (NICE). There would be a presumption that those developments adding to CO_2 emissions would not gain permission unless there was an overwhelming national case demonstrating that (a) the development should proceed even though it adds to the CO_2 inventory and (b) there are no alterative options/plans or proposals that could achieve the same objectives at a lower CO_2 total.

- All new housing areas above 500 homes should be designed and developed within a totally integrated package in which the ways in which people will move around and access services has

8 PPG13 sets out the objectives to integrate planning and transport at the national, regional, strategic and local level and to promote more sustainable transport choices both for carrying people and for moving freight..

been anticipated and structured to deliver CO_2 reductions. This will be based on the example of Vauban in Freiburg (Germany) and other successful housing developments in the EU.

Fiscal

- Road fuel taxation should be increased annually through the re-introduction of a fuel price escalator to send strong market signals to car users to make changes to their behaviour that will reduce VKT. The increases will be large enough to deliver the reduction in CO_2 based on elasticity information in the MI Scenario and will also contribute to security and other policy objectives as we seek to reduce our dependence on fossil fuels.

- Parking cash-out (Shoup, 2007) should be introduced in every workplace and on the basis of international evidence this will reduce VKT by 12 per cent which translates directly as a 12 per cent reduction in CO_2. This reduction will apply only to the totality of VKT of car trips for the journey to work.

- Parking space not associated with the workplace (supermarkets, NHS facilities, retailing, tourism, recreational destinations etc) should be charged at a rate that represents the full commercial value of the land. Parking should not be subsidised or cross-subsidised.

- UK governmental spending on walking, cycling, public transport, shared space and urban design should be adjusted to the average prevailing in Austria, Denmark, Germany and Switzerland. Spending should be reported on a per capita basis and the current geographical inequalities in the UK eliminated. Currently, London has £826 public expenditure per capita per year on transport and the Northwest is £309, West Midlands £269, Yorkshire and Humber £239 and Northeast £235.

- All subsidies for road passenger transport, aviation and road freight should be eliminated and full internalisation of external costs implemented taking care to avoid "double penalties" e.g. if fuel taxation and parking charges cover internalisation then there is no need to go further.

Behavioural change

- Best practice in mainland Europe in public transport pricing should be adopted to deliver a much more attractive deal for bus and rail fares (n.b. UK public transport fares are amongst the highest in the EU).

- Large scale 'personalised journey planning' projects should be funded in all urban areas above 100,000 population and should be along the lines of the York Intelligent travel project or the project currently underway in Brisbane (Australia) covering 350,000 people. These projects are to run continuously and not be sporadic and 'one-off'.

- Workplace travel plan along the lines of the new BSI PAS 500 specification for workplace travel plans should be introduced in every workplace in the UK employing more than 100 people. This should be funded by the organisations themselves with appropriate taxation relief and also by public bodies in the same way as the extensive Transport for London workplace travel plan operation.

- There should be a similar programme for every school in the UK to minimise car trips and maximise use of alternatives. Every school travel plan should be fully funded by highway authority through LTP funds and linked directly to local engineering interventions to close roads, install cycle routes or take whatever other measures are needed to create a demonstrably safe and secure travelling experience for all pupils up to the age of eighteen.

- A programme of 'tourism without traffic' projects (along the lines of the East Sussex project) should be introduced so that car trips to tourist destinations can be shifted wherever possible to non-car modes. A duty would be placed on all national parks and areas of outstanding natural beauty to produce such a plan and to draw down funds sufficient to deliver large-scale modal shift and CO_2 reduction.

- All universities and all NHS facilities should adopt high quality travel plans using BSI PAS 500 as the basis. This should be funded by direct government grant and linked to local engineering interventions where appropriate.

- A mandatory default speed limit should be introduced on all residential roads of 20 mph and the police instructed to enforce it. Police authorities should be funded additionally to carry out enforcement.

- Legislation should be introduced to permit all residential roads with evidence of substantial rat-running to close the road to through traffic and restore a sense of "places for people" and a harmonious living space.

Technology

- All buses should be converted to best available technology for reducing air pollution and CO_2. This will be a combination of what is currently done in Helsinki, Stockholm and Bremen.

- All taxis should be similarly converted.

- All passenger cars in use in 2050 should be PEVs or hydrogen fuel cell vehicles, both of which will utilise a 100 per cent decarbonised UK national electricity supply system.

- All passenger and freight railway lines in UK should be electrified.

Table 6.1 outlines a policy implementation framework to move towards a zero carbon transport systems in the UK. However, achieving a near zero annual CO_2 emissions by 2050 is not the only consideration as the speed of implementation is also important. It should be emphasised that the earlier a measure is implemented, the greater will be the cumulative CO_2 emission reduction by 2050 and hence the greater will be its contribution towards mitigating future climate change. For example, by 2050, a reduction measure fully implemented in 2010 will deliver 40 times the total CO_2 emission reduction achieved by the same measure only implemented in 2049 (all other things being equal).

For this reason, it is envisaged that under the MI Scenario, the onset of implementation of most of the spatial, fiscal and behavioural measures listed in table 6.1 is immediate and that for the majority of these, implementation is completed by 2020. Compact development of cities and the technological advances included in the MI Scenario bring about continuous improvements spread over the longer term with complete implementation by 2050 at the latest.

As detailed in Chapter 4, implementation of the MI Scenario measures outlined in this policy pathway could deliver a 76 per cent CO_2 reduction compared with the 2050 BAU Scenario (or a 68 per cent reduction on the BAU baseline year emissions). For road transport, the measure having the greatest effect on reducing demand would be the fuel price escalator.

It should be emphasised that only by implementing the complete package of measures will a carbon neutral road transport sector be delivered by 2050. Reducing demand (from a combination of fiscal, spatial and behavioural measures) in the MI Scenario could achieve a 76 per cent reduction in CO_2 emissions, but this will be much more difficult in the absence of alternative technologies such as PEVs and H-fuel cell vehicles utilizing decarbonised UK electricity supply. Equally, providing technological solutions alone will not deliver the required reductions if people's demand for existing technologies is not curtailed by the fiscal, spatial and behavioural measures as well. Also, a decarbonising UK electricity supply would be unlikely to meet the additional power requirements of PEVs and/ or H-fuel cell vehicles if total demand from road

Groceries by rail - the Stobart express, Scotland © Duncan Brown

Table 6.1: Policy implementation framework

Measure	2010	2020	2030	2040	2050
Road Transport					
Spatial planning					
Pedestrian-oriented design					
Road space reallocation					
High occupancy only vehicle lanes					
Compact development: for cities					
Regional co-operation model for HGVs					
Fiscal					
Road user charges					
Car parking charges					
Fuel price escalator					
VED circulation tax					
Car purchase tax/'Feebate'					
Public Transport Fares					
Behavioural					
Ecological driving					
Motorway speed limit: 60 mph					
Car share					
Modal shift for road freight:					
Technology					
Cars, LDVs, m'cycles and HGVs/buses < 12 t to be PEV or H-fuel cell (using electricity that is 100% C-neutral by 2050)					
HGVs and buses/coaches >12 t to be powered by either H fuel cells (with C-neutral sourced H by 2050) or sustainable biofuel					
LPG vehicles phased out					
Rail					
All passenger and freight rail to be powered by electricity (that is 100% carbon neutral by 2050).					
Shipping					
New technology					
Speed /Voyage Optimisation					
Cleaner Fuels					
Shore Side Measures					
Aviation					
Constrained Demand					
Aircraft Technology					
Air Traffic Management					
Fiscal Measures					
Railway Substitution					
Video Substitution					

Indicates the period over which implementation is phased in (i.e. from when the measure is initiated to when its implementation is complete and has its maximum impact on emissions).

transport is not drastically reduced at the same time. The existence of these synergies means that only the implementation of all measures (fiscal, spatial, behavioural and technological) combined can deliver a decarbonised road transport sector by 2050.

Although road and rail transport could both achieve zero CO_2 emission target, emissions from aviation and shipping are problematic and together account for the 24 per cent short-fall for the transport sector as a whole. To improve on the 76 per cent CO_2 emissions reduction for transport by 2050 therefore, would require radical interventions or technological innovations than those envisioned in the present study for these two sectors.

This report has focussed on evidence-based interventions that have a clear logical sequence between the intervention and the likely results of that intervention. This necessarily excludes other interventions that could make a substantial contribution to achieving a low carbon transport system. An example of such an intervention is a significant prioritisation, above anything currently envisaged, of public health measures (see box 6.1).

It must also be emphasised that additional policy interventions would be required to produce the 100 per cent carbon neutral UK electricity power generation sector on which zero CO_2 emissions for the road and rail transport sectors will totally depend. A detailed analysis of policy pathways leading to such a decarbonised electricity supply in the UK is outside the scope of this study. However, if electrical power sector decarbonisation by 2050 is less than 100 per cent, CO_2 emissions from road and rail transport will be substantially higher than projected for the MI Scenario. It is clear that, for the transport sector of 2050 to even achieve the 76 per cent CO_2 emissions reduction, the introduction of a programme to radically change the way electricity is generated is urgently required.

Box 6.1: The prioritisation of public health measures

The introduction of a new public health regime that actually does protect the health of residents when noise and air quality limits are exceeded. This would apply to all road and airport projects both new infrastructure and existing operations. Clear noise limits published by the World Health Organization exist on what levels should not be exceeded in order to protect public health and as well air quality thresholds developed on the same basis. The problem is that at the moment there is no expectation that they will be enforced in any way. Measures designed to protect public health are not applied in real world situations to protect the health of geographically defined populations. This could be very different and thresholds which presumably should not be exceeded could be made enforceable in the following way.

All local authorities routinely monitor air quality (AQ) through a network of AQ monitoring stations. Under a new AQ regime all exceedances of EU AQ limits would be recorded each day for the main pollutants and work carried out to identify the sources of those pollutants. Local authority AQ officers already know the sources of most pollutants (point sources, traffic, airports etc) so this is not difficult. For each day and part of each day that AQ threshold are exceeded from airport sources (for example) the airport operator would be fined £100,000 and this income would be ring fenced for the improvement of community facilities in the local authority area. For an airport operator there are ways of avoiding fines:

- reduce the number of flights;
- develop a surface access strategy to maximise public transport access and minimise car and taxi use;
- establish a Low Emission Zone and only allow the lowest polluting vans and lorries to enter the site;
- reduce the number of car parking places;
- decommission all plant that currently runs on diesel or fuel oil and switch to electricity.

For the Highways Agency or Highway Authority there are ways of avoiding fine arising from traffic pollution:

- close roads when levels trigger the danger threshold;
- implement serious demand management measures to reduce car use;
- implement serious "urban logistic" strategies to reduce HGV activity;
- switch road freight to rail and inland waterway.

Currently there is no policy connection between AQ standards and the need to improve AQ and the seriousness with which measures can be implemented in the transport sector to reduce pollution. Measures to reduce pollution will reduce greenhouse gases and will contribute to healthy, safe sustainable communities.

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"Climate change 'may curb growth in UK flying'

By Roger Harrabin BBC environment analyst 11 May 2019

Concerns over climate change might restrict the growth of flying in the UK, the government has admitted.

The advisory Committee on Climate Change (CCC) recently said the UK's planned increase in aviation would need to be curbed to restrict CO_2.

Now a senior civil servant has told a green group that means ministers may have to review aviation strategy.

The group says climate concern is so high the decision on Heathrow expansion should be brought back to Parliament.

When the government first laid out proposals for increasing aviation, the UK had an overall target of cutting CO_2 emissions by 80% by 2050.

But the CCC recently raised the bar of ambition in recommending that Britain should adopt a target of net zero emissions.

That will mean compensating for any greenhouse gases by either capturing the CO_2 and storing it, or planting more trees.

Under the previous 80% scenario, aviation had a privileged position. Its expansion would be counter-balanced by additional CO_2 cuts in other sectors, like industry.

The CCC makes it clear this is not an option in a zero-carbon Britain. But crucially, the growth in aviation must be constrained.

In a letter to a tiny pressure group Plan B, the Department for Transport (DfT) aviation head Caroline Low said: “It may be necessary to consider the CCC’s recommended policy approach for aviation.”

This may sound like a cautious civil servant covering bases, but for Plan B it is an admission that the DfT will have to confront the notion that concerns over climate change may outweigh people’s desire to fly more.

Tim Crosland from Plan B told BBC News: “We're pleased to see the government is taking seriously our request to review the expansion of Heathrow.

Mr Crosland noted that the Scottish government said this week it would review its support for Heathrow in the light of the CCC’s net zero report.

In response, the DfT said: "We take our commitment to the environment very seriously and we will give careful consideration to the net zero report.

"No decision has been taken to review the Airports National Policy Statement, however we are legally obliged to consider requests like this one." "

We may be returning to where we where with the Airport Commision's report which is essence was saying that a 3rd runway could go ahead without breaching overall climate targets only if there was limited growth elsewhere.

This is also supported by the Scottish Government:

https://www.bbc.co.uk/news/uk-scotland-scotland-politics-48191110

Scottish government scraps air tax cut 7 May 2019

Controversial plans to cut the amount of tax paid by passengers flying from Scottish airports have been scrapped after a backlash over the environmental impact.

The Scottish government had wanted to reduce air departure tax by 50% before eventually abolishing it.

But concerns were raised that the move could increase greenhouse gas emissions by increasing the number of flights.

The government has now confirmed that the tax cut will not happen.

Finance Secretary Derek Mackay said reducing air departure tax - which will replace air passenger duty in Scotland - was "no longer compatible" with its climate targets.

Sturgeon declares 'climate emergency'

Scotland to set 'faster' climate change target

Mr Mackay added: "All parts of government and society have a contribution to make to meeting this challenge.

"We continue to support our tourism industry, which is going from strength to strength, and we will work with the sector to develop in a sustainable way.

"We welcome their efforts - and those of the aviation industry - to reduce carbon emissions."

'Failed promises'

The announcement was criticised by Gordon Dewar, the chief executive of Edinburgh Airport, who said:

"We've gone from personal commitments to all-out cancellation in the space of just two weeks, which shows just how reactionary this decision is.
"It does not show leadership and means airports and airlines have been led down a path of failed promises for three years by this Scottish government.
"It also raises questions about continued support for our tourism sector when airlines have already walked away from Scotland due to this failure to deliver."
The airport had previously published a report which predicted halving the departure tax would create almost 4,000 jobs and add £1bn to the Scottish economy.
The report claimed that failing to cut the tax could see Scotland lose out on nearly a million passengers every year.
Derek Provan, chief executive of AGS Airports which owns and manages Aberdeen International and Glasgow airports, described the Scottish government's decision as a "huge blow for our airports and for Scotland's connectivity".
He added: "Over the course of the past year alone, we have seen the withdrawal by airlines of almost 30 routes from Aberdeen and Glasgow airports because of Air Passenger Duty."
And Liz Smith, chief executive of the Scottish Chambers of Commerce, said the "alarming u-turn" would "do nothing to reduce emissions and will have a significant and deleterious impact on the Scottish economy".
Legal issues
Air departure tax (ADT) was originally due to be introduced in Scotland last year, but has been hit by a series of delays - with the Scottish government announcing last month that it had been "deferred beyond 2020".
The government said this was because of legal issues regarding tax exemptions for flights departing Highlands and Islands airports.
The commitment to cutting ADT in half when it is eventually introduced, before abolishing the tax completely in the future, was included in the SNP's manifesto for the 2016 Holyrood election, with the party arguing it would boost the economy and tourism.
But there was speculation that the policy, which was backed by the Conservatives and the aviation industry, would be ditched after First Minister Nicola Sturgeon declared a "climate emergency" at last month's SNP conference.
Her government subsequently announced it wanted to reduce greenhouse gas emissions to net-zero by 2045 - five years ahead of the rest of the UK - after receiving fresh advice from an expert panel.
The u-turn came the day before Labour, the Scottish Greens and Liberal Democrats had been due to call for the tax cut to be scrapped in a Scottish Parliament debate.
They argued that the plan would amount to a £150m tax break for the aviation industry and wealthy business travellers, and that encouraging more flights would increase carbon emissions.
The Scottish Parliament was given powers to charge tax on passengers leaving Scottish airports under the Scotland Act, which came into force in 2016.
Air passenger duty (APD) will continue to be charged on all passenger flights from Scottish airports - apart from those in the Highlands and Islands - until it is replaced by ADT.
The rate of tax varies according to where the passenger is going and the class of travel, and ranges from £13 for the cheapest class of short-haul flights to more than £500 for some long-haul flights.
APD raises about £300m in Scotland and £3bn across the UK every year.
What has the political reaction been?
The Scottish Greens described the Scottish government's announcement as a "huge u-turn", which the party said was needed to show that Scotland is serious about meeting its climate change targets.
Scottish Labour said the move was long overdue as a "tax cut that benefits the richest the most and increases emissions was never the right policy".
But the Conservatives said the government had broken promises to the tourism industry and had "succumbed once again to the environmental extremists in its own nationalist movement".

Roadmap to decarbonising European aviation

October 2018

a study by

TRANSPORT & ENVIRONMENT

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Executive Summary

Aviation is already a major and growing emitter. In Europe its emissions have doubled since 1990, and globally they could, without action, double or treble by 2050. Such emissions growth needs to be reversed and brought to zero by 2050 if we are to meet the goals of the Paris Agreement. Otherwise growth in aviation emissions could rapidly consume the limited carbon budget to remain within the 1.5 and 2°C targets of that Agreement.

Aviation however is at risk of having its emissions locked in due to the growth in passenger numbers and aircraft fleet. While uncertainties exist, we do know that the sector will have a substantial fuel demand well into the 2030s, 2040s and beyond, the period when our economy needs to increasingly decarbonise. This report puts forward measures to limit that fuel requirement, but ultimately the remaining and substantial fuel demand will need to have its carbon content eliminated. The process of cutting and then decarbonising that fuel demand is the focus of this report.

The report finds that the expected technology and operations improvements will not mitigate the expected fuel demand and emissions growth from aviation. Generating incremental efficiency improvements from current aircraft designs is becoming ever more costly and difficult. Further operational improvements remain possible but do not achieve decarbonisation and require the right policies to be in place. To significantly reduce the expected fossil fuel demand and ultimately eliminate it from the sector would require further measures.

Carbon pricing needs to play a central role in bringing forward further reductions in fuel demand. Exempt from kerosene taxation and with most European aviation emissions excluded from the EU ETS, there is much that needs to be done. Our report shows that introducing fiscal measures that combined represent a carbon price equivalent to €150 a tonne can moderate demand fuel demand growth from the sector through incentivising a combination of design and operational efficiency improvements and modal shift. Other measures highlighted by the report include stricter fuel efficiency standards and incentives to speed up fleet renewal. Our report finds that, combined, these measures could cut fuel demand by some 12 Mtoe, or 16.9% in 2050 compared to a business as usual scenario.

However that still leaves substantial and increased fuel demand in 2050. This report examines how the carbon footprint of the remaining fuel demand can be cut and, where possible, eliminated. The report finds that with today's technology this can only be achieved through the use of sustainable alternative fuels. The report demonstrates that this is no easy task, highlighting the issues faced in Europe to date in reducing the carbon intensity of fuels used for road transport.

To succeed in putting aviation on a pathway to decarbonisation, new types of alternative fuels need to be brought forward. The report focuses on synthetic fuels, namely electrofuels, which will be needed to close the gap. Electrofuels are produced through combining hydrogen with carbon from CO_2. With the hydrogen produced using additional renewable electricity and with the correct source of CO_2 (ideally air capture), such fuels can be close to near zero emissions and carbon circular. Again however strict safeguards are needed to ensure synthetic kerosene would be produced only from zero emission electricity.

If produced at scale, electrofuels are likely to cost between three and six times more than untaxed jet fuel. At a cost of €2,100 per tonne in 2050, electrofuel uptake will increase ticket prices by 59%, resulting in a 28% reduction in projected passenger demand compared to a business-as-usual scenario. However, compared to the ticket price with an equivalent CO_2 price of €150 a tonne, the ticket price increase would only be 23%. The report finds that introducing a progressively more stringent low carbon fuel standard (GHG target) on aviation fuel suppliers will leave all operators flying within or from Europe needing to purchase such fuels. These rising fuel costs will increase operating costs which will inevitably be passed onto consumers, causing a fall in demand for jet fuel compared to forecasts and reducing the volume of alternative fuels that will be required to replace kerosene.

Importantly for policy makers, the report highlights the enormous demand on renewable electricity if fuel demand remains high and electrofuels are the only way to decarbonise. Using electrofuels to meet the expected remaining fuel demand for aviation in 2050 would require renewable electricity equivalent to some 28% of Europe's total electricity generation in 2015 or 95% of the electricity currently generated using renewables in Europe. It is also important to keep in mind that other sectors will need additional renewable electricity to decarbonise, for example for green hydrogen to be used in industry. However, with today's technology, synthetic fuels are the only technically viable solution that would allow aviation to exist in a world that avoids catastrophic climate change.

A further note of caution in the report is that while the use of such fuels can put aviation on a pathway to decarbonisation, getting to zero emissions, the generally accepted term for decarbonisation, will be difficult because producing alternative fuels which, on a life cycle basis, are 100% carbon free is very challenging. Advanced biofuels could play a role in substituting fossil fuel demand in aviation. However, strict sustainability safeguards are needed to ensure advanced biofuels offer genuine emission savings - these are not yet in place. If fuels with poor environmental and climate credentials would be excluded, the potential supply of advanced biofuels would be very limited. Our report finds that they could play a role - meeting up to 11.4% of the remaining 2050 fuel demand in our scenario - but alone won't be available in the quantities needed. This is partly because non-transport sectors will also have a claim to biomass feedstocks, reducing availability.

This report does not rule out the role that radical new aircraft designs could play in significantly reducing aviation emissions, for example hydrogen or electric aircraft. However such aircraft are not expected to be in operation in significant numbers until the 2040s, and will find it especially challenging to replace conventional aircraft for long-haul flights. What is less speculative is that significant liquid fuel demand will exist right through to 2050, and for that reason, the report focuses heavily on how such fuels can be decarbonised. Should hydrogen aircraft technology develop more rapidly this would not be at odds with significant investment in synthetic fuels as hydrogen is a key input for electrofuels.

Decarbonising such fuel will require significant investment, and significant investment requires certainty. That is why policy-makers need to turn their attention now to the safeguards and policies needed to bring such fuels to market, so that the availability of these fuels can be ramped up in line with the sector's need to decarbonise.

Aside from decarbonising aviation fuels, the warming from aviation's non-CO_2 effects at altitude is considerable and is a challenge that is barely being touched. While the report discusses these effects and identifies possible mitigation approaches, there remains a lack of policy focus and investment in scientific research on this topic. This failure to act means we are unable to propose a suite of mitigation measures nor estimate their effects. What is clear is that the European Commission must meet its obligations under the EU ETS Directive to foster further research and, resulting from that, come forward with proposals on measures by the start of 2020.

The case for acting on aviation emissions is clear - a failure to do so will fatally undermine efforts to achieve the goals of the Paris Agreement. This report outlines what such action should look like: aggressively cutting fuel demand, moderating the expected growth in air travel, decarbonising the remaining fuel, and addressing the sector's non-CO_2 effects. Finally, the report does not recommend offsetting as this is a solution that is incompatible with the decarbonisation logic of the Paris Agreement.

Proposed measures

- Cut fuel demand from the sector below projected levels through a carbon price equivalent to €150 a tonne achieved through a range of measures including kerosene taxation and a strengthened EU ETS;
- Cut fuel demand through additional measures such as stricter aircraft CO_2 standards and incentives for fleet renewal;
- Further reduce the climate impact of aviation through a progressively more stringent low carbon fuel standard on aviation fuel suppliers, conditional on the necessary safeguards being in place, to bring aviation close to zero emissions by 2050; and
- Ensure the Commission brings forward proposals to address aviation's non-CO_2 effects by the start of January 2020, as required by the revised EU ETS Directive.

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List of acronyms

ASA	Air Service Agreement
ASTM	American Society for Testing and Materials
BaU	Business as Usual
EASA	European Aviation Safety Authority
ETD	Energy Taxation Directive
EU ETS	European Union Emissions Trading System
GHG	Greenhouse Gas Emissions
Gpkm	Giga passenger-kilometres
HSR	High Speed Rail
ICAO	International Civil Aviation Organisation
ILUC	Indirect Land Use Changes
ktoe	Kilotonne of oil equivalent
Mtoe	Megatonne of oil equivalent
MTOW	Maximum Take Off Weight
RFNBO	Renewable Fuels of Non-Biological Origin
RED	Renewable Energy Directive
TWh	Tera Watt hours

1. Introduction

1.1. Purpose of this report

The purpose of this report is to examine whether a credible pathway to zero or near zero emissions exists for European aviation. For the purpose of this report that includes flights within and departing from Europe. That matches the scope of aviation's inclusion in the EU's 2030 target. It takes broadly accepted passenger and emissions growth forecasts out to 2050, considers the role that various policies can play in reducing fuel demand from the sector, and then proposes how the remaining fuel demand can be decarbonised.

1.2. The rise and rise of aviation emissions

Aviation is one of the fastest growing sources of GHG emissions and the most climate-intensive mode of transport. Globally, aviation emissions have more than doubled in the last 20 years[i] and, when including the significant non- CO_2 climate effects of aircraft flying at altitude, the sector is responsible for an estimated 4.9% of man-made warming[ii] (Figure 1).

Emissions from EU aviation increased 96% between 1990 and 2016[iii] while all other sectors, bar transport which grew 21%, reduced emissions. As a result, aviation emissions have grown from 1.5% of total EU emissions in 1990 to 3.6% today[1]. If the trend of traffic growth exceeding improvements in aircraft efficiency continues, aviation emissions are predicted to double or triple by 2050 and consume up to one-quarter of the global carbon budget[iv], undermining the Paris Agreement efforts to keep global warming to 1.5°C.

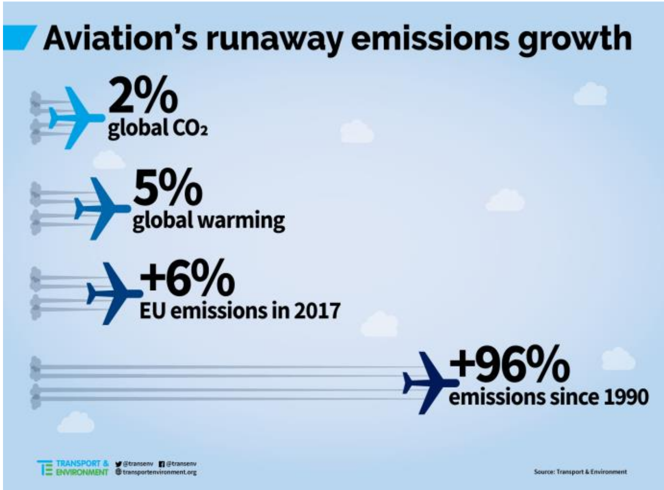


Figure 1: Global and European aviation growth

1.3. Can aviation be decarbonised?

The challenge in reducing aviation emissions is well known. Manufacturers are finding it increasingly difficult to deliver efficiency gains from new engines and aircraft designs and incremental improvements are declining. With aircraft having a lifespan of 20-30 years and current models having orders up until the mid-2020s, aircraft being delivered now are locking us into decades of fuel consumption. Truly sustainable alternative fuels are limited in volume and the significant price gap with tax-free kerosene is constraining uptake.

Growth in air traffic remains strong; up 8.5% in Europe in 2017[v], exceeding growth of 7.6% globally[vi]. Certain measures could slow some of this growth - such as ending the fuel tax exemption and other subsidies or introducing effective aircraft efficiency standards.

1.4. Regulating at what level?

Following the failure of efforts to include all aviation emissions in the EU ETS, Europe focussed on efforts to regulate these emissions at a global level through measures to be adopted by the UN's aviation agency, ICAO. Two measures in particular were advanced - a CO_2 efficiency standard for new aircraft, and a global offsetting measure for emissions above 2020 levels.

[1] From Member State reporting to the UNFCCC. https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2018

These measures have been extensively critiqued elsewhere[vii] - neither will reduce emissions from the sector in a manner consistent with the goals of the Paris Agreement. ICAO as an institution suffers from a number of flaws which, until they are resolved, make it highly unlikely that they will deliver meaningful measures to cut emissions, let alone decarbonise aviation.

1.5. European efforts

Aviation emissions have long been a weak spot in European climate policy. After earlier consideration of taxation, the EU included aviation in its ETS from 2012, but backed down later that year in the face of intense resistance from industry and a group of foreign states. As a result only flights within Europe are included for the time being. Meanwhile the sector continues to enjoy various tax exemptions (fuel duty, VAT), as well as state aid subsidies. The agreed ICAO efficiency standards for aircraft will have no significant impact on emissions[viii] and the uptake of sustainable alternative fuels has been minimal[ix].

In adopting its 2030 emissions target, the EU included all outbound aviation emissions - that is, emissions from all flights departing from Europe but not to Europe.[2] The 2030 target for the sector was set at 111 Mt CO_2e[x] - below its current level of 148 Mt CO_2e. Achieving this target will require a significant uptake in new technologies or fuels, or alternatively an increase in ambition in other sectors. However long-term decarbonisation, which Paris demands, requires the sector to bring its own emissions to zero - both CO_2 and non-CO_2.

1.6. Europe's decarbonisation strategy

The European Union is currently in the process of reviewing its long-term emissions reductions strategy, with a draft to be published in November 2018 and a final version to be adopted by member states in 2019. The revised strategy will detail Europe's contribution to the Paris Agreement objective of limiting a temperature increase to well below 2°C/pursuing efforts to limit an increase to 1.5°C. This is more stringent than the target which was the basis of the current emission reductions strategy, which also left the 2050 ambition open, setting a range of 80-95% cuts[xi] but in practice mostly working towards the lower end of that range. As a result the revised strategy will have to be more ambitious than today's. Considering that global temperatures have already risen at least 0.8°C[xii] and GHG concentrations are increasing rapidly Europe must decarbonise all sectors by 2050.

The EU's current long term emissions strategy includes emissions from outbound flights, but with relatively little detail on how reductions from the sector can be achieved. The revised strategy needs to continue to cover outbound aviation, make it clear that the aviation sector too must commit to zero emissions by 2050 and provide far more information on what sort measures and policies Europe will pursue to ensure the sector is decarbonised. It also needs to address aviation's short-lived non-CO_2 climate effects, whose transient (days to weeks) climate warming impacts equal or exceed those of aviation's accumulated CO_2 emissions[xiii].

1.7. T&E decarbonisation paper

This paper presents a decarbonisation pathway for aviation out to 2050. The scope of the analysis is the same as the EU's 2030 target - all emissions from outbound flights. As well as cutting Europe's own aviation emissions, these measures can spur similar action in other regions, by for example incentivising the development of new technologies or helping reduce their costs, by demonstrating the effectiveness of emission reduction measures, and, above all, by introducing low or zero carbon aviation fuels to the market.

[2] So Paris-Madrid and Warsaw-New York are included, but not Delhi-Rome

1.8. Methodology

T&E drew on aviation activity growth forecasts from the 2016 European Reference Scenario[xiv] to project total outbound aviation emissions from European airports up to 2050. We then modelled the application of a range of measures to reduce fuel demand to what we believe is the maximum extent possible through fuel, technical and operational efficiencies or limiting passenger number growth through price signals. The result is what T&E believes fuel demand from the aviation sector can reasonably be reduced to by 2050. We then focus on how to decarbonise that remaining fuel demand through the use of sustainable advanced biofuels and synthetic e-fuels (power-to-liquid, or PtL). Full details of the modelling approach are found in the Appendices.

2. Measures to cut fuel demand

2.1. Business as usual

The BaU scenario was developed from the 2016 European Reference Scenario. The effect of demand reduction from higher kerosene prices built into the Reference Scenario was decoupled, the result being that there is higher demand. This was undertaken to avoid double counting reduction measures and ensure that the measures added in this report are additional and not duplications. It also allows an assumption of constant fuel price, so that policy measures can be analysed in isolation, rather than on the reliance of volatile fuel prices to do the heavy lifting of decarbonisation.

The result is that aviation energy demand in 2050 under our BaU scenario is projected to be 71.3 Mtoe, compared to 65.5 Mtoe in the Reference Scenario. As passenger activity in the Reference scenario only draws on intra EU and domestic flights, an analysis of the available seat kilometres from aircraft transponder data was used as a proxy to extend this to all EU departing flights. In 2050 we calculate EU outbound passenger activity to be 6753 Gpkm, compared to the 1177 Gpkm projected for intra-EU flights from the Reference Scenario.

2.2. Design and operational efficiency

The design and deployment of more efficient aircraft and engines can play an important role in reducing fuel demand from the sector. The development of these aircraft, how quickly they enter the fleet, and their more efficient operation is open to speculation. We have divided our forecasting into the maximum possible reductions based on currently available technologies and what more radical designs may start to deliver closer to the 2050 timeline.

The EU reference scenario includes in its aviation energy demand projections an increase in fleet efficiency, measured in terms of fuel burn per passenger km, of 41% by 2050 compared to 2010. We take this to be a combination of technical and operational improvements, as a 41% improvement from current aircraft designs alone is not deemed possible.

This 0.9% improvement per annum is towards the higher end of what is possible. Within current designs, it is increasingly difficult and ever more costly to continue generating incremental efficiency improvements - for example using lighter material, more efficient variants of existing aircraft, or adding winglets etc. to reduce fuel consumption. However it's also true that we are not yet maxing out what is possible in terms of design improvements. ICAO commissioned an independent fuel burn expert group to identify the extent of achievable future fuel efficiency gains, which found that emission reductions beyond those expected under a BaU scenario were possible. But this level of improvements is not required by the ICAO CO_2 standard for both new and in-production aircraft designs. In addition, periods of low oil prices, such as the situation which has existed since 2014, also act to disincentivises fleet renewal and investments into increased efficiency - even more so when effective carbon pricing or fuel taxation is lacking.

Though this 0.9% per annum would be at the more ambitious end of what we expect is possible, our forecasting envisages a situation where governments adopt an ambitious range of measures to encourage both new designs and their deployment. For example the progressive implementation of an effective carbon price up to €150 a tonne will encourage new designs and their deployment across the fleet as well as accelerated phase outs of older aircraft. Europe could introduce other policies to encourage fleet wide efficiencies - for example fuel taxation, additionally taxing dirty aircraft to accelerate phase outs or linking the auctioning of slots at airports to aircraft efficiency. Europe could also introduce more effective aircraft efficiency standards through the EASA certification process.

Additional operational improvements could come about through the effective implementation by member states of the single European sky rationalisation of European airspace, which is essential if we're to reduce fuel demand to the maximum extent possible. It also includes accelerated upguaging (deployment of larger aircraft) and increased passenger density by curbing first and business class travel.

Our forecasting also takes into account potentially more radical aircraft designs entering the fleet from about 2040 onwards. These designs include strut systems (reducing drag), bubble designs, flying wings, hybrid and electric aircraft. New aircraft designs are obviously speculative. Their potential development is limited as, without clear government mandates, they will involve significant financial risks for manufacturers. A move to hydrogen powered aircraft will require enormous investments for manufacturers and airports. It is not at all yet clear that electric powered aircraft will have a flight range of commercial significance beyond short haul.

However under a scenario where governments aggressively mandate the development and deployment of radical new technologies, it is conceivable that from the 2040s such technologies will begin to penetrate the market, but it would take some time before they have a major impact on emission reductions.

Key drivers

- Implicit carbon pricing of €150/tCO_2 as considered below
- Stricter efficiency standards for new aircraft, either at international or, failing that, European level
- Further measures to incentivise new aircraft deployment, such as phase-out measures for the oldest aircraft
- Airport charges that are lower for more efficient aircraft.

Our estimates presumes additional fleet wide efficiency improvements of 0.2% per annum over the BaU. From 2040, more radical designs are assumed to be 30% more efficient than existing technologies. Aircraft and operational efficiency improvements could reduce fuel demand 6.3 Mtoe (or 8.8%) by 2050.

2.3. Pricing aviation and eliminating subsidies

Essential in efforts to decarbonise aviation is the introduction of carbon pricing, other forms of taxation and the phasing out of subsidies. This would have the effect of curbing demand, but also incentivising both design and operational efficiencies. Finally, it may encourage the uptake of low or lower carbon fuels by improving their business case.

Carbon pricing is the charging of those who emit carbon emissions based on the level of their emissions. It is increasingly recognised as an essential, though by itself insufficient, measure to ensure the world reaches its Paris Agreement target. Carbon pricing continues to be introduced in different jurisdictions - China and Canada at a federal level joining Europe in introducing such pricing, and with substantial subnational carbon pricing in the United States and Canada.

However the aviation sector remains lagging in the introduction of such pricing. Only flights within Europe, accounting for around 40% of the region's emissions[3], are included in EU ETS leaving long-haul flights completely unregulated. Domestic aviation is included in New Zealand's carbon market. Domestic fuel taxation exists in some jurisdictions, such as Japan, Brazil and India and to a limited extent in the US.

Outside of carbon pricing, other forms of taxation can also play a role in reducing fuel demand by limiting the growth in passenger numbers, and thereby reducing overall fuel demand. And finally, ending subsidies such as state aid to airports and airlines could also limit the growth in passenger numbers, again reducing the overall fuel demand.

Reining in aviation emissions growth, and putting the sector on a pathway to decarbonisation, cannot be achieved without all or a combination of the above measures, which have the end result of more correctly pricing aviation. Estimates put a Paris-compliant carbon price at €30 a tonne now, rising to €150 by 2050[4]. Below we consider some of the means by which such an effective carbon price can be applied to European aviation.

In describing the policies below, we also consider the revenue which can be raised. Revenue raising is secondary to the objective of decarbonisation, however it is not unrelated. The additional revenues could be used to reduce other taxes (e.g. labour taxes) or help governments raise revenue in order to fund the necessary investment required to decarbonise the economy as a whole or specific sectors.

2.3.1. Options for carbon pricing

Fuel taxation

Fuel uplifted for international aviation remains mutually tax exempt owing to language contained in bilateral aviation agreements, known as Air Service Agreements (ASAs), introduced in the period after the Second World War when states were encouraging international aviation to expand. Those exemptions remain in place, and are a barrier to the immediate introduction of kerosene taxation on international aviation. Globally, the exemption is valued at €60bn a year[xv].

Fuel taxation is possible at the EU level. The Energy Taxation Directive (ETD) permits taxation of kerosene for domestic aviation - however within the EU only the Netherlands did so. Norway and Switzerland also tax domestic fuel. The ETD also permits two or more member states to introduce kerosene taxation for fuel used on flights between those states provided this is agreed bilaterally. So far this has not happened - one reason being that air services agreements continue to provide mutual fuel tax exemptions for foreign carriers operating intra EU flights. But these operations have decreased dramatically in numbers and an intra EU kerosene fuel tax could be introduced with a de minimis provision which de facto exempts all foreign carrier operations. Amendments to the relatively few ASAs involved should also be pursued.

Applying kerosene taxation to fuel uplifted for flights from Europe requires the abolition of the mutual fuel tax exemption in air services agreements. However it is not inconceivable that as need for carbon pricing becomes ever more apparent, there are opportunities for such taxation to be introduced on a bilateral basis with non-EU countries, steadily expanding to cover an increasing share of European aviation emissions. In the event that all departing flights in Europe paid the ETD minimum tax on fuel uplifted, this would be equivalent to a CO_2 price of €130/tCO_2. A minimum price is precisely that - the level of the tax could be

[3] T&E analysis of UNFCCC and aircraft transponder data from PlaneFinder (2016). Transponder data were coupled with the ICAO fuel burn calculator methodology, and flights analysed based on journey type.

[4] There is an ongoing debate over what constitutes an appropriate carbon price. Research to date suggests that in the aviation sector a price in excess of €100 is required due to that sector's higher mitigation costs (Schafer et al, 2016). We chose a price of €150, which as outlined in this paper, is eminently achievable.

increased to achieve this paper's target of €150 a tonne, or higher if that would deliver greater mitigation benefits.

Emissions Trading Scheme

As explained above, only flights within Europe are currently covered by EU ETS. A further exemption for flights to and from Europe was granted in 2017 until the end of 2023. In recent years the system has suffered from an oversupply of allowances, bringing prices to as low as €5 a tonne, far below the sort of carbon pricing required to incentivise emission reductions. Combined with free allowances received by the sector, the scheme cost airlines only €150m in 2015 compared to EU airline profits of €7.4bn[xvi].

Since then, allowance prices have begun to recover, trading at over €25 a tonne by September 2018. Revisions to European legislation mean that from 2021 the number of aviation allowances issued each year will begin to decline, as is already the case for other sectors covered by ETS. There is also a commitment to review the number of allowances which are granted to airlines for free, rather than auctioned.

The effectiveness of the aviation ETS - in terms of revenues raised and emissions cut - will depend on the scope, the cap and allowance price. Were all emissions from Europe to be included in an effectively functioning ETS, then a path to the eventual decarbonisation of outbound flights would be clear. However achieving this scenario will require significant political ambition.

2.3.2. Other options for taxing aviation

Emissions trading and kerosene taxation put an almost direct price on emissions and are therefore the preferred policy options. However there are other means to price aviation, which while not directly putting a price on its emissions, nonetheless may reduce the growth in passenger numbers and therefore reduce fuel demand. For that reason they are considered as part of this paper.

Per plane taxes.

Ticket taxes are taxes levied on the act of passengers departing an EU airport, with costs built into ticket prices.

Per plane taxes, or "movement" taxes would be levied on aircraft/airlines by virtue of an aircraft departing an EU airport and paid directly by carriers to tax authorities with the additional costs built into ticket prices. Ticket taxes are levied in a very large number of countries around the world without legal challenge. Movement taxes on aircraft would be levied in a similar way.

The per plane tax can be based on various environmental criteria - the aircraft's certified noise rating or its certified MTOW which is a proxy for aircraft size and noise/air pollution. The tax could also approximate the flight's CO_2 emissions - which depend on the aircraft type and distance flown. A CO_2-based per plane tax could depend on MTOW, or the ICAO certified CO_2 metric value of the particular aircraft combined with a distance factor. The distance factor would need to be applied in bands as with ticket taxes, because a sliding tax applied proportionately to distance could be deemed a VAT or fuel tax contravening international agreements. The Dutch Government is currently studying movement taxes as an option for taxing Dutch aviation from 2020.

Ticket taxes

A number of member states have introduced ticket taxes on aviation, the UK as far back as 1993. These taxes are levied on all passengers and usually vary depending on distance of flight as well as in some cases the class of travel. Other states have followed the UK example, including Germany, Austria, Norway and Sweden currently such that more than half the EU market is now covered.

Ticket taxes are simple to administer, and can raise substantial sums of money; €3bn a year in the UK alone. There is no legal barrier to member states introducing such taxes, at whatever rate. They have survived numerous legal challenges from airlines. Ticket taxes are a common feature of many aviation markets around the world.

VAT

Alongside its fuel taxation exemption, aviation is also mostly exempt from sales tax/VAT. Though some European states levy VAT for domestic flights the exemption for intra EU flights is applied by all states and likewise none apply VAT to extra EU flight tickets. VAT exemptions are supposed to be primarily for essentials (medicines, food) however as with kerosene taxation, the VAT exemption for aviation is a hangover from an earlier era when all international aviation was tax free. The exemption distorts the market - encouraging consumers to spend money on this carbon intense mode of transport, instead of other, potentially lower-carbon, expenditures including rail travel.

Member states may introduce VAT on intra and extra aviation tomorrow, however the current legislation provides a practical barrier. If states were to introduce VAT, they could only do so for the portion of flights over their territory - a cumbersome way to levy such a tax, particularly as flight routes may vary and airlines could reroute to avoid such a tax.

The solution would be for the EU to amend its VAT legislation so that member states could levy VAT on the full price of the ticket at departure. The Commission has opened this possibility with a proposal earlier this year to simplify VAT rules[xvii], but these remain to be implemented. It could go further and make the levying of such VAT mandatory, but even the limited step of facilitating such a tax would be welcome.

Other subsidies

As well as the indirect subsidies from tax exemptions, aviation also receives direct subsidies for example through state aid for airports and airlines and government backed financial support granted to manufacturers. Though the EU has largely reduced direct investment in airport capacity, particularly following a damning report by European Court of Auditors[xviii], there is still some support granted to airport expansion from the European Investment Bank[xix].

At a member state level, substantial amounts of state aid continue to be granted to airports - including operational aid to airlines, which has the most distortive effect on competition. The levels of state aid are difficult to quantify but, with almost half of Europe's airports loss-making, are substantial. Often times such aid goes unreported, and in recent years the European Commission rather than attempting to rein in such aid, facilitated its provision and abuses by, for example, adding to the general bloc exemptions[xx].

State aid to this carbon intensive sector has no future in a Paris compliant scenario. And just as the EU has moved to ban state aid to the coal sector, it must also ban aviation state aid. In developing our model, the ending of these subsidies is factored into the €150 carbon price.

Key drivers

An effective carbon price of €150 can be achieved through one or a combination of the following policies:

- Introduce kerosene taxation on routes within and from Europe
- Reform EU ETS to ensure an effective carbon price (reduce free allowances, cut allowances at a faster rate and build support for its broadest possible application)
- A complete ban on state aid and other subsidies to the aviation sector
- Reform the VAT rules to facilitate member states introducing VAT on aviation tickets
- Introduce ticket taxes on all aviation tickets, pending the introduction of VAT
- Introduce per aircraft movement taxes

Our estimates are that introducing a carbon pricing of €150 on top of the design and operational efficiency measures can reduce total emissions a further 5.8 Mtoe (or 8.9%) by 2050. A carbon price of **€150 would result in an increase in ticket prices of approximately 19% in real terms.**

2.4. Modal shift

Shifting passengers from air travel to other modes of transport, especially rail, can play a role in reducing overall emissions. Particularly as rail has a viable pathway to decarbonisation through reliance on 100% renewable electricity. However it is important not to overstate the potential emission reductions resulting from such modal shift.

Flights under 600 km, which should be considered as targets for modal shift, account for only 7% of total aviation emissions in Europe[5]. Modal shift is not possible for many of these routes - due to the high cost of developing rail alternatives for what may be low frequency routes, or due to geographic barriers. There are certainly routes in Europe where the development of better and faster connections as well as additional high speed rail (HSR) services can help cut aviation emissions. Retention and reopening of night trains could facilitate a shift from aviation to rail for longer journeys. However the opportunities are limited, and there may be an excessive financial and environmental cost from expanding HSR.

In developing rail as an alternative to aviation, a range of measures will be required. Closing the price gap between the modes is essential - that includes taxing aviation as above, but also introducing stronger labour laws in the aviation sector to reduce the unfair competition resulting from the aviation sector undercutting the wages of other transport modes, and introducing greater competition in the rail sector in order to improve performance and drive down operating costs and fares.

Modal shift, or perhaps more precisely aviation demand reduction, can occur in other ways, however. A rising cost of flying, resulting from carbon pricing or the cost of alternative fuels or new technologies, could result in businesses finding alternatives to flying, such as greater use of video conferencing or rationalising the amount of business travel. Demand reduction could also take place in leisure travel - through changing destinations to reduce distance travelled, or taking fewer but longer holidays.

Key drivers

- Close the price gap with rail through taxing aviation, strengthening labour rights in the aviation sector and introducing greater competition to the rail sector

Our forecast is that modal shift will have only a limited impact in reducing fuel demand in 2050. As these reductions are limited, they are included in the passenger demand reductions resulting from carbon pricing as such carbon pricing is the policy measure expected to contribute most to modal shift. As shown in Figure 2, the combined measures described above could reduce the final aviation energy demand by 12.1 Mtoe, or 16.9%.

[5] T&E analysis on plane transponder data covering two weeks of flights in 2016, using the ICAO emissions calculator to calculate fuel burn methodology. Available: https://www.icao.int/environmental-protection/CarbonOffset/Documents/Methodology%20ICAO%20Carbon%20Calculator_v10-2017.pdf

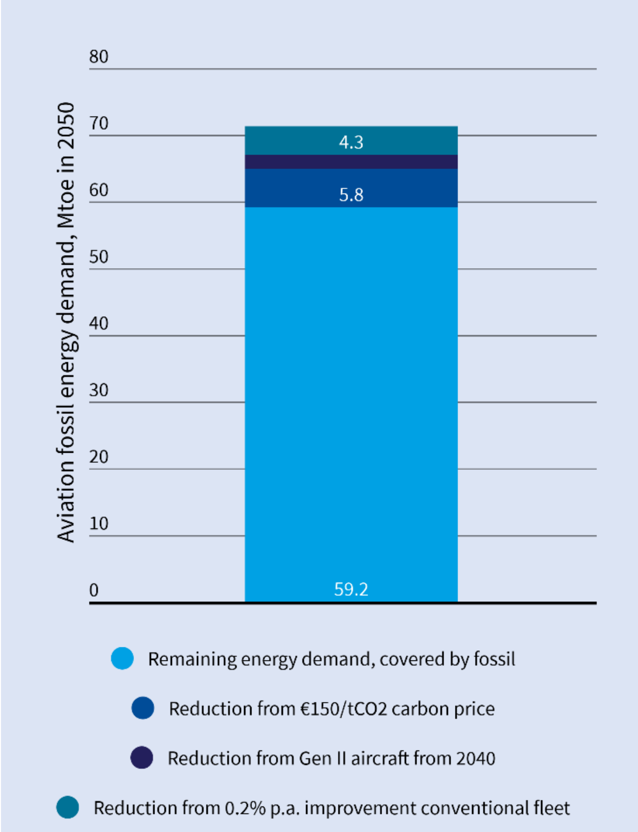


Figure 2: Contributions of technology, operational efficiency, and carbon pricing on kerosene demand in 2050. Note that 59.2 Mtoe of kerosene is 183 Mt CO_2, approximately equivalent to business as usual 2025 emissions.

3. Decarbonising aviation fuels

The above measures are estimated to bring down the sector's fuel demand from 71.3 Mtoe under a BAU, to 59.2 Mtoe under the policy scenario we have described. Decarbonisation of aviation by 2050 will therefore depend on decarbonising that remaining fuel demand.

We look at two pathways to do this - deploying sustainable advanced biofuels, and renewable fuels of non-biological origin (RFNBO). Though there are similarities between the two in terms of the existence of price gaps, issues with supply etc., there are also key differences relating to environmental integrity, how their uptake can be incentivised and most importantly, scalability. We therefore consider the two alternatives separately

3.1. Advanced biofuels

Advanced biofuels are defined as biofuels produced from waste and residues. To date alternative fuel uptake in the aviation sector has been extremely limited, largely due to the price gap between the alternative fuels currently available and traditional kerosene fuels.

Before considering measures to realise an uptake of advanced biofuels, it is important to look at what constitutes sustainable advanced biofuels, what volumes are likely to be available in the future, and what 'share' of these fuels aviation could reasonably expect to use.

The issues with many, particularly first generation, biofuels are well documented. Europe's experience with mandates for the road transport sector demonstrated that many of the biofuels used resulted in total emissions which were greater than the fossil fuels they replaced[xxi]. This was due to what's known as indirect land use change - the use of land to grow crops for biofuels displaces land which was previously used to grow crops for food. This displacement sparks further deforestation and conversion of grassland, to ensure sufficient land is cultivated for both fuel and food. This deforestation and conversion resulted in a total increase in emissions. In addition, even if we were to ignore these ILUC affects, the amount of land required to produce significant volumes of aviation biofuels would be enormous (powering the world's aviation fully with biofuels in 2050 would, directly or indirectly, require more than 3.5 million km^2 of land[6]) and would run counter to the efforts to increase negative emissions and carbon sinks, which will be required as part of the Paris Agreement.

So in assessing the future availability of biofuels, we limit our forecast to only those advanced biofuels from waste and residues which deliver real and sustainable reductions in emissions. Such feedstocks are incidental to other processes, and so will be limited in availability. Our projection is that in 2050, availability of sustainable advanced biofuels for the aviation sector will total 7,500 ktoe, meeting 11.4% of European aviation fuel demand (if the above efficiency and carbon pricing measures are realised, otherwise advanced biofuels could make up to 10.5% of BaU oil demand).

This is based on previous T&E research on the future availability of sustainable advanced biofuels[xxii]. In making this projection, our assumption is that other sectors, particularly road transport, will have transitioned entirely to direct electric or renewable hydrogen propulsion, and by 2050 will have no need to decarbonise through the use of alternative fuels. This assumption underlines how essential it is to drive electrification of all types of road transport, and how necessary it is to adopt an overarching emissions strategy for all transport modes. Non-transport sectors will also have a claim to biomass feedstocks, and this is factored into our assumptions. Were demand from the non-transport sector for advanced biofuels feedstocks to exceed what is in our assumptions that would have implications for the availability of this fuel for the aviation sector.

Sustainable advanced fuels will contribute to decreasing GHG emissions, but there are not so many which show pathways towards zero or negative emissions through their life-cycle. If some fuels, for example, achieve 80% emission reductions, then their use will still result in emissions from the sector; i.e. not achieve decarbonisation. To contribute to the decarbonisation of aviation, their production and entire life cycle impact (including indirect impacts) must be zero carbon. Therefore decarbonising aviation is coupled with broader efforts to decarbonise the economy, as reducing the carbon intensity of other activities such as heat, industrial processes and electricity generation will help reduce the lifecycle emissions from advanced biofuels. It is crucial for EU policies to account for all GHG emissions (also indirect) from advanced fuels. For accounting purposes, we assign zero emissions to these fuels in our modelling exercise.

Our forecast is that an availability of 7,500 ktoe of alternative fuels will contribute to reducing fossil kerosene demand by 6.8 Mtoe (or 11.4%) of aviation fuel demand in 2050.[7]

3.2. Synthetic e-fuels

In the context of this report, renewable fuels of non-biological origin (RFNBO) refers to the use of additional renewable electricity to extract hydrogen from water through electrolysis, which is then combined with CO_2 captured from the atmosphere, to produce a drop-in liquid hydrocarbon fuel. In this report, these fuels are referred to as electrofuels. We only examine drop-in electrofuels - i.e. electrofuels which can be used by aircraft through combustion in a jet turbine, with minimal or no modifications to the aircraft, engines or ground refuelling infrastructure. This draws a line with other types of fuel, such as hydrogen, which requires completely new aircraft designs and new airport refuelling infrastructure, the potential emission reductions out to 2050 of which are accounted for under Sec 2.2. However, it is important to note that a hydrogen

[6] Own calculations: international aviation will consume around 800 Mt of fuel in 2050. The NCV of kerosene is 44.1 TJ/kt. That equals 35.28 EJ = 843 Mtoe by 2050. 1 Ha produces 100 GJ of biofuel.

[7] An increasing uptake or blend of biofuel will reduce the CO_2 price, and the associated demand reduction.

scenario has similar, though slightly lower, implications to synthetic fuels in terms of costs and additional electricity needs.

The emission reductions resulting from the use of electrofuels depend mainly on what electricity is used to produce the hydrogen and the choice of the source of CO_2 leads to different impacts. Using CO_2 from a fossil carbon origin, such as the one being emitted in a steel or a power plant, means the fuel is not carbon circular because the CO_2 ends up in the atmosphere anyway. Designing a synthetic fuel production chain around carbon capture risks locking-in one sector to decarbonise the other, creating a disincentive to move towards full decarbonisation. In a 2050 timeframe, the alternative is to use CO_2 captured directly from the atmosphere - a more expensive process, but one which ensures the electrofuels is fully circular.

Despite these cost impacts, our decarbonisation proposals argues that as fuel efficiency improvements will not decarbonise aviation, and with sustainable advanced biofuels unable to meet all of aviation fuel demand in 2050, if the sector wishes to decarbonise, it must steadily and in a sustainable manner increase electrofuels production to meet the remainder of its fuel demand. At least until more radical technology breakthroughs become available.

However the cost implications of electrofuels will remain substantial. Direct air capture costs are falling but will remain considerable for some time. And while renewable electricity costs are falling, and in some cases reaching parity or falling below non-renewable electricity costs, the fact that electrofuels production requires enormous quantities of electricity means that its cost will likely exceed that of untaxed kerosene.

It's unlikely that, even with carbon pricing, electrofuels will reach cost parity with kerosene. As a result, policies will need to be put in place to ensure the uptake of electrofuels. These policies are detailed below, but any policy which requires airlines to purchase a more expensive fuel will result in an overall increase in operational costs. At least some of that increase can be expected to be passed onto consumers, increasing the price of tickets, and thereby reducing demand. In our forecasts, we factor in the impact that this reduced demand will have on air traffic and thus the overall demand for fuels.

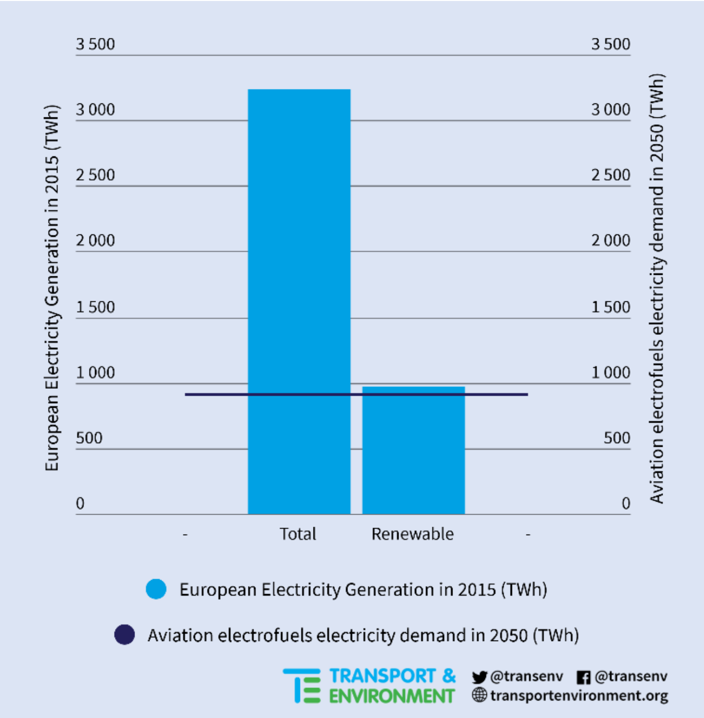


Figure 3. Electricity required to produce electrofuels for EU aviation in 2050

It's worth nothing the impact that electrofuels uptake will have on overall electricity demand - our forecasts are that meeting aviation fuel demand with electrofuels will require 912 TWh. This amount is equivalent to 28.2% of Europe's total electricity generation of 3234 TWh in 2015, or 94.4% of the 966 TWh of renewables generation [xxiii] (Figure 3). Note that this electricity used in the production of electrofuels will have to be renewable and additional for the resulting fuel to be considered zero carbon. Also, other sectors, such as industry, are expecting to use some types of electrofuels as a way to decarbonise. Such demand will have a considerable impact on broader efforts to decarbonise the European economy - it could mean that additional renewable electricity is used to create electrofuels, when it could have been used in a more efficient manner by other sectors of the economy. These competing demands for additional renewable electricity need to be taken into account to assess the realistic amounts of electrofuels which could be used in aviation.

In the production of electrofuels only a portion will be suitable for use in the aviation sector. We've put that share at 80% - a very optimistic assessment - meaning there will be residual fuels from this process which may be of use to other sectors.

As with sustainable advanced fuels, there is a risk of some residual emissions from electrofuels. And as stated above, the zero carbon status of these fuels is dependent on their potential displacement impacts, the manner of their production and therefore on the broader decarbonisation of the economy.

In our scenario electrofuels are produced from 100% additional renewable electricity using direct air capture CO_2. **With a cost of €2,100 per tonne in 2050, electrofuel uptake will increase ticket prices** a **further 23% compared to a ticket price with a €150/tonne CO_2** equivalent price, resulting in a 28% reduction in projected passenger demand compared to a business-as-usual scenario.

Policy options
Our policy recommendations are broken into two categories which are relevant for both types of alternative fuels - safeguards and uptake. Only when the former are in place should policy makers move to the latter.

3.3. Safeguards

3.3.1. Advanced sustainable biofuels

The legislative basis for use of advanced sustainable biofuels in Europe is the revision to the Renewable Energy Directive (RED II), which concluded several months ago. Contrary to the 2009 RED, the new law does not force member states anymore to support first generation biofuels and will phase out the support to those first generation biofuels which have the most damaging impact on the climate and the environment.

However the REDII revision falls short of ensuring only sustainable biofuels, which deliver maximum emission reductions, are used. For that to have been achieved, the revision would have had to completely phase out the support to first generation biofuels and contain sustainability criteria which would have included indirect impacts. When it comes to advanced biofuels listed in Annex IX of the Directive, no matter whether they are used in road or aviation, the list still includes some problematic items such as unsustainable forest feedstocks. In addition, the sustainability criteria are not fit to tackle impacts of this variety of biofuels, on soil carbon for example. There is also uncertainty on how biofuels produced from feedstocks not in this annex or which are not crop biofuels will be treated.

In order to ensure that these fuels are a partial long-term sustainable option for aviation, support should be limited to biofuels produced from wastes or residues, in line with the waste hierarchy, which deliver significant GHG savings after taking into account both direct and indirect impacts and other concerns such as loss in biodiversity, soil degradation or water pollution. This will greatly limit the availability of advanced sustainable biofuels, and is the reason biofuels cannot be relied on to fully decarbonise aviation.

3.3.2. Electrofuels

Safeguards are essential in order to ensure that electrofuels results in actual emission reductions, without negative side effects on other sectors. As discussed above, the two areas of concern are the supply of electricity and the supply of CO_2.

The RED II Directive addresses neither of these concerns effectively. The Directive doesn't include a requirement for electrofuels to use air capture and doesn't ensure that only renewable electricity will be used to produce electrofuels and will be additional. The Commission is expected to develop a methodology which could address these issues.

Our recommendations, and the related projections, are that strict sustainability safeguards are put in place[xxiv]. Briefly, electrofuels should be produced from additional renewable electricity, the CO_2 source should be from air, and strict sustainability criteria should be developed regarding land and water use.

3.4. Current limits to fuel blending

The industry certifying body ASTM currently sets different blending limits for alternative fuels (biofuels and synthetic) which depend on the fuel and vary from as low as 10% to up to 90%. These limits are set to ensure an appropriate level of safety and to guarantee the smooth operation of aircraft engines because lubricity can be an issue with alternate fuels. These blending limits obviously restrict the emission reductions currently possible from using alternate fuels. Over time these blending restrictions may be reduced or potentially abolished through new approaches to engine tuning or the development of new engine additives. Our report is based on the expectation that such solutions will be found.

3.5. Achieving fuel switching

Our forecasts are that, in part owing to the necessary safeguards for both sustainable alternative biofuels and electrofuels and the electricity requirements for electrofuels, a significant price gap will exist between these alternative fuels and the kerosene they are seeking to replace.

Currently, there are limited measures in place to encourage an uptake of aviation alternative fuels. The EU ETS recognises alternative fuels, with airlines able to reduce their allowance purchase obligations if they can demonstrate alternative fuel use. However low prices of allowances in recent years removed any incentive for airlines to switch to alternative fuels.

Important for aviation in the REDII is a de facto binding 2030 target of 7% for advanced biofuels including biofuels from waste and residues, electrofuels, renewable electricity and recycled carbon fuels. Renewable energy use in aviation can be counted towards achieving the overall 14% target of renewable energy use by 2030 and after 2020 the contribution of advanced fuels used in the aviation sector will be counted as 1.2 times the fuel's actual energy content towards meeting the 7% subtarget for advanced fuels. This is meant to incentivise fuel producers to bring alternative fuel into the aviation market, but it is unclear whether a multiplication factor of 1.2 will actually result in such fuels going to the aviation sector. The majority of the targets are likely to be filled by the road sector.

Our projected carbon price of €150 may encourage some fuel switching towards fuels which are on the lower end of the price spectrum. However full fuel switching will require different measures.

Fuel mandates have a chequered history in terms of environmental effectiveness, for example in Europe where a fuel mandate for the road transport sector has resulted in the wide scale use of food-based biofuels to reach the required targeted. As a result, any obligation on fuel supplied to the aviation sector in Europe will need to be crafted so as to ensure it does not incentivise the production of alternative fuels with negative environmental effects, like crop based biofuels.

One avenue to ensure that a fair share of advanced fuels is targeted at aviation, would be by requiring fuel suppliers to split their advanced fuels target proportionally between land and air transport[xxv]. Such a policy for advanced aviation fuels, which would cover both sustainable biofuels and synthetic fuels, needs to be based on these fuels' climate performance, not just on whether they are labelled 'renewable' or not.

So member states should be encouraged to adopt a low carbon fuel standard as this offers the best framework for incentivising the delivery of renewable advanced low-carbon fuels. The REDII allows member states to change their energy targets into a low carbon fuel standard provided the required level of renewable energy is realised by 2030. When all direct and indirect emissions are accounted for, it provides a performance-based differentiation and a competition for best performing technologies while giving clear market signals and incentives for clean fuel investments in the EU[xxvi]. Germany for example regulates alternative fuels through a GHG target.

3.6. A new dedicated EU policy for alternative fuels in aviation

However it is unclear whether member states will implement the RED II in a way which will enable a real uptake of advanced fuels in aviation. One way to overcome this would be for the EU to develop a specific amendment to the policy framework, in the form of a dedicated GHG target i.e. a low carbon fuel standard for sustainable advanced fuels in aviation. Such a standard would require fuel supplied on the EU aviation market to meet a progressively lower GHG intensity by using only sustainable advanced fuels.

At the same time, it would be crucial to ensure that such an additional policy tool does not lead to an increased demand in overall volumes for advanced biofuels compared to what is already required by the RED II. This is especially relevant for sustainable advanced biofuels feedstocks which are available only in limited quantities. Additional growth should be focused on electrofuels - which can be scaled sustainably - and the law should be crafted in a way that achieves this goal.

3.7. GHG – low carbon fuel standard for aviation

The Commission could propose an amendment to the REDII which requires suppliers placing aviation fuel on the EU market to comply with a gradually lower carbon intensity. Suppliers would be given several years to meet each level of the GHG intensity target which would apply either across the EU or at member state level. Member states would be required by EU legislation to enforce the GHG intensity target at member state level in a similar manner to the way Fuel Quality Directive (FQD) standards are currently implemented. A system of registration of aviation fuel suppliers would need to be established (that for road fuel suppliers was established through the tax provisions of the ETD.) The legislation could include a malus/bonus penalty on fuel suppliers for not achieving/over-achieving the requirement. “Aviation fuel suppliers” would need to be defined to include refiners, airport fuel farms and fuel importers etc.

All fuel uplifted for commercial aviation in the EU would be affected - i.e. for both intra and extra EU flights. The retail price of fuel sold to airlines across the EU would rise to reflect suppliers’ higher costs. Safeguards might need to be considered to ensure suppliers did not cross-subsidise higher aviation fuel costs by passing some of the increased costs onto the road sector. The low carbon fuel standard would need to be drafted in such a way as to ensure suppliers acted in tandem across the EU to avoid regional price distortions and potentially airline tankering.

Policy

- Introduce sufficient safeguards to ensure that sustainable alternative biofuels and electrofuels deliver promised emission reductions without negative consequences on sustainability;
- Member states should require fuel suppliers to split their advanced fuels target proportionally between land and air traffic and adopt a GHG target/a low carbon fuel standard as this offers the best framework for incentivising the delivery of renewable advanced low-carbon fuels;
- An amendment to the RED II requiring all fuel suppliers placing aviation fuel on the EU market to meet a decreasing carbon intensity, with the purpose of bringing all fuel sold to near zero carbon by 2050.

4. Decarbonising aviation results

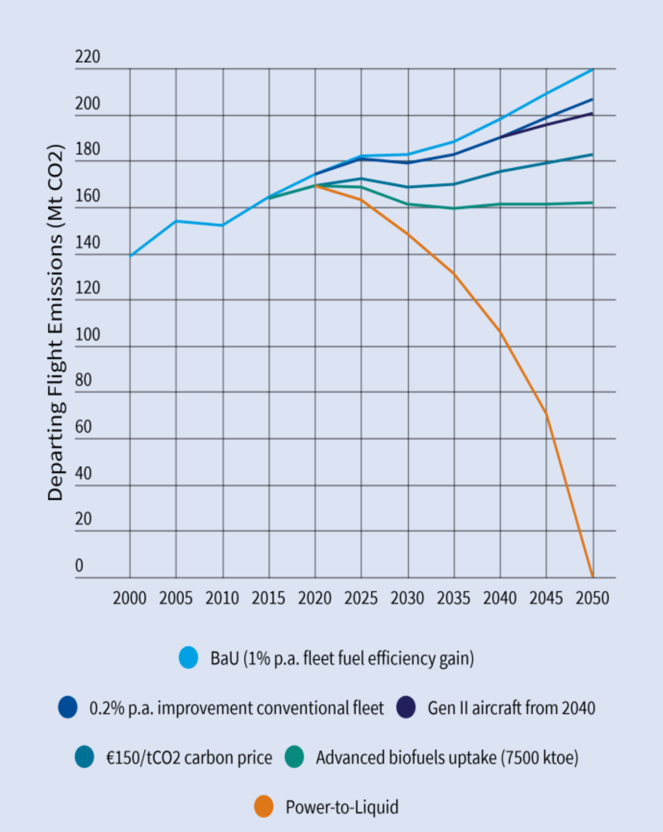
From the above discussion, Table 1 summarises the scenarios, the assumptions, and the resultant effect on aviation energy demand and aviation passenger activity. In a BaUs scenario, passenger activity is expected to grow by 80% from 2015 to 2050, from 722 million departing passenger movements to 1,117 million. Full details of calculation methodology can be found in the Appendices.

Table 1: Summary of aviation CO_2 mitigation scenarios

Scenario	Energy demand	Passenger demand	Notes
BaU	The fleet is assumed to improve 1% p.a.	No Change	Taken from Reference Scenario 2016. Energy demand increases 23% from 2015 to 2050. Fleet improvement is a combination of technical and logistical improvements. The Reference Scenario assumes 940€/ktoe for fuel in 2050. With the same methodology as is used to reduce demand with an increase in price, the BaU energy demand is increased with a constant and lower €600/ktoe price.
Fleet efficiency	Additional fleet improvements of 0.2% p.a.	No Change	No rebound considered from cheaper tickets based on lower fuel consumption
Gen II aircraft	30% more efficient than conventional fleet, picks up 1% demand p.a.	No Change	No rebound considered from cheaper tickets based on lower fuel consumption. Gen II are bubble type, strut wings, etc.
Aviation pricing	Reduction driven by change in passenger demand	€150/tCO_2 results in 12% reduction in demand.	There is 3.15 tCO_2 per tonne of fuel. Fuel cost assumed to be 25% of short haul ticket price and 20% of long haul. Passenger weighted elasticities (see Appendix B) from intra-vistas and long term income elasticities are adjusted to -0.48 for all EU departing flights. Ticket prices increase 17% over BaU.
Biofuels	7500 ktoe available in 2050	No Change	Growth following an S-curve, beginning from 2020
PtL demand	100% aviation demand met by 2050	Demand reduces from additional cost.	Reduced demand from €150/tCO_2 is nullified. PtL consumption from 2020 follows an S-curve.

The results of the different measures are presented below. A sensitivity analysis is provided in the Appendices.

Figure 4 (left) shows the CO_2 emissions trajectories from 2000 to 2050. Rapid decarbonisation is shown to occur from 2030 onwards, where the combined measures of demand reduction, efficiency measures, advanced biofuels and electrofuels curb CO_2 emissions to approximately 2010 levels. From that point on and with the increasing uptake of electrofuel and renewable electricity production, a rapid decrease ensues. In 2050, the CO_2 emissions from the departing flights in the EU is zero. Figure 4 (right) shows how the measures stack up in terms of liquid fuel consumption.



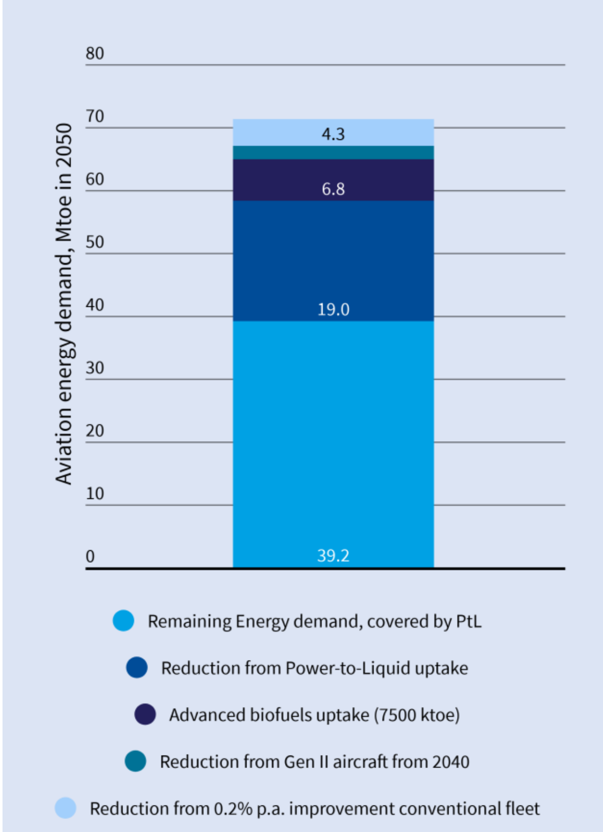


Figure 4: (Left) Reduction in European departing flight CO_2 emissions. (Right) PtL consumption of European departing flights in 2050 after demand reduction measures have been applied.

One of the biggest measures in and of itself is the reduction in demand from PtL. Note that in 2050, the demand reduction from the charges equivalent to €150/tonne of CO_2 have been nullified, as the kerosene no longer has a fossil component. Aside from being a driver for more efficient aircraft and their operations, the importance of the carbon pricing can be seen in the cumulative emissions savings. They have been calculated to reduce emissions by 180 Mt CO_2 cumulatively over the 2020 to 2050 period, compared to no price. With the remaining 39.2 Mtoe, at the price of 2,100€/t of fuel, this equates to an annual fuel bill for airlines fueling in Europe exceeding €82 billion. This compares to approximately €35 billion today spent on fossil kerosene.

The passenger activity for the BaU and the two scenarios that affect passenger demand are shown in Figure 5. As can be seen, this analysis shows that demand levels off from 2030 with an increasing share of PtL, owing to both its uptake and price. The 2050 passenger activity is equivalent to the business as usual activity in the early 2030s, thus an increase in overall passenger activity is still envisaged in this analysis. However, as passengers will be travelling further, this does not equate to a greater number of total flights. Modal shift will be most successful for short segment flights, while longer flights contribute significantly to the passenger activity metric as a single flight can usually take more passengers a multiple further. Thus, growth in activity does not justify increasing the capacity of airports, particularly in Western Europe where many airports are at capacity. Limiting growth by simply avoiding airport expansion is an effective way to keep downward pressure on demand.

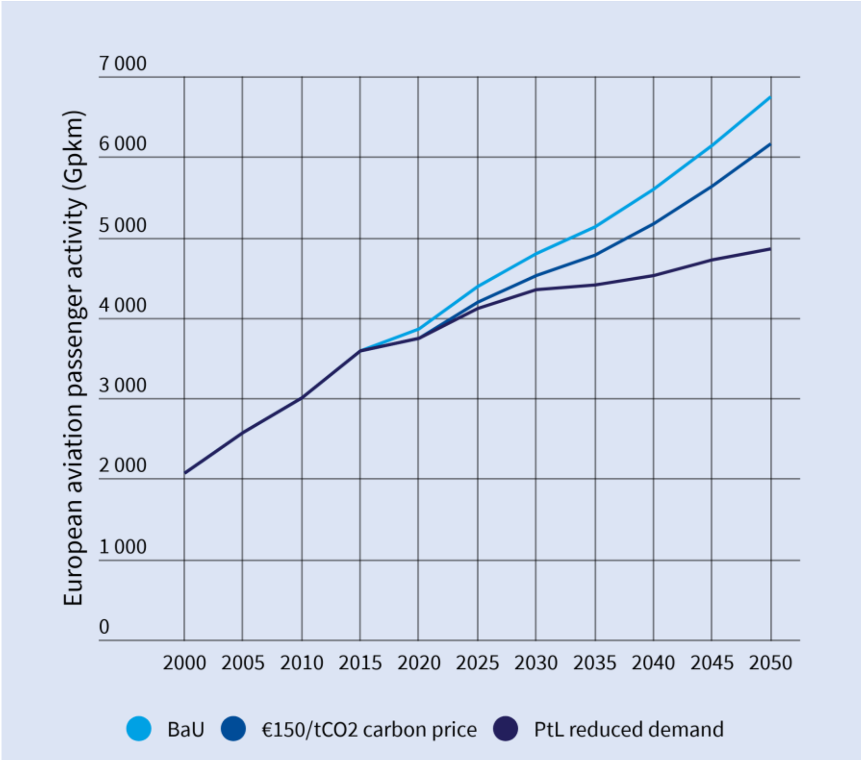


Figure 5: Passenger activity from demand reduction

5. Aviation's non-CO_2 effects

Aviation's non-CO_2 climate effects include NO_x emissions at altitude, contrails, cirrus cloud formation, soot and water vapour etc. and can equal or exceed the climate impact of aviation CO_2. Despite the ongoing uncertainties as to how these effects impact the climate and their extent, it is essential when drawing up an aviation decarbonisation strategy that policies to address these non-CO_2 effects are included, particularly where varying the fuels aircraft use is being considered.

There are currently no measures in place to address aviation's non-CO_2 climate impacts. When aviation was being included in the EU ETS Directive in 2008, Parliament sought to add a non-CO_2 multiplier to airline's obligations to purchase allowances, but this was rejected. A study for the Commission proposed the imposition of a cruise NOx charge with distance, but this was not acted upon[xxvii]. Since then, research into determining the exact climate impacts of these non-CO_2 effects has continued. The understanding of contrail-cirrus effects and their climate impact has improved over the years and potential measures involving changed flight trajectories so as aircraft avoid climate sensitive areas are being put forward[xxviii]. On the other hand, the aerosol-cloud effects of aircraft, if they exist, remain largely unknown. Sulphate aerosols from jet engines which may vary with fuel properties might change the properties of low level clouds which cool while emitted soot particles might trigger cirrus which might cool or warm.

In the 2017 revision of the EU ETS Directive, a requirement was included for the Commission to come forward by January 2020 with proposals to address these non-CO_2 effects if appropriate (Art 30(4) of the revised Directive). In the meantime, further research is expected to be published which might reduce uncertainties regarding the climate warming impact of some of the non-CO_2 effects.

Measures to reduce fuel demand and thus commercial traffic will reduce non-CO_2 effects insofar as they result in less flight activity. And since non-CO_2 effects are transient - hours or months (with the exception of CH4 cooling from NOx emissions, which will diminish in decades) - the reduced warming will be immediate - whereas CO_2 once emitted persists in the atmosphere along with its warming impact at diminishing levels for thousands of years.

The exhaust from biofuels and e-fuels will contain less soot than that from kerosene and can be expected to result in some reduction of non-CO_2 effects[xxix] but because water vapour and NOx will continue to be emitted from the engines, the principal sources of aviation non-CO_2 warming will persist. So the overall non-CO_2 impact of a switch to using cleaner fuels cannot be quantified here.

When aircraft operate at certain flight levels and atmospheric conditions conducive to ice crystals forming (as the hot and humid exhaust cools and mixes with the environment) climate warming contrails and cirrus cloud can form. If aircraft are rerouted (changed flight levels, route deviations) to avoid these atmospheric conditions, then the contrails/cirrus will not form. How much climate warming can be mitigated in this way is open to debate but estimates suggest very significantly[xxx]. Changing flights levels and deviating may incur small additional flying time and fuel burn penalties/costs which are the main reasons why industry opposition has ensured such measures have not been adopted. Such opposition is likely to continue but the sorts of CO_2 reductions outlined in this decarbonisation pathway would far exceed any CO_2 penalties from aircraft rerouting and allow a clear case to be made for adopting measures to have aircraft avoid climate sensitive areas. Such measures would require much improved weather forecasting 12 hours out to identify sensitive climate areas and allow for flight plans to be changed.

We have not sought to quantify the possible reductions from the above alternatives. Neither are the possible impacts of a transition to electric or hydrogen aircraft on non--CO_2 effects considered here, because the deployment of such aircraft in a meaningful commercial quantity is beyond the 2050 timeline we have analysed, the technologies remain speculative and the science about non-CO_2 impacts unclear.

Policy

Mitigating aviation's non-CO_2 effects must be included in any long-term emissions reduction strategy. Rerouting around climate sensitive areas holds promise and needs to be considered as a viable option. Reductions in CO_2 burn from measures we have outlined would likely more than compensate from any fuel burn penalty or rerouting. A switch to cleaner fuels may well reduce non- CO_2 impacts but these cannot be quantified here. Any aviation decarbonisation strategy must include the provision of significant additional funding into non-CO_2 issues and in particular to understand the non-CO_2 impacts of low/zero carbon fuels, the potential reductions in non-CO_2 warming of flights by avoiding climate sensitive areas, and the enhanced weather forecasting capabilities etc. that such measures would require. The Commission has a little over a year now to meet its obligations under the EU ETS Directive to come forward with potential non-CO_2 mitigation measures by January 2020.

6. Conclusions

Since its deregulation, European aviation emissions have taken off. Artificially cheap tickets through tax exemptions and through government subsidies have propped up and propelled the industry. Unfortunately, there is little awareness of the severe climate impacts and dangers that this mode of transport causes. As it stands, aviation flies in the face of the Paris Agreement, the goals of which are essential for the environment, society, and the economy.

If Europe is to pursue a zero-carbon economy, it must address this major and rapidly growing source of emissions. Europe's climate policy to date has either neglected this sector, or pursued false solutions such as offsetting. The IPCC's most recent report warns that time is rapidly running out to limit a dangerous increase in temperatures; there is no more time for delay.

This report outlines the measures needed to put aviation on a pathway to decarbonisation, and does not shy away from the challenges this poses. Fuel demand can be cut substantially, but only when aggressive policy measures are put in place. Its fuel can be decarbonised, but there are substantial challenges. Non-CO_2 effects must finally be addressed if we are serious about arresting aviation's climate impact.

The longer action is delayed, the greater the challenge of decarbonisation will be. With the EU revising its long-term decarbonisation strategy, now is the time to ensure Europe acts. This report therefore shows one of many possible pathways to decarbonise aviation. Passenger demand must not increase to the levels that many analysts predict, but largely plateau, and as soon as possible. This will mean ending the tax breaks, the government subsidies, and airport expansions.

Significant effort and resources will be required to collect and process sustainable feedstocks to produce the maximum amount of advanced biofuels to reduce the amount of electrofuels required to cover the remaining kerosene demand. This pathway therefore requires significant amounts of additional renewable electricity to be rapidly installed which will be required to produce electrofuels at considerable cost.

Finally, the decarbonisation pathway presented in this report requires active engagement from policy makers to ensure a decarbonised future. Multiple, concrete, feasible, and legally sound measures are proposed that need to be urgently implemented, that policy makers, politicians, and citizens can push for.

Appendix A: Calculations and inputs

In order to calculate the effects of efficiency gains and pricing policies on the future of European aviation, the 2016 EU Reference Scenario is utilised. This is used as a basis to generate a BaU scenario in this report (see Section 2.1). The key factors used in this report are shown in the table below, for two salient years. Alternative fuel uptake is assumed to increase in line with a logistic function (or an S-curve), other measures are assumed to increase linearly.

Parameter	2015	2050	Description/notes
Aviation Energy Demand (Mtoe)	53.3	71.3	All departing flights from the EU. Final demand adjusted from 65.5 Mtoe to account for differences in fuel cost
Population (million)	505	522	The GDP per capita over this period is thus projected to increase by 62%
GDP (in billion $€_{2013}$)	13,400	22,500	

There are several assumptions already built into the EU Reference Scenario that we take advantage of. The first is the fleet efficiency, which improves on average 1% per year from 2010 to 2050. As mentioned above, the price of fuel in the 2016 Reference Scenario is projected to increase to approximately €930/t; we correct the aviation demand for this by assuming that the fuel price remains constant at €600/t, which results in a 13% cheaper ticket price. This is calculated based on the assumptions detailed in Appendix B. This is step was undertaken in an attempt to unpick the demand reduction measures built into the Reference Scenario to avoid double counting them, and to avoid relying on an increase in fuel price to reduce demand.

Further inputs are shown in the table below.

Parameter	2020	2050	Description/notes
Kerosene price (€/t)	600	600	Assumed constant
Fuel price fraction of ticket price (domestic & intra EU)	25%	25%	See Appendix B for how the extra-EU flights increase their share
Fuel price fraction of ticket price (extra EU)	20%	20%	
Extra improvement on fleet compared to the BaU	0%	6%	0.2% per annum from 2020. This metric includes fuel and operational efficiency
Gen II aircraft	0%	3%	From 2040, 1% per year ingress of 30% more efficient aircraft design
Advanced biofuels (ktoe)	50	7500	In 2020 the amount of 50 ktoe is assumed to be available[xxxi], requires 33% year on year growth.
CO_2 price (€/t)	30	150	From ETS, VAT, kerosene tax
PtL price (€/t)	5000	2100	Mallins (2017) What role is there for electrofuel *technologies in European transport's low* carbon future?
PtL conversion efficiency	38%	50%	Schmidt, P., & Weindorf, W. (2016). Power-to-Liquids. Potentials and Perspectives for the Future Supply of Renewable Aviation Fuel. Dessau-Roßlau. Mallins (2017) What role is there for electrofuel technologies in European *transport's low carbon future?*

When applying efficiency measures, no rebound effect is assumed that may result from airlines passing on fuel savings to customers. Similarly, the introduction of advanced biofuels are assumed to cause no reduction in demand due to their higher price, to simplify the analysis. As these fuels only attain a blend of 13%, if they were double the price of kerosene, the change in ticket price would be around 3%, implying a demand in reduction of only 1.5% in 2050.

The measures are applied in the same order as outlined in the report: The fuel fleet and operational efficiencies are applied, on top of which a carbon price, followed by advanced biofuels, and finally electrofuels. The implication of this is that an uptake of biofuels has the effect of reducing the CO_2 price proportionally to the blend. The remaining fossil kerosene is then replaced by electrofuels, which reduce the carbon price to zero by 2050, however owing to the 2050 price of €2100/t (equivalent to a the effect of a carbon price of €500/t), there is still a significant drop in demand resulting from the uptake of this fuel. The way in which fuel and carbon prices affect the ticket price, and thus passenger demand, are described further in Appendix B.

As mentioned previously, electrofuel uptake is assumed to follow an S-curve, increasing from small amount in 2020, reaching half the required capacity in the year 2045 (denoted y_0) and meeting 100% of fossil kerosene demand in 2050. The growth rate factor, k, was 0.2, where the amount of PTL produced for a given year, y, is:

$$PTL_y = \frac{PTL_{2050}}{1 + e^{-k(y-y_0)}}$$

The Reference Scenario only includes passenger activity for the intra-EU segments, while included energy demand for all outbound flights. From a combination of analysis of transponder data from PlaneFinder, Eurostat passenger numbers, and an assumption that in 2050, extra EU flights will on average be 7000 km, the passenger activity from all departing passengers was calculated and projected to 2050.

Appendix B: Elasticities

This Appendix gives greater detail on how each measure effects aviation demand.

Price elasticities

There are a number of factors that influence air travel demand, as outlined by IATA's Air Travel Demand study from 2008[xxxii]. In most general terms, increasing the cost of flying reduces its demand. The reduction is not universal across the market, as it depends on factors such as the choice and utility of other modes of transport to undertake the journey (such as train, bus, or car), and how wealthy the passenger is. In this study, price and income elasticities are calculated based on Air Travel Demand, and are described in further detail in this Appendix. Furthermore, the income elasticities are modified in the context of more recent studies, such as The income elasticity of air travel: A meta-analysis[xxxiii] and UK Aviation Forecasts[8].

In the first step, the relevant elasticity coefficients for the flight segments based on distance band, price increase coverage, and geography are listed.

[8] UK Aviation Forecasts - Moving Britain Ahead. (2017) Department for Transport. Available: assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/674749/uk-aviation-forecasts-2017.pdf

Code	Disaggregation of flight segments	Elasticity coefficient	Description
LH	Long haul	1	Short haul flights have more options available to avoid the flights (such as car, train, bus)
SH	Short haul	1.1	
RL	Route level	1.4	Route level taxes can push passengers to cheaper routes (highly price sensitive), and national taxes can result in re-routing to other countries. This study assumes EU wide measures, i.e. at the supra-national level, which reduces passenger options for modal shift.
NL	National level	0.8	
SL	Supra-national level	0.6	
EU	Intra EU	1.4	Geographical location determines the cost sensitivity based on fast growing developing markets, and mature developed markets.
TA	Trans Atlantic	1.2	
AS	EU - Asia	0.9	

Combining the appropriate factors gives the following price based demand elasticities.

Segment	Elasticity	Elasticity coefficient combination
Domestic	-0.92	-1 * SH * SL * EU
Intra EU	-0.84	-1 * LH * SL * EU
Extra EU	-0.63	-1 * LH * SL * (TA + AS) / 2

According to these elasticities, an increase in ticket price of 10% for an intra-EU flight will result in a 8.4% reduction in demand.

Income elasticities

The price elasticities described above will not tend to be constant in time. Another key driver of aviation demand is wealth, whereby as people become richer, they tend to fly more. Income elasticities are computed from the segments for flights originating from developed economies. An elasticity of greater than 1 tends to indicate a luxury item.

Code	Segment	Elasticity	Description
SH	Short haul	1.3	As people become wealthier, they tend to demand more air travel. Long and very long haul flights become increasingly desirable with wealth.
MH	Medium haul	1.4	
LH	Long haul	1.5	
VH	Very long haul	2.2	

Combining the appropriate factors gives the following income based demand elasticities:

Segment	Elasticity	Elasticity coefficient combination
Domestic	1.3	SH
Intra EU	1.5	(MH + LH) / 2
Extra EU	1.9	(LH + VH) / 2

According to these income elasticities, a per capita increase in wealth of 10% will result in an increase in 15% of intra-EU flights, ceteris paribus, assuming ticket prices remain stable. As can be seen from Appendix A, Europeans are projected to be 62% times as wealthy in 2050 as they were in 2015. It is not clear to what extent the EU reference Scenario has used these elasticities, but it is assumed that these elasticities are causes in accelerating aviation demand to the levels that are projected. These elasticities have been used to compute the passenger share evolution in each flight segment, as described below.

There is evidence that as markets mature, these elasticities reduce. Gallet & Doucouliagos (2014) suggest that when taking both income and price elasticities into account, the income elasticity would be 0.633. The UK Department for transport foresee long term income elasticities of 0.6, also significantly lower than those presented in the IATA study. This assumes that the market is mature.

Accounting for price and income elasticities

When combining price and income elasticities, the standard approach would be to sum the net effects of both elasticities on the demand. For example, if a ticket price increase would result in a 10% reduction in passengers, but an increase in wealth would increase demand by 5%, the net effect would be a 5% reduction. In this analysis, however, passenger demand is assumed to have price and income elasticities built in. Therefore, the standard approach is not suitable in this case.

In this study, the income elasticity of 0.6 is applied directly to the price demand in 2050. If wealth considerations were not included, the segment weighted elasticity in 2050 would be -0.79. However, adjusting the elasticities based on wealth considerations gives a final segment and wealth adjusted price demand elasticity of -0.48 in 2050. This indicates a mature market where wealthier travellers are less affected by price increases.

The underlying reasoning behind using price and income elasticities is to see how pricing mechanisms such as a CO_2 price can reduce aviation passenger demand, which will reduce the amount of electrofuels the EU would need to produce. These elasticities are highly uncertain, however. To have a clearer view of how this can change the results, a sensitivity analysis is conducted and is presented in Appendix C.

Evolution of aviation segments projections

The income demand elasticities show that long and very long haul flights are expected to increase at a greater rate than domestic and intra-EU flights. The departing passenger numbers, P, of 2016 provided by Eurostat[9] have their 2050 projections weighted by the income elasticities, E, as per the following formula:

$$P_{i,2050} = \sum P_{i,2015} \cdot L_i \cdot (1 + G) \frac{E_i \cdot P_{i,2015} \cdot L_i \cdot (1 + G)}{\sum E_i \cdot P_{i,2015} \cdot L_i \cdot (1 + G)}$$

For the domestic, intra-EU, and extra-EU segments, i, with total passenger number growth measured in pkm G = 75%, taken directly from the reference scenario projections between 2015 and 2050. The passenger weighted average length of the domestic and intra-EU segments are calculated from transponder data in 2016, and are assumed to be constant. Extra-EU flight segment lengths are assumed to be 7000 km on average. This results in the following growth rates for each segment, shown in passenger numbers.

Flight segment	Departing passengers 2015 (millions)	Growth in pkm (2015-2050)	Departing passengers 2050 (millions)
Domestic	158.0	33%	210.2
Intra EU	393.2	48%	583.6
Extra EU	170.7	89%	323.3

[9] Eurostat, Table: avia_paoc. Accessed September 2018

Appendix C: Sensitivity analysis

This paper presents policy requirements that Europe needs to pursue in order to decarbonise aviation by 2050. This Appendix explores additional scenarios, where efficiency measures, SAFs, and other demand reduction measures are not taken, and the sensitivity analysis on the use of income elasticities. The results of this analysis is presented in the table below, showing the effect final passenger numbers and the

Sensitivity analysis scenario		2050	
		Passengers Activity in Gpkm (% reduction from BaU in 2050)	Electricity demand for electrofuel in TWh (% EU 2015 generation)
0	Business as usual	6753	N/A
1	Pathway to decarbonisation as detailed in this paper	4853 (-28%)	912 (28.2%)
2	No efficiency, alternative fuels, or demand reduction	4853 (-28%)	1191 (36.8%)
3	Scenario 1 with no long term income elasticity adjustment	3587 (-47%)	628 (19.4%)
4	Scenario 2 with no long term income elasticity adjustment	3587 (-47%)	880 (27.2%)
5	Scenario 1 without advanced biofuels	4853 (-28%)	1086 (33.6%)

The results show that if short term measures are not applied as a long term strategy to decarbonisation, the required PtL production will increase by 31%, or to 36.8% of 2015 EU generation of 3234 TWh. Between Scenarios 1 and 2, there is no difference between passenger demand as when there is 100% SAFs and SEFs in the blend, there is no CO_2 price demand reduction. Passenger demand is 28% less than projected in 2050, or roughly equivalent to 2030 levels. Scenarios 3 & 4 show the effect of applying unadjusted price elasticities. In the case where price elasticities were to be constant, the price of electrofuels would result in nearly halving the passenger demand from the business as usual scenario, equivalent to passenger activity in 2020. The implication is that with lower passenger activity, there is less requirement to produce electrofuels. Finally, scenario 5 shows the electrofuel required in the case where no advanced biofuel is available to aviation, which may be the case based on the demand from competing sectors for the biomass and from increasingly stringent sustainability criteria that may be legislated for. The result here shows that almost 20% more additional and renewable electricity would be required to produce enough electrofuels.

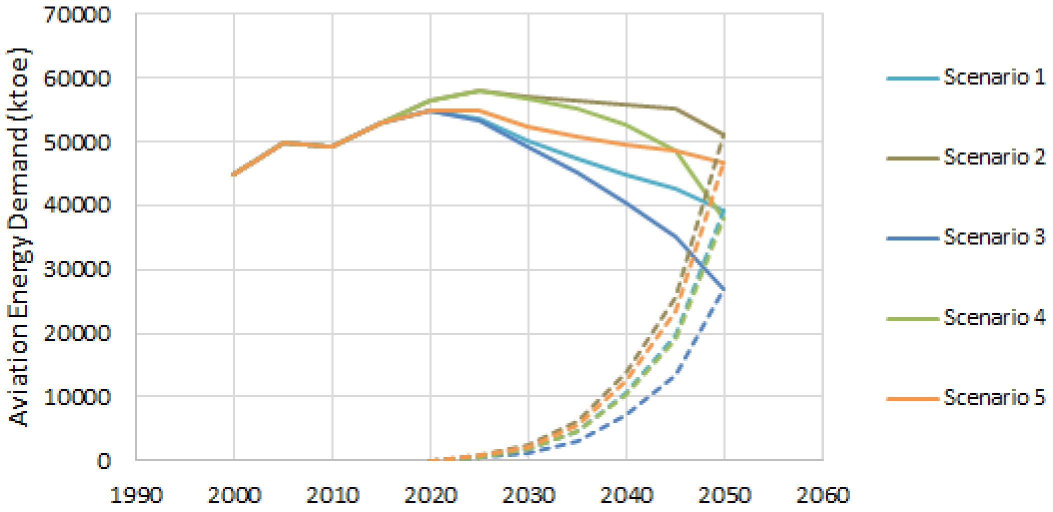


Figure 6: Results of sensitivity analysis scenarios. Dashed lines indicate the PtL production curve following an S-Curve required to meet fuel demand by 2050.

Selection of appropriate elasticities is thus crucial to approximating the future passenger and energy demand of aviation, particularly how they will evolve over the next 30 years to 2050. There is an underlying assumption that elasticities are constant irrespective of the price change. From the literature review conducted to attain the elasticities used in this report, there has been no discussion on the fairness of this assumption. For example, the assertion that a proportional change in demand will be the same for a 5% change in price compared to a 50% change is not verifiable. The main takeaway from this analysis is that demand reduction is necessary to reduce the amount of additional renewable electricity capacity required in the EU, irrespective of whether long term elasticities change or not. The final values attempt to give an order of magnitude appreciation of how much additional renewable electricity this will equate to.

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Taxing aviation fuels in the EU

CE Delft

Committed to the Environment

Taxing aviation fuels in the EU

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Content

1 Summary

This paper analyses the taxation of aviation fuels in EU Member States on intra-EU flights. Its main focus is the legality of these taxes and it also provides estimates of the potential revenues.

Fuels used in commercial aviation are exempt from excise duties in the EU, in contrast to fuels used on road and rail transport. However, the Energy Taxation Directive permits EU Member States to impose a tax on aviation fuel used in domestic flights without limitation as well as on intra-EEA flights between Member States on the condition that the affected States have entered into a bilateral agreement to do so.

If Member States were to enter into a bilateral agreement to tax fuel on flights between them, such a measure could also affect aircraft operators registered in a non-EU Member State, as they sometimes operate on intra-EEA routes. In that case, it is possible that some of these airlines would be subject to separate bilateral air service agreements that prohibits both States from taxing fuels.

Such a situation could potentially distort the competitive market. This report explores whether, and if so how, such a market distortion could be limited or avoided altogether.

The legal analysis shows that it appears to be possible for EU Member States to tax aviation fuels on flights between them even when non-EU carriers are enjoying a mutual exemption from fuel tax operate on those routes. There are several ways to minimise the chances that a legal challenge by these carriers would be successful. The most promising option seems to be the introduction of a *de minimis* threshold.

The potential revenues of an excise duty on aviation taxes is several billions of euros per year.

2 Introduction

2.1 General subject and nature of the report

This paper analyses the taxation of aviation fuels in EU Member States on intra-EU flights. Its main focus is the legality of these taxes and it also provides estimates of the potential revenues. The paper is primarily intended to draw attention to the possibility of taxing aviation fuels on domestic and
intra-EEA flights and to identify some remaining issues which need to be clarified. A full legal and economic analysis was beyond the scope.

2.2 Problem definition

Fuels used in commercial aviation are exempt from excise duties in the EU, in contrast to fuels used on road and rail transport[1]. However, the Energy Taxation Directive permits EU Member States to impose a tax on aviation fuel used in domestic flights without limitation as well as on intra-EEA flights between Member States on the condition that the affected States have entered into a bilateral agreement to do so[2].

Currently, all EEA Member States exempt aviation fuels sold to aircraft on international voyages from taxation (both for intra-EEA and extra-EEA flights), but some levy excise duty on domestic flights.

If Member States were to enter into a bilateral agreement to tax fuel on flights between them, such a measure could also affect aircraft operators registered in a non-EU Member State, as they sometimes operate on intra-EEA routes. In that case, it is possible that some of these airlines would be subject to separate bilateral air service agreements that prohibits both States from taxing fuels.

Such a situation could potentially distort the competitive market: Suppose two EU Member States agree to tax aviation fuels on flights between those states, and that an airline from a non-EU country operates one or more flights between those countries. This airline could argue that it would not have to pay the tax due to the bilateral air service agreement between either of the EU Member States and the non-EU country in which the airline is registered. If this argument is justified, the non-EU airline would have lower costs and could gain a competitive advantage relative to EU carriers operating on the same route.

This report explores whether, and if so how, such a market distortion could be limited or avoided altogether. It especially analyses the potential of *de minimis* provisions in fuel taxation as a way to limit the distortion.

[1] Energy Tax Directive 2003/96/EC (Article 14(1)(b)): Member States shall exempt the following from taxation (…): energy products supplied for use as fuel for the purpose of air navigation other than in private pleasure-flying.

[2] Energy Tax Directive 2003/96/EC (Article 14(2)): Member States may limit the scope of the exemptions (...) to international and intra-Community transport. In addition, where a Member State has entered into a bilateral agreement with another Member State, it may also waive the exemptions provided for in Paragraph 1(b).

2.3 Outline of the report

Chapter 3 summarises the legal analysis of a *de minimis* threshold in an agreement between Member States to tax aviation fuels. Chapter 4 presents an estimate of the potential revenues. Chapter 5 provides conclusions.
Annex A contains the full text of the legal analysis. Annex B is a list of non-EU aircraft operators active on intra-EEA routes.

3 Possibilities for and constraints to taxing aviation fuels in Europe

3.1 Subject and nature of this chapter

This chapter contains a summary of two legal analyses of the possibilities for EU Member States to impose excise duties on fuel used for on intra-EEA flights. It is based on more elaborate analyses that are reproduced in Annexes A and B.

3.2 Legal analysis of possibilities to tax aviation fuels

EU Member States wishing to tax aviation fuel on flights between those states can enter into a bilateral agreement to do so. This was explicitly allowed for under the Energy Taxation Directive (ETD) from 2003. Even though such a bilateral agreement would subject aviation to a new tax, the chances of successful legal action of EU carriers operating routes between those states against that tax would be small because the ETD specifically allows for such a bilateral agreement and the law governing the EU internal air transport market does not address fuel taxation.

There are a number of non-EU aircraft operators that are offering commercial services between airports in EEA Member States (see Annex C). Most of these consume limited amounts of fuel on
intra-EEA routes, with three exemptions: a Swiss low cost carrier and two American Express Airlines. Many of these foreign airlines operate under bilateral air service agreements or under the EU-US Open Skies Agreement which exempt them from fuel taxes[3].

This means that if EU Member States were to conclude a bilateral agreement to tax aviation fuel on flights between those states, non-EU airlines could oppose such a tax with a reference to the air service agreement. If this opposition would be successful, a situation could emerge in which EU carriers would be taxed, whereas their foreign competitors would not. This would distort the competitive market.

The issue of distorting the competitive market does not arise with regard to taxing fuel used on domestic flights. The only foreign carriers that have the right to operate domestic flights in
EU Member States are members of the European Common Aviation Area (ECAA). In addition to being granted the rights to operate domestic EU flights under the ECAA, they must agree to abide by additional EU aviation legislation, including the Energy Taxation Directive. Therefore any domestic fuel tax in an EU Member State can be imposed the same on that countries domestic carriers and any other EU or ECAA carriers operating domestically within that country. There are several places around the world (e.g. in the US, Brazil, India and

3 Article 11(2): “There shall also be exempt, on the basis of reciprocity, from the taxes, levies, duties, fees and charges referred to in Paragraph 1 of this Article, with the exception of charges based on the cost of the service provided: (…) (c) fuel, lubricants and consumable technical supplies introduced into or supplied in the territory of a Party for use in an aircraft of an airline of the other Party engaged in international air transportation, even when these supplies are to be used on a part of the journey performed over the territory of the Party in which they are taken on board”.

Japan) which impose taxation on domestic but not international flights without any issues arising.

However, EU Member States have several recourses to legal action against fuel taxes:

1. A *de minimis* provision could be introduced exempting non-EU carriers in practice. Whether this provision is on the basis of the amount of fuel used, the number of flights, or yet another basis is not a legal case. There is a legal precedent in the EU ETS directive, which introduced an exemption on the basis of the number of flights and the total quantity of emissions. In case of a fuel tax, the *de minimis* threshold could for example be based on the amount of fuel, on the number of flights, or on the total tax receipt.
2. Several recent air service agreements allow for the taxation of fuels. This means that foreign aircraft operators from these countries could not bring a case on the basis that there is a bilateral agreement which has been breached. The Member States and the EU could renegotiate the agreements with the other countries involved. The EU-Swiss bilateral for example, already does not provide a fuel tax exemption and thus does not need to be renegotiated[4]).
3. In the case of American carriers, the EU-US Open Skies Agreement foresees in referral of tax cases to the Joint Committee, which should decide on the basis of consensus. If consensus is not reached, the EU and the US may seek arbitration. The outcome of such a procedure is by nature unpredictable but the guidance provides for the suspension of 'comparable benefits' which would presumably including the US imposing fuel taxation in the US, which, in fact, is already being imposed.
4. Finally, most bilateral air service agreements exempt fuel used from taxation 'on the basis of reciprocity'. While the question has not been tested in court, this could be interpreted to mean that either party to the agreement can terminate the reciprocity. If this interpretation holds up in court, it would allow for the taxation of fuel used by foreign airlines.

A question that will arise is how a possible taxation ties into the Emissions Trading System (ETS) which places a cap on the amount of CO_2 intra-EU aviation can emit. However, the ETS was not designed to be the only measure mitigating aviation's climate impact. The ETS Directive states itself that it is part of a wider "comprehensive and coherent package of policies and measures implemented at Member State and Community level." And the ETS was designed as a Directive in order to be a minimum harmonising measure.

3.3 Remaining issues

The legal analyses conclude that a *de minimis* threshold could be a way to facilitate the introduction of taxation of aircraft fuel on intra-EEA flights and circumvent obstacles pertaining to mandatory exemptions regarding taxation of aircraft fuel raised by air services agreements.

Another way to facilitate the introduction of intra-EU fuel taxation would be for the EU to abrogate its exemption of fuel taxation in the international agreements. Both legal analyses conclude that (while not tested in court), since the EU-US Open Skies Agreement only exempts fuel from taxation on the basis of 'reciprocity', that reciprocity can be withdrawn at any time to allow either side to impose taxation. The legal analysis in Annex B considers

[4] See the text of the Agreement here ec.europa.eu/transport/modes/air/international_aviation/country_index/switzerland_en

the procedure under the EU-US Open Skies Agreement to conclude that US agreement to withdrawing that reciprocal exemption would not necessarily be required. And in the event that it was and arbitration under the agreement resulted, the end result would be the withdrawal of comparable benefits by the other side, i.e. the US could begin to tax EU carrier fuel on flights departing the US (there are no intra-US flights by EU carriers).

Still, several issues remain to be analysed in more detail, such as:
- At which legislative level would the *de minimis* threshold be set? The legal analysis suggests that the threshold should preferably be set at the EU level, potentially as an amendment of the Energy Taxation Directive, rather than at the bilateral or national level, in order to prevent distortion of competition. However, taxes would be levied by Member States, and an EU-wide *de minimis* threshold would require them to exchange information on the amount of fuel taxes. A threshold per Member State would circumvent this problem.
- If non-EU carriers benefitting from a mutual fuel tax exemption were to exceed the threshold in the future due to an increase in their activities or otherwise, would they then become liable for a tax?
- Would any *de minimis* provision be deemed to act as a cap on activity and as such be at odds with other provisions of the air service agreement?
- Should the threshold be based on the amount of fuel uploaded, the number of flights or another parameter?
- How the threshold would be implemented in practice. A tax rebate would probably have the lowest administrative costs and the lowest potential for fraud, but would a tax rebate be the same as an exemption?

3.4 Conclusion

Aviation fuel used on flights between Member States can be taxed if Member States enter into a bilateral agreement or a series of bilateral agreements to do so. In order to minimise the risk of successful legal action by non-EU carriers operating between these Member States and enjoying a mutual exemption from fuel tax, a *de minimis* threshold for the tax appears to be a good instrument, although there are also other options. How the tax and the threshold would best be designed, requires more analysis.

4 Possible revenues of aviation fuel excise

The potential revenues of an aviation fuel excise duty are about 6 billion euros for international
intra-EEA flights and approximately 50% higher when domestic aviation is also included, as shown in Table 1.

Table 1 - Calculation of potential revenues of an aviation excise duty

Item	Quantity	Source
Verified aviation CO_2 emissions in the EU ETS, 2016 (million tonnes)[5]	61	European Environmental Agency ETS Data Viewer
Calculated fuel use in EU ETS scope	20	IPCC emission factor for jet kerosene is 3.15
Amount of jet fuel supplied in EEA for domestic flights, 2016 (million tonnes)	6	Eurostat, Supply, transformation and consumption of oil - annual data [nrg_102a], version 1-2-2018
Calculated fuel use on international flights in EU ETS scope (million tonnes)	13	
Calculated fuel use on international flights in EU ETS scope (billion litres)	17	Exxon Mobile fuel specifications: Jet kerosene energy density is 775-840 kg/m^3. Here, the value 800 kg/m^3 is used.
Potential tax revenue when taxed at € 330 per 1,000 litres (€ billion)	5.6	Energy Taxation Directive minimum rate

This amount does not take a *de minimis* threshold into account.

According to the EU ETS Transaction Log, emissions of non-EEA airlines in the scope of the EU ETS amounted to 0.9 Mt, or about 1.5% of total emissions. The largest airline consumed about 74 million litres of fuel on intra-EEA routes. Exempting airlines the first 100 million litres from taxation for each airline would suffice to ensure that these airlines do not have to pay tax.

A tax revenue of € 5 billion would, if passed on to the passengers, amount to a little over € 10 per passenger.

5 Note that flights to and from outermost regions are exempt from the EU ETS. As a result, the total emissions on inter-EEA flights are higher than the verified emissions under the EU ETS. Flight data analysis suggests that the different amounts to 5.5 Mt CO_2 per year.

5 Conclusion

Is appears to be possible for EU Member States to tax aviation fuels on flights between them even when non-EU carriers and enjoying a mutual exemption from fuel tax operate on those routes.
There are several ways to minimise the chances that a legal challenge by these carriers would be successful. The most promising option seems to be the introduction of a *de minimis* threshold.

The potential revenues of an excise duty on aviation taxes is several billions of euros per year.

A Preliminary legal analysis of taxation of aviation fuels in Europe

By Pablo Mendes de Leon
February 2018

Executive Summary

Directive 2003/96/EC mandatorily exempts aircraft fuel consumed on commercial flights between EU States from taxation. Taxes are levied on energy products as defined in this Directive. At the same time it allows EU/EEA Member States to waive this exemption pertaining to taxation of aircraft fuel through bilateral agreements, and for other purposes as detailed below.

So far, no examples of such bilateral agreements are known. The present brief report endeavours to contextualise this option in light of European and international law. From an international air law point of view, aircraft fuel used on transit flights is not taxable. The same is generally true for aircraft fuel introduced in foreign territory and used on international flights.

However, multilateral air services agreements such as the EU-US agreement on air transport and certain bilateral air services agreements all of which have been concluded in the 21st century open the door for a waiver of this exemption on intra-EU/EEA flights when two, or more, European States engage into an agreement on taxation of aircraft fuel, or when they refer to a waiver pursuant to domestic law. Thus, they provide a legal basis for the introduction of taxation of aircraft fuel.

A revision of Directive 2003/96/EC ought to address these recent developments, and explain the term “international conventions” justifying, in the views of the EU policymakers, a continuation of the aircraft fuel tax exemption.

In order to facilitate the introduction of taxation of aircraft fuel and circumvent obstacles pertaining to mandatory exemptions regarding taxation of aircraft fuel raised by air services agreements, thought could be given to include a *de minimis* measure in a revised version of Directive 2003/96/EC. Such a measure should preferably be taken at the EU rather than at any other level, whether bilateral or national, in order to harmonise conditions for the introduction of a partial or total waiver of the exemption. However, the establishment of such a measure requires a very careful assessment of its legal and economic implications.

A *de minimis* measure has been used in, for instance, the EU ETS Directive (2008/101). When the EU considers the introduction of an aircraft fuel tax, preferably in conjunction with a *de minimis* measure, regard must be had to general principals of EU law. They include the non-discrimination principle, the fiscal neutrality of the proposed tax measure, a prohibition of infringement of free movement of air services and compliance with European competition and State aid rules.

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A.1 The position of carriers under European LAW

A.1.1 The scope of the EU Energy Taxation Directive 2003/96

EU Council Directive 2003/96, henceforth also referred to as the Directive, is the principal directive addressing the taxation of energy products including aircraft fuel. It obliges EU States to impose taxes on energy products in accordance with the Directive. That said, it proceeds from the fiscal autonomy of the EU States which is evidenced by the large number of exemptions and derogations laid down the Directive. Moreover, EU States must take into account their relations with non-EU States as to which see Section A.2.

Among others the Directive is designed to enhance the level playing field in the internal market by establishing minimum levels of taxation at an EU level. At the same time, it endeavours to promote the competitiveness of EU undertakings internationally.

The last mentioned objective plays an important role in relation to international air transport as commercial air transport between EU/EEA States is mandatorily exempted from taxation of aircraft fuel. However, fuel consumed for the performance of air transport can be taxed in the event of:

a Private pleasure flying in which case fuel must be taxed, following which provision France, Portugal, the United Kingdom, Malta and Sweden attempted to disregard the concerned exemption in which effort they did not succeed because the EU Commission wished to strictly apply the Directive.
b Commercial air traffic using fuel which is not jet fuel (CN code 2710 1921).
c Domestic air traffic, that is, carriage by air within an EU State.
d Intra-EU traffic in case two EU States have entered into a bilateral agreement, in which case the concerned Member States are allowed to apply a level of taxation below the minimum level set out in the Directive.

As far as we can see, the last mentioned event has not been put in practice but it is referred to in the EU-US agreement on air transport of 2007 as amended in 2010 as to which see Section A.4.

While the Directive speaks of ‘a bilateral agreement’ between two EU States, it does not specify the form, let alone does it give indications for the substance of such an agreement. Thus, at first sight, it would seem that EU States are free to choose the form and substance of such an agreement.

The question is whether ‘a bilateral agreement’ means:

- A new bilateral agreement between two EU States, focussing exclusively on taxation of aircraft fuel to be applied by the EU air carriers flying the routes covered by the new bilateral agreement, in which case it may be critical to apply the new bilateral agreement to non-EU air carriers because they are subject to another regime, for instance the EU-US agreement on air transport of 2007 as amended in 2010 as to which see Section A.3.2, or exempted by virtue of a *de minimis* measure as to which see Section A.1.4.
- An amendment of an existing air services agreement as to which see Section A.3.1.
- An amendment of a tax agreement between two EU States which is not the most likely option as it covers subjects which are different from the current one, that is, principally, the avoidance of double taxation of companies and persons working in the two States.

Remarkably, Article 11(6) of the EU-US Agreement on air transport (see Section A.3.2) speaks of a waiver to be granted by “two or more Member States” pursuant to Directive 2003/96 whereas 14(2) of this Directive refers to bilateral agreements between EU States. Reference is made to the remarks on this point made in Section A.4.

A.1.2 The EU/EEA internal market

The EU internal air transport market is governed by EU Regulation 1008/2008. Its geographical scope is extended to the territories of the European Economic Area (EEA), that is, Norway, Iceland and Liechtenstein. Special arrangements are made with Switzerland in a treaty with the EU.

While EU Regulation 1008/2008 principally aims to create a level playing field in the EU internal air transport market by harmonising conditions for the operation of air services within that market,

it does not address taxation of aircraft fuel.

At various instances, Regulation 1008/2008 refers to “bilateral agreements between Member States” notably in the context of access to intra-EU routes pricing freedom of EU air carriers. This Regulation stipulates that restrictions on access to routes and pricing are abolished and that provisions in such “bilateral agreements between Member States” are “hereby superseded.” The bilateral agreements in question are bilateral air services agreements.

It follows that Regulation 1008/2008 supersedes the relevant provisions of bilateral air services agreements between EU States but that such agreements are not cancelled in toto by this regulation as such bilateral agreements contain provisions which are not covered by it, for instance, the taxation of aircraft fuel. Reportedly, Spain has cancelled all its bilateral air services agreements with other

EU States whereas the Swedish website, listing all of its bilateral air services agreements, does not mention the intra-EU agreements.

From a legal perspective it would seem that the bilateral air services agreements between EU States ought to stay in force as not all matters covered by these agreements are superseded by EU law, as exemplified by taxation of aircraft fuel, cooperation in the context of aviation security conventions and transportation between EU States who have overseas territories and such overseas territories as such territories fall outside the scope of Regulation 1008/2008 and EU law generally.

A.1.3 The regime of the European Common Aviation Area (ECAA)

In December 2005 the EU concluded a Multilateral Agreement on the establishment of a European Common Aviation Area (ECAA) with eight South-East European partners, namely, Albania, Bosnia and Herzegovina, Bulgaria, Croatia, the former Yugoslav Republic of Macedonia, Romania, Serbia and Montenegro and the U.N. Mission in Kosovo. The objective

of this agreement is to integrate the said neighbouring South-East European countries with the EU's internal aviation market which, at the time, consisted of 25 EU Member States as well as Norway and Iceland.
The eight South-East European countries agreed to the full application of the EU's aviation law also referred to as the EU acquis. They will do so in a step by step procedure which is supervised by the EU Commission. Once they fully implement the EU's aviation acquis, airlines from the South East European countries will have open access to the enlarged EU internal air transport market.
The acquis of the EU encompasses the implementation of the above Directive 2003/96. The only applicable provisions applying to the 'accession countries' are those laid down in Article 14(1)(b) and (2) pertaining to the exemptions in air transport. Reference is made to the discussion in Section 1.1.

A.1.4 The *de minimis* option under EU law

In Section A.1.1 it was concluded that EU States are permitted to engage into bilateral agreements, however framed, with the purpose of taxing aircraft fuel on intra-EU flights covered by that agreement. In that context, it must be examined how to deal with non-EU air carriers operating the same intra-EU flights as they are flying under other agreements. For instance, US cargo carriers operate intra-European services under the EU-US agreement of 2007 as amended in 2010 as to which see Section A.3.2. It may be critical to subject non-EU air carriers to bilateral agreements concluded between EU States because, for instance, other agreements such as the mentioned anterior EU-US agreement, may conflict with the provisions of the intra-EU bilateral agreement.
The application of the *de minimis* threshold could be adopted as an exemption measure for carriers who do not meet the criteria drawn up in the measure. This option would legally circumvent the obstacle referred to above, that is, that it may be critical to subject non-EU air carriers to a bilateral agreement between EU States in light of existing arrangements. While the EU Court of Justice has observed that, among others, the freedom to provide services, including the provision of air services, is so fundamental that restrictions ought not be permitted, the same court has, in other decisions, expressed the view that, if the effect of the measure is "too remote" and it lacks a significant effect on the market access, it is not caught by EU Treaty provisions. These decisions regarded EU undertakings, whereas the current scenario would principally and practically be designed to affect non-EU undertakings, that is, non-EU airlines. However, it will be shown below, in relation to the EU ETS Directive, that non-EU airlines may also be exempted from environmental measures pursuant to the *de minimis* measure.
Regulation 1008/2008 does not provide quantitative thresholds for accessing the air transport market governing the operation of intra-EU/EEA air services. All EU/EEA carriers meeting the quality standards mentioned there are permitted to operate these services, and must comply with all of the conditions drawn up in that regulation. The same regime applies to air carriers operating their air services under bilateral and multilateral air services agreements as to which see Sections A.3.1 and A.3.2.
De minimis provisions, do, however, occur in European regulations affecting air transport. For instance, EU environmental law provides examples of *de minimis* and/or quantitative measures exempting operators of aircraft from compliance with the concerned obligations. In the first place, reference is made to EU Directive 2008/101 on the establishment of the EU Emission Trading System (ETS). It comprises *de minimis* exemptions for airlines, whether EU/EEA or non-EU/EEA airlines, operating either fewer than 243 flights per period for three consecutive four months periods or flights with total annual emissions lower than 10,000 tonnes CO_2 per year. Thus, the provisions drawn up in Annex I of EU ETS Directive 2008/101 could serve as an example for a proposal pertaining to the introduction of an aircraft fuel taxation measure.

Secondly, there are other examples of EU regulations providing for quantitative thresholds. However, the situation envisaged in those regulations is different from the present scenario.
The establishment of a *de minimis* measure must be diligently scrutinised because of its legal and economic impact. It may affect the competitive conditions of the performance of intra-European air transport, and thus, the level playing field, raising also air policy and legal questions.

A.2 The position of air carriers under the International framework

A.3 The Chicago Convention on international civil aviation (1944)

The Chicago Convention of 1944 forms the constitution of international civil aviation. It is adhered to by 192 States per February 2018, that is, practically all States in the world, including all EU/EEA States. The EU is not a party to it as only States can accede to this convention. It would seem that the proposal for an amendment of Directive 2003/96 when referring to "international conventions" preventing the EU from abolishing these exemptions has this convention in mind.
The Chicago Convention contains one provision which directly affects the subject of this study, namely, Article 24(a) which reads as follows:

- "*Fuel, lubricating oils*, spare parts, regular equipment and aircraft stores on board an aircraft of a contracting State, on arrival in the territory of another contracting State and retained on board on leaving the territory of that State shall be *exempt from customs duty, inspection fees or similar national or local duties and charges*. This exemption shall not apply to any quantities or articles unloaded, except in accordance with the customs regulations of the State, which may require that they shall be kept under customs supervision." (italics added).

The term "similar national or local duties and charges" must be understood to encompass national taxes. For instance, Germany may therefore not tax fuel that was tanked in France on board aircraft making a stop in Frankfurt or flying through German airspace without stop in Germany to Moscow, even if such fuel was consumed in Germany, falling under Germany's fiscal jurisdiction.
However, the cited provision does not say anything about the taxation of fuel taken on board in, for instance, Portugal, when such fuel is used for a flight between Lisbon and Rio de Janeiro. This matter is regulated by air services agreements as to which see the next section.

A.3.1 Air Services Agreements

There are about 5,000 Air Services Agreements (ASAs) concluded between States regulating the operation of international air services internationally. As a matter of international and constitutional law or other national acts, international agreements including ASAs normally supersede the application of national law. Hence, even if national law, or in the case of the EU, EU law would allow taxation of aircraft fuel, the ASA would supersede the application of domestic law, EU law being regarded as domestic law. This legal state of affairs may explain why the EU refers to the applicability of "international conventions" in, for instance, the proposal for an amendment of Directive 2003/96.
Most of the ASAs are bilateral agreements, with notable exceptions such as the EU-US agreement on air transport of 2007 as amended in 2010 as to which see the next section, and the EU-Canada agreement on air transport of 2009. These are multilateral agreements

as they are concluded by the EU and its Member States on the one side, and the US and Canada respectively on the other side.
The vast majority of the ASAs contain language which forbids taxes and levies on fuel, lubricants, spare parts and the like which are not unloaded from an aircraft but re-exported to another country on the international air services agreed upon in the concerned ASA. It follows from the previous section that taxation of aircraft fuel in transit is not only contrary to Article 24 of the Chicago Convention as signalled in the previous section but also to ASAs including such a clause.
ASAs also address fuel supplied in another State. Under most ASAs, fuel introduced in into an aircraft on the territory of the other State - party to the relevant ASA - is equally exempted from taxation and charges under exemption clauses in ASAs.
The following expressions in those clauses merit attention:

- The word “use” could be interpreted in such a way that fuel that is taken on the aircraft but not used for the subsequent international flight could be taxed. This practice is known as ‘tankering’ but little or nothing is known about its application in practice.
- The words “on the basis of reciprocity” can be understood to mean that only as long as the two concerned States exempt aircraft fuel from taxation such exemption falls under the scope of the exemption. In other words, the quoted words would leave the door open for one of the two bilateral partners to go its own way as to tax exemption because such exemption is subject to the condition of reciprocity. However, this interpretation has never been put to a legal text whereas not all ASAs contain this language. Should one of the two States proceed to tax fuel on its territory used by aircraft engaged in an international flight falling under an ASA including the clause that State would positively discriminate its own designated airline(s) because it or they would be more victimized by the taxation than any other airline. Positive discrimination is allowed under international trade law. However, this practice has never been legally checked.
- The prohibition to tax aircraft fuel is directed towards States. In the United States, individual states, for instance, Florida or California, can tax aircraft fuel consumed even on international flights.

Meanwhile States may, or are reviewing their policies and laws in this respect. For instance, the Agreement between the United Kingdom and the Kingdom of the Netherlands of 2006 on the operation of air services by carriers of the Netherlands Antilles allows for the imposition of taxation of aircraft fuel on domestic and international flights falling under this agreement. While it may be too early to speak of a trend, the cited clause may be seen as a sign on the wall to begin with.

A.3.2 The EU-US agreement on air transport of 2007 as amended in 2010

This agreement merits special attention because of the large amount of air traffic representing around 14 per cent of global air traffic. Moreover, some of the largest non-EU carriers that operate on intra-EU routes are US carriers (see Section A.1.4). As such, they could be affected by a bilateral agreement between EU Member States regarding the taxation of aviation fuel.
The EU-US agreement on air transport proceeds from the traditional model exempting aircraft fuel used on international flights, and this on the basis of reciprocity. However, the same article opens the door for taxation of fuel used by US airlines on intra-EU flights covered by an agreement concluded between “two or more” EU States envisaging to apply a waiver of the exemption contained in Article 14.1(b) of EU Council Directive 2003/96. In such cases, the Joint Committee established under this agreement must consider the matter.

These provisions have not been modified in the Protocol of 2010 amending the agreement of 2007. However, the Protocol articulates the “importance of protecting the environment” and stimulates Parties to discuss environmental, including noise and emission related measures, to the greatest extent possible, through the Joint Committee.
During the nineteenth meeting of the U.S.-EU Joint Committee Meeting of the Joint Committee which took place on 16 November 2016 in Berlin, the US delegation raised concerns about “environmental taxes imposed by EU Member States” and “had reached out to EU States to address any adverse effects on international aviation and to ensure compliance with Article 15” of the EU-US agreement on air transport. The records of this meeting do not refer to taxation of aircraft fuel, or to the application of Directive 2003/96. Hence it is presumed that the US concerns expressed above do not directly affect the present subject.

A.3.3 ICAO resolutions

ICAO continues to promote the imposition of charges benefitting international civil aviation rather than taxes which serve the national budget generally. Moreover, ICAO also supports tax exemption clauses pertaining to exemption of aircraft fuel used on international flights.

A.4 Conclusions and possible solutions

The above report is designed to analyse provisions of Directive 2003/96 with particular reference to the exemption of taxation of aircraft fuel. Following that analysis, it has indicated ways and means to address this exemption.

For intra-EU/EEA commercial air traffic, the Directive provides for a principal avenue, that is,
the conclusion of bilateral agreements between EU/EEA States. Such agreements must pave the way for partial or total waivers of the exemption in question. That solution raises the question as to how free EU States are to conclude a new bilateral agreement or to amend an existing air services agreement in light of the current European, and international aviation law regime.

The above sections contextualise this avenue by looking at various branches of law. The interaction between various branches of law, that is, principally environmental law, air transport law, international law and European law, create a rather complicated picture of the legal state of affairs.

It is concluded that the legal status of bilateral air services agreements between EU/EEA States is unclear. According to European law, provisions of such agreements which are governed by European law are “superseded” by European law but this is not the case for the present subject which is not
‘re-regulated’ by European law. Thus, the clauses on taxation of aircraft fuel laid down in such
intra-EU/EEA air services agreements should still be in place but it is questionable whether the EU/EEA States still manage their intra-EU/EEA air services agreements and consider them as a basis for the intra-EU/EEA operations.

An amendment of the Directive with the aim of introducing the taxation of aircraft fuel on intra-EU/EEA flights through Article 14 is apparently not on the agenda. The document laying down a proposal for an amendment explains that this position is caused by the presence of “international conventions” preventing the EU from abolishing these exemptions. The term “international conventions” is not specified in the said document.

Also, attention could be paid to the formulation of Article 14(2) of the Directive where it refers to bilateral agreements between EU States whereas Article 11(6) of the EU-US Agreement speaks of a waiver to be granted by “two or more Member States.” This provision, with special reference to the words “or more” appears to be a more logical option. The EU-US Agreement appears to provide the more logical option because it creates flexibility and enhances the geographical scope of the measure from a bilateral to a plurilateral regime.

Importantly, the *de minimis* threshold for emission trading ought to be regulated at the EU level rather than in a bilateral agreement between EU States. The threshold should be set at such a level that non-EU air carriers are not subject to the application of aircraft fuel taxation, thus avoiding prohibitions laid down in existing bilateral air services agreements to that effect, as to which see Section A.3.1. The advantage of regulation of a *de minimis* threshold at the EU/EEA level would harmonise the conditions of such bilateral agreements on the taxation of aircraft fuel. It would not only exclude non-EU/EEA air carriers from the application of taxation of aircraft fuel but also EU/EEA air carriers operating air services below the threshold set by the EU measure. Harmonisation at the EU level may be relevant in light of the applicability of general EU principles such as non-discrimination, compliance with competition law provisions and the maintenance of a level playing field in the internal air transport market.

Thus, thought could be given to propose an amendment of Article 14 of Directive 2003/96 by adding a provision to the effect that, while EU States are permitted to enter into bilateral agreements on the taxation of aircraft fuel, they should take into account the *de minimis* measure as defined by the same amended Directive. EU Directive 2008/101 could serve as an example for this. At the same time, the consequences of the establishment of such a measure in the present context should be cautiously checked in light of economic, legal and air policy considerations.

B Legal Analysis of Domestic and Intra-EU Aviation Fuel Taxation

By Aoife O'Leary, December 2017

CONTENTS

B.1 Introduction

This annex considers consider the legal possibilities for imposing a tax upon the fuel used in EU member state domestic and intra-EU aviation. It will consider the relevant treaties and laws:
the Chicago Convention, the EU-US Open Skies Agreement, the Energy Taxation Directive, and the Excise Duty Directive. It reaches the conclusion that taxation can be imposed on fuel used in domestic aviation without legal impediment. But for intra-EU aviation, in order to comply with the bilateral agreements the EU has signed with third countries, the EU must ensure that fuel uplifted by foreign carriers is not taxed until these constraints are removed. A de minimis exemption from intra-EU fuel taxation can achieve this. The Netherlands and Norway (a member of the European Common Aviation Area - detailed below) have domestic aviation fuel taxes although domestic flights in the Netherlands have been phased out. Internationally, the US, Japan, India and Brazil, amongst others, have domestic fuel taxes. There are no intra-EU aviation fuel taxes.

It should be noted at the outset that the question of taxing domestic fuel in the EU has been considered before by the UK Parliament and by Prof. Eckhard Pache for the German Federal Environment Agency, both of which came to the conclusion that taxing domestic aviation fuel in the EU presented no legal difficulties.

B.2 The Energy Taxation Directive

The Energy Taxation Directive (ETD) 2003/96/EC allows Member States to tax fuel used in domestic aviation and to agree bi-laterally to tax flights between two Member States. Article 14 in relevant part states:
"(1)...Member States shall exempt the following from taxation…(b)energy products supplied for use as fuel for the purpose of air navigation other than in private pleasure-flying…(2) Member States may limit the scope of the exemptions provided for in Paragraph 1(b) and (c) to international and intra-Community transport. In addition, where a Member State has entered into a bilateral agreement with another Member State, it may also waive the exemptions provided for in Paragraph 1(b) and (c). In such cases, Member States may apply a level of taxation below the minimum level set out in this Directive."

This allows Member States to place a tax on fuel supplied for domestic aviation, i.e. to limit the tax exemption to just intra-EU and international flights without requiring any change to EU law or any agreement with any other Member State.

It further allows Member States to impose taxation on flights between one Member State and another where the two Member States have signed a bilateral agreement. Under this wording, for a tax to be applied to all intra-EU flights it would require all Member States to sign a bilateral agreement with every other Member State. However, if all Member States agreed to tax intra-EU aviation fuel, then amending the Directive to remove the need for bilateral agreements would be a more appropriate procedure.

The ETD allows Member States to agree bilaterally to impose taxation on all flights between those Member States agreeing to do so. However, there are other bilateral and horizontal agreements between Member States or the EU and third countries which exempt fuel used in international flights from taxation. If, for example, Germany and France agreed bilaterally to tax fuel on all flights between the two countries but a US carrier also operated flights between these two countries, and therefore was subject to the fuel tax, this could be a violation of the exemption from fuel taxation in the US-EU Open Skies Agreement (detailed below). Exemptions from fuel taxation in agreements with third countries are not compatible with two Member States being able to agree bilaterally to tax fuel uplifted for flights between them (unless some sort of an exemption for international carriers is provided for). Therefore, the EU must expedite the renegotiation of those agreements with third countries in order to allow Member States to implement intra-EU fuel taxation as envisaged in the ETD.

B.3 2002 Open Skies Case

Where the EU does not have a bilateral agreement in place with a third country, there are often bilateral agreements between the individual EU Member States and the third country. However, it is probable that any exemption from fuel tax included in a such a bilateral agreement between an individual Member State and a third country would not be valid as far as intra-EU fuel taxation is concerned. This is because in the 2002 Open Skies case[6] the Court of Justice of the European Union (CJEU) ruled that provisions of such bilateral agreements breached EU law where it was not in the competency of the Member State to grant exemptions to third countries. The exemptions in that case related to the right of establishment for air carriers. However, a similar argument could be made in relation to

6 Commission v United Kingdom, Denmark, Sweden, Finland, Belgium, Luxembourg, Austria, Germany, Cases C-466/98,
C-467/98, C-468/98, C-469/98, C-471/98, C-472/98, C-475/98 and C-476/98.

fuel taxation, as the EU now has established competence through the Energy Taxation Directive.

B.4 Excise Duty Directive

Council Directive 2008/118/EC of 16 December 2008 concerning the general arrangements for excise duty (the 'Excise Duty Directive') sets out when and how excise duty can be placed on aviation fuel. Article 1 of the Directive states that it applies "to excise duty which is levied directly or indirectly on the consumption of the following goods (hereinafter 'excise goods'): (a) energy products and electricity covered by Directive 2003/96/EC". Directive 2003/96/EC covers aviation fuel and it thus comes under the provisions of the Excise Duty Directive.

The Excise Duty Directive states in article 7(1) that "Excise duty shall become chargeable at the time, and in the Member State, of release for consumption." Aviation fuel is released for consumption at the airport as the aircraft is fuelling. This would mean that the tax should be charged at that point. Therefore, a domestic fuel tax system cannot require airlines to submit all their domestic flight information once a year (for example) and pay the tax at that point, but rather the tax must be imposed as the aircraft fuels. Aircraft may take on fuel for more than just a domestic flight, while the tax is to be imposed on fuel used in domestic flight. The Excise Duty Directive does contemplate reimbursements under Article 11 "for the purpose of preventing any possible evasion or abuse." Tax paid on fuel use for non-domestic flights could be reimbursed this way, for example if an airline uplifted fuel for safety purposes that was not ultimately used in the flight, but tax had been paid thereon, that tax could be reimbursed later.

B.5 The Emissions Trading System

The Emissions Trading System (ETS) seeks to account for the CO_2 emissions of aviation. Therefore, a question could be asked whether it would be permissible to impose a fuel tax as it could be primarily an environmental measure and thus seen as duplicating the work of the ETS.

There is nothing in the ETS Directive (2003/87/EC) which says it can be the only charge on the carbon emissions from entities covered by the ETS. Indeed, Recital 23 of the ETS Directive situates the ETS within the wider context of "a comprehensive and coherent package of policies and measures implemented at Member State and Community level." And recital 26 of the ETS states that further measures at EU, Member State and international level will be needed: "notwithstanding the multifaceted potential of market-based mechanisms, the European Union strategy for climate change mitigation should be built on a balance between the Community scheme and other types of Community, domestic and international action." These recitals clearly contemplate additional measures imposed as well as the ETS.

In general EU law, Directives (such as the ETS) are intended to be minimum harmonisation measures only, i.e. Member States have the possibility to enact further or more stringent measures in addition to the legislation in the Directive. This is especially so with regard to environmental measures where the right for Member States of "maintaining or introducing more stringent protective measures" for the environment is explicitly retained in Article 193 of the Treaty on the Functioning of the European Union. However, it must be noted that there are certain conditions attached to enacting policies under Article 193:
1. The additional measures must result in a level of protection of the environment that is higher than the one pursued by the EU measure.
2. It must fall within the field of application of the EU measure by following the same objectives.
3. It must not frustrate the secondary objectives of the EU measure.
4. Where such an additional measure would affect other EU provisions, it must not violate the principle of proportionality.
5. And it must be notified to the European Commission.

None of these conditions should present a problem for any Member State wishing to impose a fuel tax on its domestic flights. Importantly the Netherlands and Norway already tax domestic aviation fuel and Norway even labels its fuel tax as a “CO_2-tax”.

In three cases the CJEU has looked at the objectives of the ETS and found that the protection of the environment by reducing GHGs is the principal, overarching objective of the ETS. The secondary objectives found were cost-effectiveness and economic efficiency. The imposition of a fuel tax should not interfere with these objectives other than that it could be argued that to the extent that the fuel tax lowered emissions, it would also then lower the ETS price. This could be seen as reducing the economic efficiency for other sectors under the ETS as it would incentivise less emissions reductions. However, as a fuel tax would accord with the primary objective of the ETS, it is unlikely a challenge to a fuel tax based on distorting the economic efficiency of the ETS could succeed.

B.6 The Chicago Convention

The Chicago Convention provides no obstacle to placing a tax on domestic or intra-EU aviation fuel. The Convention bans parties from imposing taxes on fuel already on board an aircraft when it lands in another country but it contains no prohibition on taxing the fuel sold to aircraft in a country. Further, the Chicago Convention is not applicable to domestic aviation.

It is often suggested that the Chicago Convention exempts aviation fuel from taxation. However, the Chicago Convention only exempts fuels already on-board aircraft when landing, and retained on board when leaving, from taxation. Article 24 states: "Fuel ... on board an aircraft of a contracting State, on arrival in the territory of another contracting State and retained on board on leaving the territory of that State shall be exempt from customs duty, inspection fees or similar national or local duties and charges.”

Therefore, Article 24 does not prohibit the taxing of fuel taken on board in a particular country but rather prohibits the taxation of fuel that was already on board the aircraft when it landed, i.e. Member States cannot tax aviation fuel purchased in another country that arrives on board the aircraft.
The purpose of this Article is to prevent double taxation.

Another article of the Chicago Convention that is sometimes said to ban fuel taxes is Article 15. This article states: "No fees, dues or other charges shall be imposed by any contracting State in respect solely of the right of transit over or entry into or exit from its territory of any aircraft of a contracting State or persons or property thereon."

Therefore, it prohibits only those charges which are levied solely for transit, entry into or exit from a particular country. A domestic fuel tax would not be levied to grant transit rights but rather for general revenue raising reasons, along (probably) with an environmental component, meaning that the tax would not be based on transit, entry into or exit from a country and so not fall foul of the Article 15 ban.

Second, the tax would not be a 'charge' - a charge is a levy based on a service rendered as opposed to a tax which is levied without any service given in return. It could be questioned whether a tax would come under the definition of 'fee' or 'due' but the wording makes clear that 'fee' and 'due' are simply types of charges. Indeed, ICAO itself has distinguished between taxes and charges in numerous policy documents, for example in the 5th recital of the "Council Resolution on Environmental Charges and Taxes" of 9 December 1996:

"Noting that ICAO policies make a distinction between a charge and a tax, in that they regard charges as levies to defray the costs of providing facilities and services for civil aviation, whereas taxes are levies to raise general national and local governmental revenues that are applied for non-aviation purposes."

Therefore, Article 15 does not prohibit the levying of general taxation without a service provided, i.e. it does not prohibit the imposition of a tax on fuel for domestic aviation or intra-EU aviation either to raise general revenues or for environmental purposes.

ICAO has produced various policy documents that suggest that no taxes should be placed on aviation fuel. However, none of these are legally binding and thus will not be examined here.

Finally, even if Article 24 or 15 of the Chicago Convention banned fuel taxation - which they do not - the Chicago Convention is not applicable to domestic air transport. Therefore, regarding the case of a domestic fuel tax, the Chicago Convention is not relevant.
The Chicago Convention is an international treaty designed to promote and facilitate international civil aviation. This is clear from its official title - "Convention on International Civil Aviation" and from the wording of the preamble which consistently refers to developing international aviation. Therefore, only where specific provisions refer to domestic aviation should they be made applicable to domestic flights. Neither of the articles referred to in this note do so and therefore it must be assumed that they apply only in relation to international aviation.

B.7 Bilateral Aviation Agreements

The EU and its member states have many bilateral aviation agreements with third countries. As such it is beyond the scope of this paper to detail all the agreements. Instead, this section shall look at the agreements involving the EU Member States themselves, the European Common Aviation Area Agreement and the Open Skies EU-US bilateral agreement.

B.7.1 Agreements between EU Member States

All EU Member States have had unlimited cabotage rights in all other Member States since 1996 (Regulation (EEC) 92/2408). However, the Energy Taxation Directive was agreed in 2003, after the unlimited cabotage rights were granted. If a member state had needed the permission of another Member State to impose a fuel tax on domestic aviation this would have been reflected in the Energy Taxation Directive. Indeed, it is clear from Article 14(2) of the Directive that bilateral agreements are needed to tax fuel used in flights between Member States but no such bilateral agreements are needed for the taxation of fuel used on domestic flights. This makes clear that the Member State can place a tax on the fuel of the aircraft of another Member State operating domestic flights in its territory without the explicit consent of the other Member State.

With regard to imposing an intra-EU fuel tax, again, as the Energy Taxation Directive was agreed after unlimited cabotage rights were granted, the ETD must be assumed to have taken the unlimited cabotage rights into account. As discussed above, the ETD clearly allows Member States to sign bilateral agreements to tax the fuel used on flights between the Member States signing the bilateral agreement. This will include the flights between those two Member States that are flown by aircraft of another Member State due to the unlimited cabotage rights being granted before the ETD was signed.

B.7.2 The European Common Aviation Area

The European Common Aviation Area (ECAA) grants all members all nine freedoms of the air.
This means that each of the ECAA countries has the right to fly domestically in every other member of the ECAA, i.e. it grants cabotage rights to all ECAA members. In terms of a domestic fuel tax, it could mean fuel taxes being placed not just on aircraft operated by EU registered airlines, but ECAA airlines as well. Therefore, it must be questioned whether it would violate any legal agreements to tax fuel used by ECAA member airlines for a domestic flight in another ECAA member.

Article 1 of the ECAA Agreement applies the Energy Taxation Directive (ETD) to all the members of ECAA. As discussed, the ETD expressly allows all Member States to apply taxation to domestic aviation fuel. By adopting the ETD into the list of EU laws by which all the members of ECAA must apply, it means that the members of ECAA must also agree that each member is entitled to impose a domestic aviation fuel tax. Further, as mentioned above, both the Netherlands and Norway (both ECAA members) have taxes on domestic fuel, applied without legal challenge. Further, there is a Joint Committee established by Article 17 of the ECAA Agreement which monitors the implementation of the Agreement. There have been no reports of any objections to domestic fuel taxation in the ECAA Joint Committee. Therefore, it can be concluded that applying a domestic fuel tax does not violate the ECAA agreement.

No other bilateral agreements have been signed with countries outside the EU which grant traffic rights within Member States. There are agreements (notably the EU-US bilateral) which allow other countries traffic rights between Member States but not domestically within a single Member State. Therefore, bilateral agreements with countries outside of the EU do not preclude taxation of aviation fuel for domestic flights as no foreign airlines have the right to operate domestic flights on which they would have to pay the tax.

In considering an intra-EU fuel tax, the members of ECAA must abide by the ETD. Therefore, to impose a fuel tax on flights between an EU member state and an ECAA member state, a bilateral agreement must be signed. Once a bilateral agreement is signed then the carriers from that ECAA state could be taxed the same as any other EU Member State carriers flying between those two countries - no specific exemption would need to be made for the ECAA members.

B.7.3 The EU-US Open Skies Agreement

Article 11 of the EU-US Open Skies Agreement concerns fuel taxation (among other things). Article 11(1) repeats the ban from the Chicago Convention on taxing fuel already on board an aircraft when it lands in another country (Article 24 of the Chicago Convention discussed above). Article 11(2) then goes on to state:

“2. There shall also be exempt, on the basis of reciprocity, from the taxes, levies, duties, fees and charges referred to in Paragraph 1 of this Article [all import restrictions, property taxes and capital levies, customs duties, excise taxes, and similar fees and charges that are (a) imposed by the national authorities or the European Community, and (b) not based on the cost of services provided, provided that such equipment and supplies remain on board the aircraft], with the exception of charges based on the cost of the service provided:
- (c) fuel, lubricants and consumable technical supplies introduced into or supplied in the territory of a Party for use in an aircraft of an airline of the other Party engaged in international air transportation, even when these supplies are to be used on a part of the journey performed over the territory of the Party in which they are taken on board”.

Therefore, this fuel exemption throws up three interesting points:
- Fuel is exempted from taxation based on reciprocity (discussed below).
- The only exempt taxation is that imposed by the national authorities or the EU, i.e. US States, German Länder, French Departments, etc. can impose a fuel tax without violating the agreement (US States already do).
- The Agreement only exempts fuel used in international flights, not domestic flights - therefore EU Member States can place a tax on all domestic flights without violating the Open Skies Agreement.

B.8 Reciprocal Exemptions

As stated above, fuel used in international flights under the EU-US Open Skies Agreement, is exempt from taxation "on the basis of reciprocity". It is important to understand what reciprocity means. There is no definition in the Agreement. One explanation is suggested by a 1999 report written for the European Commission by a consortium including the International Institute of Air and Space Law where it was stated:

"It is noted that the words "on the basis of reciprocity" could be understood to mean that only as long as the two concerned countries exempt aircraft fuel from taxation, such exemption falls under the scope of the cited provision. Thus, the quoted words would leave the door open for one of the two bilateral partners to go its own way as to tax exemption, because such exemption is subject to the condition of reciprocity. This interpretation has however never put to a legal test."

Under this interpretation, then either side (the US or EU) can begin to tax fuel used in international aviation without violating the agreement. The wording of Article 11 is not a ban on fuel taxation, rather an agreement that if one party begins to tax fuel, the other party may too. There are some further articles of the Open Skies Agreement that assist with understanding what reciprocity was intended to mean.

Article 18 of the Open Skies on the Joint Committee reads:
"1. A Joint Committee consisting of representatives of the Parties shall meet at least once a year to conduct consultations relating to this Agreement and to review its implementation.

2. A Party may also request a meeting of the Joint Committee to seek to resolve questions relating to the interpretation or application of this Agreement…

4. The Joint Committee shall also develop cooperation by: … (e) making decisions, on the basis of consensus, concerning any matters with respect to application of Paragraph 6 of Article 11."

Article 11(6) states: "In the event that two or more Member States envisage applying to the fuel supplied to aircraft of U.S. airlines in the territories of such Member States for flights between such Member States any waiver of the exemption contained in Article 14 (b) of Council Directive 2003/96/EC of 27 October 2003, the Joint Committee shall consider that issue, in accordance with Paragraph 4(e) of Article 18."

Thus, the Open Skies Agreement sets up a Joint Committee to review implementation and resolve questions relating to the Agreement. Article 11(6) and 18(4) require consensus decision making if any Member States wished to come to a bilateral agreement to tax the fuel used on all flights between the Member States as foreseen in Article 14 of Council Directive 2003/96/EC: the Energy Taxation Directive (ETD).

It is important to note that Article 18 detailing the purpose of the Joint Committee only refers to consensus decision making in two places. One is Article 18(4) above – where two (or more) Member States agree bilaterally to impose fuel taxes under the current ETD wording – and the other is related to Annex 4 ownership of airlines. This suggests that nothing else in the Open Skies Agreement must be decided by consensus. If you specifically state that consensus is required for two types of issues that could arise under the agreement, then the assumption must be that consensus is not required for other types of issues arising under the agreement. Therefore, if the EU imposed a fuel tax in any manner which was not that of Article 14(b) of the ETD, the agreement of the US would not be required. Where fuel tax is imposed in a manner that is not via a bilateral agreement as foreseen in Article 14(b) of the ETD, there is no requirement for consensus. The Open Skies Agreement very clearly only refers to consensus in two situations and while one is the bilateral imposition of a fuel tax in accordance with Article 14(b) of the ETD, the other is not the imposition of a fuel tax in any other manner (it relates to the ownership of airlines). While there is no reason given for the imposition of a requirement for consensus for the case of a bilateral agreement to tax fuel, as opposed to a decision to tax fuel agreed in any manner outside of Article 14(b) of the ETD, it could be supposed it would be because the imposition of a fuel tax in only two countries and only for the flights that travel between those two countries could be seen as a breaking up of the common aviation market in the EU and so require a higher level of agreement, compared to the imposition of a fuel tax across all intra-EU flights.
In such a situation - where the ETD was amended to require aviation fuel tax on all intra-EU flights - then there are still two reasons to involve the Joint Committee as set out in Article 18: (1) to review implementation and (2) if there was a request for interpretation resolving, but neither of these reasons to involve the Joint Committee require the Joint Committee to come to a consensus decision.

If the reciprocity clause is interpreted to allow the EU to impose fuel taxes under Article 11 as it currently stands then this would be a matter for discussion at the Joint Committee under Article 18(1) but anything referred to the Joint Committee under Article 18(1) does not require approval by the US before it can go ahead - as stated above, consensus between the EU and US is only required for two reasons: where bilaterals under the ETD are agreed or where the ownership of airlines is in question.

The EU could also present an intra-EU tax to the Joint Committee for interpretation because the EU is unsure of whether they are allowed under Article 11 to impose intra-EU fuel taxation without amending the Open Skies Agreement. Under Article 18 they can seek an agreed interpretation of Article 11. Under Article 18(2) the parties are to “seek to resolve” questions of interpretation. Therefore, while the EU should seek to resolve any question of interpretation in good faith, the agreement of the US would not be required before the EU could unilaterally impose a fuel tax.

Regardless of how the EU approaches the Joint Committee, if an intra-EU fuel tax was to be imposed, and a consensus was not reached (even if not required), the dispute can be referred to “any person or body agreed by the parties”, or failing that to arbitration under Article 19. The arbitration would consist of one judge appointed by each of the parties and one appointed by agreement of the judges already appointed. If the third judge cannot be agreed by consensus, then ICAO appoints the third judge.

If something is not resolved by the arbitration or one of the parties does not comply with the decision of the arbitration then under Article 19(7), “the other Party may suspend the application of comparable benefits arising under this Agreement until such time as the Parties have reached agreement on a resolution of the dispute. Nothing in this paragraph shall be construed as limiting the right of either Party to take proportional measures in accordance with international law.” There is no definition of what exactly “comparable benefits” are under the agreement. But it could be assumed that it would be the imposition of taxes on EU carriers (extra-US as no EU carriers fly intra-US).
However, all of this is moot if the EU can find a way to impose intra-EU fuel taxes (the Open Skies does not concern itself with domestic taxes as explained above) without any incidence on US carriers.

B.9 Exempting US carriers

The Open Skies agreement sets outs the rights of both EU and US carriers to operate in both places. For the purposes of this paper, the important question is if an intra-EU fuel tax was imposed, would any US carriers conducting international flights be caught by it. The answer is that US cargo carriers have as much as 90 flights a week between EU Member States. If an intra-EU fuel tax is imposed and the US carriers paid fuel tax on those intra-EU flights (and the definition of reciprocity under Article 11 did not mean either party could unilaterally impose a fuel tax), then this would violate the Open Skies Agreement.

B.10 De Minimis

Either to exempt the US carriers entirely or avoid any disagreement over the interpretation of reciprocity in Article 11, the EU should consider a *de minimis* arrangement for all airlines operating intra-EU flights.

There are various EU laws which allow for *de minimis* exemptions from otherwise binding requirements. Therefore, in considering how to impose a *de minimis* on intra-EU aviation, looking at other areas where the EU has granted *de minimis* exemptions from EU law is illustrative.

Without going into detail on EU competition law or State aid law, there are exemptions that provide a basis for a fuel tax *de minimis*. First, under general competition law, market distortions that affect less than 10% of the market do not raise concern. Second, the EU is generally not concerned with 'small' aid to businesses i.e. up to € 200,000 over three years. Third, under the ETS Directive, carriers operating a limited number of flights into the EU are entirely exempt from having to report their emissions or surrender allowances. Based on these existing *de minimis* exemptions, the following are options which create no legal obstacles and could be employed to ensure that US carriers or other foreign carriers would be entirely exempt from an intra-EU fuel tax:

a *De minimis* based on the amount of fuel tax paid: Under this *de minimis* provision, all airlines would pay tax on all intra-EU fuel but if in any year an airline pays less than € 66,000 (i.e. € 200,000 over 3 years) then they could apply to get a full rebate of tax paid. It is possible to look on this as a subsidy (similar to a State aid) and so € 200,000 over 3 years is a precedent for a similar type of subsidy the EU allows. The tax would have to be set at a rate where the US carriers would never pay more than € 66,000 a year.

b *De minimis* based on the number of flights: All airlines would have a certain amount of flights exempt per week or month, e.g. all airlines are allowed up to 90 tax-free flights a week before they must begin to pay fuel tax on the rest of their flights.

c *De minimis* based on CO_2 emitted or fuel used: Small emitters under the ETS are granted an exemption based on emitting less CO_2 than a certain threshold. As an intra-EU fuel tax would be an environmental measure, two thresholds could be set rather than currently where there is just one. This would mean all emitters below the lowest threshold don't have to worry about the ETS or pay fuel tax. Those between this threshold and the higher threshold would have to comply with the ETS and then those above the second threshold would have to comply with the ETS and pay fuel tax.

d *De minimis* based on city or airport pairs: A 2005 Commission Working Paper suggested that a fuel tax on intra-EU and domestic flights could be implemented "by making it mandatory while allowing for the possibility to exempt all carriers on specific routes where non-EU carriers operate and benefit from exemptions under unchanged ASAs [bilateral agreements]. Ongoing renegotiation of ASAs would then gradually allow for the taxation of third country carriers on intra-EU flights"[7].

If US airlines were entirely exempt from any intra-EU fuel tax then no issues under the Open Skies Agreement arise. The Agreement exempts carriers from paying tax but imposes no restriction on the EU imposing a tax on all other carriers.

US carriers might attempt to argue that a *de minimis* arrangement would essentially cap their growth but as long as the *de minimis* was periodically reviewed to ensure that no US carrier had to pay fuel tax, such an argument could not succeed. A fuel tax *de minimis* would not restrict traffic volume or the type of aircraft that could be used by US carriers. No restriction on traffic volumes or type of aircraft follows even indirectly from a fuel tax. The subject of regulation would solely be the environmental externalities caused by aviation or the raising of general tax revenue.

[7] Staff Working doc SWD 7 final of COM 2018.20 (2018) 20 final.

In summary, Article 11 ensures that if one party imposes a fuel tax, both sides will be free to tax fuel on a reciprocal basis but does not ban the imposition of taxation. The requirement to consult with the Joint Committee is simply to “seek to resolve”, i.e. a soft arrangement which doesn’t prevent unilateralism on tax or for the parties to go to arbitration if they desire. There is no reason why an intra-EU fuel tax cannot exist with a *de minimis* to ensure that US carriers do not pay any tax and thereby avoid any non-EU carriers entirely.

B.11 Conclusion

The Energy Taxation Directive permits EU Member States to impose a tax on aviation fuel used in domestic flights and via bilateral agreements, on intra-EU flights. Nothing in the Chicago Convention prevents the imposition of domestic or intra-EU fuel tax. All ECAA members have unlimited cabotage rights in all other EU Member States. This does not prohibit fuel taxation as the Energy Taxation Directive is included in the ECAA Agreement and clearly contemplates Member States imposing a tax on domestic and intra-EU aviation. Both the Netherlands and Norway have domestic aviation fuel taxes. The Excise Duty Directive requires a fuel tax to be imposed at the time of release for consumption, which would be as the aircraft fuels at the airport and this could result in the situation where airlines pay tax on fuel that is used in extra-EU flights. However, as long as a rebate system is established (potentially by using the data from the ETS) to refund any tax paid on fuel used internationally, this does not pose a problem. There is no reason why a fuel tax and the ETS cannot cover the same domestic and intra-EU flights. The Open Skies agreement only exempts fuel used in international, not domestic, flights from taxation.

It can be argued that the Open Skies Agreement allows for each side to unilaterally impose fuel taxation as the exemption is only on the basis of reciprocity and can be withdrawn at any time. In addition, there are several ways that US airlines could be exempted from any intra-EU fuel taxation including a *de minimis* based on the amount of tax paid, the number of flights or the routes. In conclusion, a domestic fuel tax can be imposed without any legal concerns arising. As long as a *de minimis* is established for intra-EU fuel taxation to ensure foreign carriers are exempt, that too can be imposed, and no legal issues prevent it.

C List of non-EEA aircraft operators active on intra-EEA routes

Aircraft operators flying on routes between EEA airports have to report their emissions to the competent authority and surrender allowances in order to comply with the EU ETS.

The EU Transaction Log contains the names of these operators as well as the verified amount of emissions on intra-EEA routes. Based on information from the Transaction Log, we have compiled the list in Table 2.

Most non-EEA operators have just a few flights on intra-EEA routes and consequently use little fuel. EasyJet Switzerland is the largest non-EEA aircraft operator in terms of fuel use and emissions, followed by UPS and FedEx.

Table 2 - Non-EEA aircraft operators active on intra-EEA routes in 2016

Aircraft operator	Amount of fuel used on intra-EEA routes in 2016 (tonnes)
Latam Airlines Group, S.A.	8,030
Air China Limited	6,556
Cathay Pacific Airways Limited	3,543
China Southern Airlines	2,664
ETHIOPIAN AIRLINES	11,950
Iran Air, The Airline of the Islamic Republic of Iran	1,696
CAL CARGO AIRLINES	3,924
Nippon Cargo Airlines	3,947
EU ETS trading account for KOREANAIR	7,635
Asiana Airlines	4,964
Kuwait Airways Corporation	3,237
Qatar Airways	7,080
VDA_Operator	4,487
Air Bridge Cargo	8,180
Singapore Airlines Limited	9,987
EASYJET SWITZERLAND	66,789
SWISS INTERNATIONAL AIR LINES LTD	111
Emirates	12,805
Atlas Air, Inc.	5,933
United Parcel Service Co	51,689
FEDERAL EXPRESS CORPORATION	56,891

Leaked study shows aviation in Europe undertaxed

Study shows this is especially the case when compared to non-European markets

May 2019

Summary

A leaked report, completed last year for the European Commission but yet to be made public, finds that the European aviation sector is chronically undertaxed relative to other aviation markets, that international law does not prevent the introduction of greater aviation taxation in Europe, and that taxing aviation fuel would cut emissions by at least 10% and raise revenue while having no impact on overall GDP and employment.

This report should be published immediately as its findings justify introducing measures such as fuel tax aviation which are currently under discussion at European and member state, including at a high level ministerial meeting on aviation taxation next month in the Hague.

1. Context

The report was commissioned by the European Commission following a commitment in its 2015 Aviation Strategy to examine the status of aviation taxation in Europe. This is the final version of that yet to be published report. It looks at taxes which are in place, but also tax exemptions, and contrasts taxation levels in Europe with other aviation markets.

It concludes that European aviation is significantly undertaxed even compared to such countries as the US, Australia, Brazil and China. Most member states have zero taxation of international aviation while twelve do not even tax domestic aviation despite the total absence of any legal barriers to do so. This stands in contrast to other parts of the world, where ticket taxes are widespread and taxing kerosene for domestic aviation is common.

2. Examination of specific types of aviation taxation

The report looks principally at three types of taxation - passenger ticket taxes, VAT and kerosene taxation. The legal basis for each type of taxation is set out and taxation levels in Europe and compared with key EU aviation partners.

A model is used to assess the impact of either removing existing taxes, or applying taxes at consistent rates across the EU 28, using metrics such as GDP, employment, revenue, CO2 emissions and noise impact.

2.1. Ticket taxes

The report defines ticket taxes as "taxes imposed on all air passengers to the benefit of national (or regional) government's treasury".

The report details the existing ticket taxes in Europe, including variation of rates depending on destination or class of travel, as well as the collection method. The report finds that only seven states in the EU/EEA have such taxes, with the UK's Air Passenger Duty levying the highest rate. That rate is varies from €14.42 for short haul economy travel to €499.24 for long-haul business class. Other European states have minimal rates, for example the French rate is €45.07 for long-haul business class but only €1.13 for short-haul economy. EU-wide, the average ticket tax per passenger is around €11 a ticket.

These low or non-existent taxes compare unfavourably with major EU aviation partners. Australia levies a €40 ticket tax on all international departures, Mexico €37.50, Brazil €30.70 and the US €15.04. Not noted in the report is that the US taxes inbound international passengers at the same level[1].

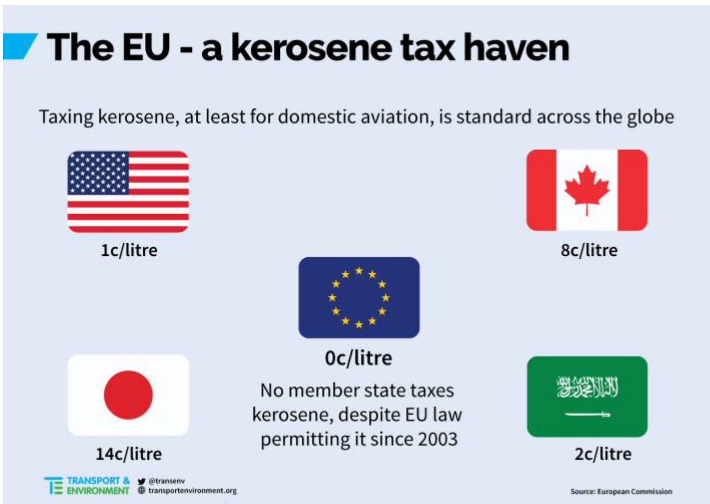
2.2. VAT

VAT on passenger tickets for flights between European states were zero rated before the Union was created and this practice codified in EU Directive (2006/112/EC). Nevertheless this hasn't stopped 23 member states applying VAT to domestic flight tickets at rates varying from 6% (Portugal) to 25% (Croatia). The weighted EU-28 VAT average per ticket is €4.

Internationally, VAT, also known as a sales or consumption tax, is applied in many domestic aviation markets including Australia (10%), Vietnam and Indonesia (10%), Japan (8%), Thailand (7%) Malaysia (6%), Canada (5% domestic and to the US), US (7.5% for domestic and flights to Mexico and Canada) and Mexico 4% for all domestic/international flights.

2.3. Kerosene taxation

In Europe, fuel for commercial aircraft is exempt from taxation under Directive 2003/96/EC but from 2003 member states were permitted to tax fuel for domestic aviation, and, subject to bilateral agreement with another member state, tax fuel used for flights between them. None of the EU-28 currently tax fuel uplifted for domestic flights nor for flights within the EU on a bilateral basis.



By contrast kerosene uplifted for domestic aviation is taxed in a good number of states; Canada, the USA, Hong Kong, Australia, Japan, Armenia, Saudi Arabia, Laos, Myanmar, Philippines, Thailand and Vietnam.

Importantly the report notes that the Chicago Convention "does not explicitly prohibit the taxation of jet fuel", only the taxation of fuel already on board an aircraft upon arrival in another state. It makes clear that exemptions from taxing jet fuel largely arise from bilateral air services agreements. Our study "Taxing Aviation Fuel in Europe" details how this barrier can be overcome.

[1] http://airlines.org/dataset/government-imposed-taxes-on-air-transportation/

3. Modelling the impact of aviation taxation

The second part of the report models the impact of three different taxation scenarios across the EU28; 1) abolishing the existing ticket taxes in Europe; 2) applying VAT on tickets for all flights to, from and within Europe 3) taxing aviation kerosene uplifted for all flights to, from and within Europe. The report does not examine the political or legal feasibility of each of the above scenarios. Instead, it models the impact on passenger demand, flights and connectivity, jobs, GDP, fiscal revenue from the aviation sector, CO2 emissions and noise.

In the model scenario where existing ticket taxes are abolished (scenario 1), EU-wide passenger demand, flights and connectivity increases 4%; ticket prices fall 4%; CO2 emissions increase 4% and those people affected by aircraft noise rise 2%. Member state revenues fall by 74% or €2.6bn, leaving revenue from the only remaining tax in place - domestic VAT. Jobs and value-added rise 4% in the aviation sector matched by an equal fall of 4% in jobs elsewhere. So a net effect of zero on total employment and GDP. This directly contradicts industry-sponsored reports which claim that abolition of existing ticket taxes would result in an increase in GDP and total employment[2].

The other two scenarios - introduction kerosene taxation and VAT - produce opposite results. The impact of both is modelled separately.

Imposing a fuel tax on all departing flights to all destinations at the 33 cents EU energy tax minimum would cause ticket prices to rise 10%; flights, passengers and CO2 emissions all fall 11%, people affected by noise drop 8% and fiscal revenues rise from €10 billion to €27 billion. Jobs and aviation value added falls 11% but the overall impact on EU jobs and GDP is zero.

VAT applied at the German rate of 19% on all tickets reduces passenger demand and flights by 19%; direct jobs and value added in aviation fall 18% while the overall effect on EU jobs and GDP is negligible. Member state revenues rise from €10 billion to €40 billion while CO2 emissions fall 18% and number affected by aircraft noise 12%.

4. Impact of the introduction of kerosene taxation in EU-28

Modelled impact of the introduction of taxation on all kerosene uplifted for flights within and departing from the EU. The rate of kerosene taxation is €0.33/litre, the minimum rate in the 2003 Energy Taxation Directive. The model does not consider to legal or political feasibility of these policies.

	Passenger numbers	Connectivity (Number of flights)	Jobs (all sectors) (1,000 FTE)	GDP (€bn)	Revenue raised (billion euro)	CO2 (%)	Noise (People affected)
EU wide	-11%	-11%	No effect	No effect	26.9	-11%	-8%
Austria	-8.00%	-8.00%	No effect	No effect	0.3	-8.00%	-7.00%
Belgium	-17.00%	-17.00%	No effect	No effect	0.5	-17.00%	-12.00%
Bulgaria	-11.00%	-11.00%	No effect	No effect	0.1	-11.00%	-5.00%

[2] https://a4e.eu/tax/

Croatia	-6%	-6%	No effect	No effect	0.06	-6.00%	na
Cyprus	-10.00%	-10.00%	No effect	No effect	0.09	-10.00%	na
Czechia	-8.00%	-8.00%	No effect	No effect	0.1	-8.00%	-5.00%
Denmark	-9.00%	-9.00%	No effect	No effect	0.3	-9.00%	-6.00%
Estonia	-4.00%	-4.00%	No effect	No effect	0.01	-4.00%	na
Finland	-12.00%	-12.00%	No effect	No effect	0.3	-12.00%	-10.00%
France	-9.00%	-9.00%	No effect	No effect	3.5	-9.00%	-7.00%
Germany	-12.00%	-12.00%	No effect	No effect	4.8	-12.00%	-8.00%
Greece	-7.00%	-7.00%	No effect	No effect	0.6	-7.00%	na
Hungary	-5.00%	-5.00%	No effect	No effect	0.1	-5.00%	-4.00%
Ireland	-8.00%	-8.00%	No effect	No effect	0.3	-8.00%	-7.00%
Italy	-8.00%	-8.00%	No effect	No effect	3.2	-8.00%	-5.00%
Latvia	-14.00%	-14.00%	No effect	No effect	0.04	-14.00%	na
Lithuania	-10.00%	-10.00%	No effect	No effect	0.03	-10.00%	-8.00%
Luxembourg		//	No effect	No effect			
Malta	-10.00%	-10.00%	No effect	No effect	0.04	-10.00%	na
Netherlands	-19.00%	-19.00%	No effect	No effect	1.2	-19.00%	-15.00%
Poland	-10.00%	-10.00%	No effect	No effect	0.2	-10.00%	-8.00%
Portugal	-11.00%	-11.00%	No effect	No effect	0.5	-11.00%	-6.00%
Romania	-9.00%	-9.00%	No effect	No effect	0.1	-9.00%	-5.00%
Slovakia	-12.00%	-12.00%	No effect	No effect	0.02	-12.00%	-10.00%

Slovenia	-5.00%	-5.00%	No effect	No effect	0.02	-5.00%	na
Spain	-11.00%	-11.00%	No effect	No effect	2.4	-11.00%	-9.00%
Sweden	-8.00%	-8.00%	No effect	No effect	0.6	-8.00%	-7.00%
United Kingdom	-12.00%	-12.00%	No effect	No effect	7.3	-12.00%	-8.00%

Further information

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Ministry of Housing,
Communities &
Local Government

Our ref: APP/M1900/W/17/3178839

Mr Douglas Symes (Agent)
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39 Main Road
Middleton Cheney
Banbury
Oxfordshire
OX17 2ND

4 April 2019

Dear Sir,

TOWN AND COUNTRY PLANNING ACT 1990 – SECTION 78 AND 79
APPEAL MADE BY RJD LTD AND GOWLING WLG TRUST CORPORATION LIMITED
LAND AT WARE PARK, WADESMILL ROAD, HERTFORD
APPLICATION REF: 3/0770-16

1. I am directed by the Secretary of State to say that consideration has been given to the report of John Woolcock BNatRes(Hons) MURP DipLaw MRTPI, who held a public local inquiry on 1-4, 9-11, 18 May and 23-25 October 2018 into your client's appeal against the decision of Hertfordshire County Council (HCC) to refuse your client's application for planning permission for the phased extraction of sand and gravel, mobile dry screening plant, stockpile area, weighbridge, wheel cleaning facilities, ancillary site offices, construction of a new access onto Wadesmill Road with phased restoration to landscaped farmland at a lower level, in accordance with application ref: 3/0770-16, dated 4 March 2016.

2. On 23 February 2018, this appeal was recovered for the Secretary of State's determination, in pursuance of section 79 of, and paragraph 3 of Schedule 6 to, the Town and Country Planning Act 1990.

Inspector's recommendation and summary of the decision

3. The Inspector recommended that the appeal be dismissed and planning permission be refused.

4. The Inspector further recommended that your client's request to determine the appeal on the basis of an alternative 1.25 Mt scheme be declined.

5. For the reasons given below, the Secretary of State agrees with the Inspector's conclusions, except where stated, and agrees with his recommendations. He has decided to dismiss the appeal and refuse planning permission. He also declines your client's request to determine the appeal on the basis of the alternative 1.25 Mt scheme.

Ministry of Housing, Communities & Local Government
Maria Stasiak, Decision Officer
Planning Casework Unit
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A copy of the Inspector's report (IR) is enclosed. All references to paragraph numbers, unless otherwise stated, are to that report.

Environmental Statement

6. In reaching this position, the Secretary of State has taken into account the Environmental Statement which was submitted under the Town and Country Planning (Environmental Impact Assessment) Regulations 2011 and the environmental information submitted before the inquiry opened and during the inquiry (IR5). Having taken account of the Inspector's comments at IR351, the Secretary of State is satisfied that the Environmental Statement and other additional information provided complies with the above Regulations and that sufficient information has been provided for him to assess the environmental impact of the proposal.

Procedural matters

7. As set out by the Inspector at IR2, the original application was for the extraction of 2.6Mt sand and gravel, but this was subsequently changed to 1.75Mt. It is the scheme for the extraction of 1.75Mt which was refused by HCC in determining the application and that is now the appeal scheme.

8. As outlined by the Inspector at IR4, a second scheme proposed by the appellants would omit Phase 4 and the stockpile area from the 1.75Mt scheme, and reduce the tonnage of sand and gravel extracted to 1.25 Mt. The 1.25 Mt scheme was the subject of a separate planning application (Ref.3/2352/17), which was refused by HCC on 26 April 2018. The appellants have requested that the current appeal be decided by the Secretary of State on the basis that the 1.75 Mt scheme be considered first, and if found to be unacceptable, that a condition limiting the scheme to 1.25 Mt be imposed. All the written representations to HCC about the application for the 1.25 Mt scheme were submitted to the Inquiry.

9. A list of representations which have been received since the inquiry is at Annex A. The Secretary of State is satisfied that the issues raised do not affect his decision, and no other new issues were raised in this correspondence to warrant further investigation or necessitate additional referrals back to parties. Copies of these letters may be obtained on written request to the address at the foot of the first page of this letter.

Policy and statutory considerations

10. In reaching his decision, the Secretary of State has had regard to section 38(6) of the Planning and Compulsory Purchase Act 2004 which requires that proposals be determined in accordance with the development plan unless material considerations indicate otherwise.

11. In this case the development plan consists of the East Herts District Plan (EHDP), adopted in October 2018 and the saved policies of the Hertfordshire Minerals Local Plan Review (MLP) 2007. The Secretary of State considers that the development plan policies of most relevance to this case are those set out at IR38-42.

12. Other material considerations which the Secretary of State has taken into account include the National Planning Policy Framework ('the Framework') and associated planning guidance ('the Guidance'), and those other matters set out in IR55-56. The revised National Planning Policy Framework was published on 24 July 2018, and unless

otherwise specified, any references to the Framework in this letter are to the revised Framework.

13. In accordance with section 72(1) of the Planning (Listed Buildings and Conservation Areas) Act 1990 (the LBCA Act), the Secretary of State has paid special attention to the desirability of preserving or enhancing the character or appearance of conservation areas.

Emerging plan

14. Consultation on a review of the Minerals Local Plan (eMLP) was undertaken between December 2017 and February 2018. The consultation draft plan did not include the appeal site as a preferred area for sand and gravel extraction. The Local Mineral Planning Authority intends to submit the plan to the Secretary of State for examination in summer 2019. The Secretary of State considers that the emerging policies of most relevance to this case include draft policies 3, 4, 12, 14, 15 and 16.

15. The Bengeo Neighbourhood Plan is at an early stage of development, and has not yet been submitted to the local planning authority. Bengeo Field is identified in the draft as an area of designated local green space.

16. Paragraph 48 of the Framework states that decision makers may give weight to relevant policies in emerging plans according to: (1) the stage of preparation of the emerging plan; (2) the extent to which there are unresolved objections to relevant policies in the emerging plan; and (3) the degree of consistency of relevant policies to the policies in the Framework. Given the early stages of development, the Secretary of State considers that the eMLP carries limited weight and the emerging Bengeo Neighbourhood Plan carries little weight.

Main issues

Location of site

17. The Secretary of State notes that significant areas of the appeal scheme would be located outside the boundaries of the Preferred Area for mineral extraction. He agrees with the Inspector's analysis at IR441, and agrees that the scheme would not accord with MLP Policy 3.

Green Belt

18. The Secretary of State has considered carefully the Inspector's findings at IR362-374 about the impact of the scheme on the Green Belt. He agrees with the Inspector at IR366 that plant, equipment, access and activity associated with the mineral extraction here would, to some extent, impair the openness of the area, but not enough to exceed the threshold or tipping point for the purposes of applying paragraph 146 of the Framework.

19. He has also considered the Inspector's reasoning at IR366-374 in relation to the effect of the bunds and tree planting on the openness of the Green Belt and the setting of historic Hertford. In reaching his conclusion, the Secretary of State has taken into account that the bunds could exist for up to 10 years, which for GLVIA3 in landscape terms marks a boundary between medium term and long term effects (IR367), and that the adverse effects on openness would be fully reversible in time (IR368). He has also taken into account that there would be no permanent built development impacting on the openness of the Green Belt, and that tree planting does not constitute development and therefore is not inappropriate development in the Green Belt. He does not consider that the tree

planting would be in conflict with the purposes of the Green Belt. Overall the Secretary of State considers that the exception for mineral extraction at paragraph 146 of the Framework does apply, the proposed mineral extraction is therefore not inappropriate development in the Green Belt, and there is no conflict with local or national Green Belt policies.

Character and Appearance

20. The Secretary of State has carefully considered the Inspector's analysis at IR375-388. He agrees with the Inspector that while not subject to any designation given to landscape, the appeal site is a landscape resource and visual amenity of considerable importance because of its proximity to the urban area (IR378), and the fact the appeal site retains its natural landform makes it important in its local context (IR379). For the reasons given in IR375-382, the Secretary of State agrees with the Inspector that the operational development to extract, screen, stockpile and transport sand and gravel would have an adverse effect on the character and appearance of the area of major significance, albeit of a limited duration (IR388).

21. The Secretary of State has gone on to consider impacts following restoration. He agrees with the Inspector for the reasons given in IR384 that the restored landform would give the landscape an artificial crumpled appearance, and that the proposed low-level restoration would not be appropriate in the landscape context which applies here. He further agrees for the reasons given in IR385-388 that that appellants' hedgerow and tree planting would be the wrong landscape strategy for the appeal site (IR385) and that the cumulative impact of the appeal scheme, over time, adds to the overall harm to the landscape resource (IR387). He therefore agrees with the Inspector at IR388 that on restoration the scheme would have an adverse effect of moderate significance. Overall the Secretary of State agrees with the Inspector's conclusions that the appeal scheme would have an adverse effect on the character and appearance of the area of substantial significance (IR388), which carries substantial weight against the proposal (IR433), and would not be accordance with MLP Policies 12 and 18(ii) (IR442).

Amenity and living conditions

22. The Secretary of State has carefully considered the Inspector's reasoning at IR389-402 and agrees with his analysis. Overall the Secretary of State agrees with the Inspector that the appeal scheme would have an adverse effect on the living conditions of residents and on the amenity of the area which carries moderate weight against the proposal and would not accord with MLP Policy 18(viii) or with the aim of the NPSE to avoid significant adverse impacts on the quality of life (IR394, 402, 433, 442).

Hydrogeology

23. For the reasons given at IR406-420, the Secretary of State agrees with the Inspector's analysis of the risks from the development to the hydrogeology, including groundwater pollution, harm to the aquifer and the public water supply. He agrees with the inspector's conclusion at IR419 that the risk of contaminating groundwater would give rise to an adverse effect of moderate significance, which should given substantial weight because of the implications for the public water supply. He further agrees with the Inspector at IR420 that in the absence of an appropriate mechanism and planning condition to safeguard the aquifer, the proposed development would pose an unacceptable risk to groundwater pollution, and so would conflict with MLP Policies 17(iv) and 18(ix), and

would have an unacceptable adverse impact on the natural environment for the purposes of applying paragraph 205(b) of the Framework (IR420).

Benefits of the scheme

24. For the reasons given at IR429-431 and IR435 the Secretary of State considers that the employment and economic benefits, including the contribution of minerals from the appeal site, carries great weight in favour of the proposal. For the reasons given at IR403-405, the Secretary of State agrees with the Inspector at IR437 that the permanent enhancements to the PRoW network carry slight weight in favour of the scheme.

Other matters

25. The Secretary of State agrees with Inspector's reasoning in relation to highway safety, biodiversity and supply of housing (IR421-422, 423-425 and 428 respectively).

26. The Secretary of State agrees with the Inspector at IR 426 that, for the reasons stated, there would be some harm to agricultural land which would be an adverse effect of minor significance. He therefore considers that it carries slight weight against the proposal.

Planning conditions

27. The Secretary of State has given consideration to the Inspector's analysis at IR450-466, the recommended conditions set out at the end of the IR and the reasons for them, and to national policy in paragraph 55 of the Framework and the relevant Guidance. With the exception of the matter flagged up at IR464 he is satisfied that the conditions recommended by the Inspector comply with the policy test set out at paragraph 55 of the Framework. However, as he does not consider that the imposition of these conditions, either as outlined or in revised form, would overcome his reasons for dismissing this appeal and refusing planning permission, he has not referred back to parties on this matter.

Planning obligations

28. The Secretary of State has given consideration to the Inspector's analysis at IR467-470, the planning obligation dated 15 November 2018, paragraph 56 of the Framework, the Guidance and the Community Infrastructure Levy Regulations 2010, as amended. With the exception of the matters flagged up in IR469 and IR470, the Secretary of State agrees with the Inspector's conclusion that the obligation complies with Regulation 122 of the CIL Regulations and the tests at paragraph 56 of the Framework. However, the Secretary of State does not consider that the obligation, either as outlined or in revised form, would overcome his reasons for dismissing this appeal and refusing planning permission. He has therefore not referred back to parties on this matter.

Planning balance and overall conclusion

29. For the reasons given above, the Secretary of State considers that the appeal scheme is not in accordance with development plan policies relating to location, character and appearance, living conditions and amenity, and hydrogeology, and is not in accordance with the development plan overall. He has gone on to consider whether there are material considerations which indicate that the proposal should be determined other than in accordance with the development plan.

30. The Secretary of State considers that the employment and economic benefits, including the contribution of minerals from the appeal site, carries great weight in favour of the proposal, and that the permanent enhancements to the PRoW network carry slight weight in favour of the scheme.

31. The Secretary of State considers that the impact on landscape and character, and hydrogeology each carry substantial weight against the proposal. He considers that the impact on living conditions and amenity of local residents carries moderate weight against the proposal, and the harm to agricultural land carries slight weight against the proposal.

32. The Secretary of State considers that there are no material considerations which indicate the proposal should be determined other than in accordance with the development plan. He therefore concludes that the appeal should be dismissed, and planning permission should be refused.

The 1.25Mt scheme

33. For the reasons given at IR473-480, the Secretary of State agrees with the Inspector's conclusion at IR480 that the likelihood of prejudice arising is such that the Wheatcroft principles are not satisfied and the applicant's request to determine the appeal on the basis of the 1.25 Mt scheme should be declined.

Formal decision

34. Accordingly, for the reasons given above, the Secretary of State agrees with the Inspector's recommendation. He hereby dismisses your client's appeal and refuses planning permission for the phased extraction of sand and gravel, mobile dry screening plant, stockpile area, weighbridge, wheel cleaning facilities, ancillary site offices, construction of a new access onto Wadesmill Road with phased restoration to landscaped farmland at a lower level, in accordance with application ref: 3/0770-16, dated 4 March 2016.

35. For the reasons given above, the Secretary of State further agrees with the Inspector's recommendation on the alternative scheme. He hereby declines your client's request to determine the appeal on the basis of an alternative 1.25 Mt scheme.

Right to challenge the decision

36. A separate note is attached setting out the circumstances in which the validity of the Secretary of State's decision may be challenged. This must be done by making an application to the High Court within 6 weeks from the day after the date of this letter for leave to bring a statutory review under section 288 of the Town and Country Planning Act 1990.

37. A copy of this letter has been sent to Hertfordshire County Council and notification has been sent to others who asked to be informed of the decision.

Yours faithfully,

Maria Stasiak

Authorised by the Secretary of State to sign in that behalf

Annex A Schedule of representations

General representations

Party	Date
Mark Prisk MP	28/11/2019
Sir Oliver Heald QC MP	03/01/2019

Report to the Secretary of State for Housing, Communities and Local Government

by John Woolcock BNatRes(Hons) MURP DipLaw MRTPI

an Inspector appointed by the Secretary of State

Date: 3 January 2019

Town and Country Planning Act 1990 Sections 78 and 79

appeal by

RJD Ltd and Gowling WLG Trust Corporation Limited

against the decision of

Hertfordshire County Council

Inquiry held on 1-4, 9-11, 18 May and 23-25 October 2018

Land at Ware Park, Wadesmill Road, Hertford

File Ref: APP/M1900/W/17/3178839

File Ref: APP/M1900/W/17/3178839
Land at Ware Park, Wadesmill Road, Hertford, Hertfordshire

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant planning permission.
- The appeal is made by RJD Ltd and Gowling WLG Trust Corporation Limited against the decision of Hertfordshire County Council (HCC).
- The Application No:3/0770-16, dated 4 March 2016, was refused by notice dated 24 March 2017.
- The development proposed is phased extraction of sand and gravel, mobile dry screening plant, stockpile area, weighbridge, wheel cleaning facilities, ancillary site offices, construction of a new access onto Wadesmill Road with phased restoration to landscaped farmland at a lower level.

Summary of Recommendation: The appeal be dismissed.

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ABBREVIATIONS

AOD	Above Ordnance Datum
AW	Affinity Water
BAE	BAE Hatfield aerodrome site
BMV	Best and most versatile agricultural land
BNAP	Bengeo Neighbourhood Area Plan
CD	Inquiry Core Document
COPD	Chronic obstructive pulmonary disease
Defra	Department for Environment Food and Rural Affairs
EA	Environment Agency
EHDP	East Herts District Plan 2018
EIA	Environmental Impact Assessment
eMLP	Emerging review of the Minerals Local Plan
ES	Environmental Statement dated March 2016
FEI.1	Further Environmental Information dated December 2016
FEI.1a	Further Environmental Information dated January 2017
FEI.2	Further Environmental Information dated February 2018
FEI.3	Further Environmental Information dated 27 April 2018
Framework	*Revised National Planning Policy Framework 2018*
GLVIA3	*Guidelines for Landscape and Visual Impact Assessment, Third Edition* Landscape Institute
Guidance	*National Planning Practice Guidance*
HCC	Hertfordshire County Council
HGV	Vehicle over 7.5 tonnes
HIA	Health impact assessment
HSE	Health and Safety Executive
ID	Inquiry Document – document submitted at Inquiry
IAQM	Institute of Air Quality Management
LAA	Local Aggregates Assessment
LCA	Landscape Character Area
MLP	Hertfordshire Minerals Local Plan Review 2007
Mt	Million tonnes
NPSE	*Noise Policy Statement for England*
PA2	Preferred Area 2 Rickneys Quarry in MLP
PM	Particulate Matter
PRoW	Public Rights of Way
RCS	Respirable crystalline silica
RQE	Rickneys Quarry Extension
SBQ	Stop Bengeo Quarry Group
section 106	Section 106 of the Town and Country Planning Act 1990
SoC1/SoC2	Statements of Case dated June 2017 and April 2018
SoCG1	Statement of Common Ground 3 October 2018 (ID94)
SoCG2	SoCG re sand and gravel dated 24 April 2018 (ID11)
SoCG3	SoCG re health dated 3 May 2018 (ID20)
SPL	Sound power level
SPZ	Source Protection Zone
VSC	Very special circumstances for Green Belt policy
Wadesmill PS	Wadesmill Road Pumping Station
WHO	World Health Organisation
$\mu g/m^3$	Micrograms per cubic metre

Procedural and background matters

1. The application by RJD Ltd and Gowling WLG Trust Corporation Limited (hereinafter the appellants) was accompanied by an Environmental Statement, dated March 2016, (ES) in accordance with the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 2011 (hereinafter the EIA Regulations).[1] This included a non-technical summary, and set out the alternatives considered by the appellants, along with a description of the proposed development and environmental impacts.[2]

2. The original application was for the extraction of 2.6 million tonnes (Mt) of sand and gravel.[3] The proposed restored landform was subsequently changed and this reduced the extraction to 1.75 Mt.[4] Further Information 1 was submitted in December 2016, with additional reports on Landscape and Visual, Ecology, Highways and Air Quality (FEI.1). Additional technical data was submitted by the appellants in Further Information 1a, dated January 2017 (FEI.1a). It is this scheme for the extraction of 1.75 Mt that was refused by Hertfordshire County Council (HCC) in determining the application, and that is now the appeal scheme.

3. HCC refused the application on six grounds because the proposal; (1) is in the Green Belt where screening bunds, stockpiling areas, plant and activity would not preserve openness, resulting in inappropriate development, where the very special circumstances of benefits of mineral extraction and potential avoidance of sterilisation do not clearly outweigh the harm to the Green Belt and any other harm, including harm to landscape, rights of way, air quality and health, contrary to Policy GBC1 of the East Herts Local Plan 2007 and the NPPF; (2) would have a significant detrimental impact upon landscape, including from Phase 4, stockpiling areas, plant, site access with associated loss of hedgerow, and the restored landform, contrary to MLP Policies 12, 13, 17 and 18; (3) has not demonstrated that it would not have detrimental impact upon air quality, and this has not been assessed via a Health Impact Assessment (HIA) contrary to MLP Policy 18 and the NPPF; (4) would have a negative impact upon existing rights of way contrary to MLP Policies 3 and 18; (5) includes land outside the Preferred Area contrary to MLP Policy 3; (6) has not demonstrated that noise would not have a detrimental impact upon nearby residential property contrary to MLP Policy 18 and national policy/guidance.

4. A second scheme proposed by the appellants would omit Phase 4 and the stockpile area from the 1.75 Mt scheme, and reduce the tonnage of sand and gravel extracted to 1.25 Mt. The Grounds of Appeal in the appellants' original Statement of Case were based upon the 1.25 Mt scheme, with a projected

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[1] The transitional provisions in the Environmental Impact Assessment (EIA) Regulations 2017 mean that the 2011 EIA Regulations continue to apply here.
[2] CD2.
[3] The Composite Operations Plan No.1217/CO/1 is at CD2 document 1 and Restored Landform at ID51.
[4] The revised landform was to reduce the steepness of the western slope and to achieve a gentler gradient. APP10 paragraph 3.2.4.

timescale of 5-7 years (SoC1).[5] Subsequently, Statement of Case 2 was submitted on 5 April 2018 regarding the case for the 1.75 Mt scheme (SoC2). The appellants would like the appeal to be decided by the Secretary of State on the basis that the 1.75 Mt scheme be considered first, and if found to be unacceptable, that a condition limiting the scheme to 1.25 Mt be imposed. The 1.25 Mt scheme was also the subject of a separate planning application (Ref.3/2352/17), which was refused by HCC at a committee meeting held on 26 April 2018.[6] All the written representations to HCC about the application for the 1.25 Mt scheme were submitted to the Inquiry.

5. The appellants were required by letter dated 24 November 2017 to submit Further Environmental Information pursuant to Regulation 22 of the EIA Regulations, to include the risk of soil contamination, cumulative impact, and a revised non-technical summary. These were submitted in February 2018 (FEI.2).[7] The appellants were further required by letter dated 3 April 2018 to submit Further Environmental Information, to include a revised description consistent with the proposal for extraction of 1.75 Mt, along with likely significant effects. This was submitted on 27 April 2018 (FEI.3).[8]

6. On 23 February 2018 the appeal was recovered for decision by the Secretary of State by a direction made under section 79 of the 1990 Act. The reason for the direction was that the appeal involves proposals for significant development in the Green Belt, and major proposals involving the winning and working of minerals.

7. A Pre-Inquiry Note was issued on 20 April 2018 to deal with procedural matters.[9] A Statement of Common Ground (SoCG1) agreed between the appellants and HCC is dated 3 October 2018.[10] I requested an up-to-date agreed written statement by HCC and the appellants about the supply of, and demand for, sand and gravel in the locality (SoCG2).[11] A Statement of Common Ground – Health, by the appellants and HCC, is dated 3 May 2018 (SoCG3).[12]

8. On application, both the Stop Bengeo Quarry Group (abbreviated to SBQ in this report) and Cllr Andrew Stevenson, were granted Rule 6(6) status pursuant to The Town and Country Planning (Inquiries Procedure) (England) Rules 2000. Both participated fully in the Inquiry, opposing the proposed development. SBQ's intervention in the appeal was initially limited to the risk of water pollution posed to the underlying chalk aquifer, or groundwater source, which supplies the Wadesmill Road Pumping Station (Wadesmill PS).

[5] SoC1 paragraph 5.1.3. The amendment was intended to restrict all operations within PA2, and Composite Operations Plan 1217/O/1 v8 was withdrawn, but v8 had been replaced by v9 in FEI.1a (see CD4 paragraph 2.3.1). SoC1 paragraph 5.4.10. Timescale of 5-7 years is at SoC1 paragraph 4.1.3.
[6] CD19.
[7] CD16.
[8] CD40.
[9] CD39.
[10] ID94.
[11] ID11.
[12] ID20.

But this was subsequently extended to include the appellants' HIA and air quality, as set out below.

9. The Inquiry opened on 1 May 2018. An appropriate notification letter about the Inquiry was not sent until 23 April 2018, which was less than two weeks before the Inquiry opened. However, I do not consider that anyone would be prejudiced by this late notification as the Inquiry was not closed until 20 November 2018.

10. The Inquiry overran its scheduled seven days. During an adjournment the parties submitted procedural notes I had requested concerning submissions about considering an amended scheme at the appeal stage.[13] SBQ's note stated that the appellants' submission of new expert evidence, the HIA, at an unacceptably late stage in these Inquiry proceedings had caused material prejudice to SBQ. I invited the views of the parties about whether the submission of the HIA had been prejudicial to the interests of any party or persons, and if so, whether any measures would now be necessary to remedy that situation. After hearing submissions I adjourned the Inquiry.[14] Amended Statements of Case concerning the HIA were submitted by the parties.[15] Provision was made for written representations about the HIA to be received up until 28 August 2018.[16] The Inquiry resumed on 23 October 2018 and sat for a further three days.

11. The Inquiry sat for a total of 11 days. The proceedings were recorded in accordance with an agreed protocol. An accompanied site visit took place on 4 May 2018. I also visited the site and its locality unaccompanied on 8 May and 22 October. The parties were given time to submit a signed planning agreement and to finalise the wording of suggested planning conditions in the event that planning permission was granted. The Inquiry was subsequently closed in writing on 20 November 2018.

12. In response to the Pre-Inquiry Note the appellants indicated on 17 April 2018 that no legal agreement was proposed, subject to any other comments. No final draft of any obligations was submitted by the opening of the Inquiry. However, draft planning obligations were submitted on day 5 of the Inquiry. These were the subject of revision until a signed planning agreement was submitted dated 15 November 2018.[17] The obligations were discussed at the Inquiry, and parties given the opportunity to comment on the final version. In summary, the section 106 obligations include provisions to;
    1) commence the development within three years and to complete restoration within 10 years or such later date as is agreed with HCC,
    2) enter into a section 25 agreement in respect of the construction and dedication of a new byway,
    3) enter into a highways agreement and carry out highway works.

[13] ID75, ID76 and ID77.
[14] My ruling is at Annex A of this report.
[15] ID91.1 to ID91.4.
[16] 156 written representations were submitted and are included at ID93 with a list of those who made representations at Annex B of this report.
[17] ID57, ID83 and ID114.

13. The lead up to the Inquiry was not straightforward, and a chronology of events and submission of documents is included in ID80. The Inquiry heard evidence about both the 1.75 Mt and 1.25 Mt schemes, and this is referred to in the first sections of this report. The Conclusions section then first considers the appeal against the refusal of the 1.75 Mt scheme. If the Secretary of State is minded to allow the appeal then it would not be necessary to consider further the submissions about the 1.25 Mt scheme. In the event that the Secretary of State is minded to dismiss the appeal for the 1.75 Mt scheme, the report then goes on to consider the options open to the Secretary of State concerning consideration of the 1.25 Mt scheme.

The proposed development

14. The appeal scheme would extract 1.75 Mt of sand and gravel over a period of up to 10 years in four phases, with phased restoration to agriculture and woodland thickets, and aftercare for five years. The scheme includes an office, messroom and weighbridge, which would be sited within a floodlit area, along with a fuelling area with tank, wheel cleaning facility and water attenuation area. The application form states that the scheme would be operated by six full-time employees.

15. Bunds would be constructed around excavated and operational areas. Some bunds would be temporary and associated with a particular Phase of the operation, but those around the stockpile and attenuation areas could remain for up to 10 years. The Bund Schedule at ID22 indicates that at any one time there would be between about 500 m and 1,000 m of bunds, mostly 2-3 m high, but including 230 m of Bund 1 at 4 m high. In addition, for the duration of the operation there would be a length of 825 m of bunds, 3 m or more in height, screening the stockpile and attenuation areas. This would include some 335 m about 4 m high for the NE Stockpile Area Bund, and 270 m some 4-7 m high for the SW Stockpile Area Bund.

16. A restricted working zone would be created within 70 m of properties at The Orchard, within which operations would not take place when the wind direction was from the north-eastern quadrant.[18] The screener and loading shovel would not be operated within 250 m of any residential premises. Noise limits are proposed for nearby residential properties.

17. The fuelling area would be sited in an area that is shown on the site geology plan to be underlain by clay.[19] Plant would be refuelled only in a bunded fuel storage area. The stockpile area would be sited on a level platform with a base of about 50 m AOD, with the height of stockpiles no higher than 5 m.[20]

18. Landscaping would include early tree and hedgerow planting in year 1. A 10 m wide undisturbed buffer would be provided between St John's Wood and the proposed northern bund. The restored landform would include agricultural buffer strips, new hedgerow and tree planting, infill planting within existing hedgerows, and wildflower planting around the retained

[18] CD4 paragraph 2.2.3.
[19] Site geology Drawing 1701/HIA/-01/07 CD2 doc2.
[20] CD2 paragraph 4.6.2.

attenuation area.[21] No controlled waste would be imported to the site, so an Extractive Materials Management Statement is not expected to be needed. The only other control may be on the mobile dry screening unit which may fall under Process Guidance Note 3/08(12) – statutory guidance for quarry processes, but this is not normally required for the proposed development.[22] Foul sewage waste water would be taken off-site with no requirement for on-site discharge.

19. Access would be via a new junction on Wadesmill Road, which is part of the B158. This would include visibility splays and a segregated right turn lane for HGVs to wait to turn into the site.[23] HGV movements would be limited to 50 in and 50 out in any working day, and required to use an approved wheel wash. Signs would be erected at the site exit requiring all HGVs to turn left onto the B158 towards the recently improved Anchor Lane roundabout on the A602.

20. The proposed depth of excavation is shown in illustrative cross sections.[24] The appellants also submitted a plan showing the interpolated elevation of the top, or rockhead, of the underlying chalk.[25] These contours were derived from log data from boreholes located within and near to the appeal site. It is proposed that these contours would generate a 3D GPS model that would be used to control the depth of excavation. The undisturbed material that would remain above the chalk, using these contours to determine the position of the chalk rockhead, is shown on Isopachytes Drawings.[26]

21. A restricted Byway (RB1), which becomes a footpath (FP14), traverses the appeal site. This would be diverted for 2 to 3 years in the 1.75 Mt scheme. Permissive paths would be created during the operation, and the section 106 agreement provides for upgrading the part of FP14 within the site to a restricted Byway, along with a new bridleway linking RB1 to the B158. Existing and proposed Public Rights of Way (PRoW) are shown at Appendix 3 of APP5.

22. The amended scheme would extract 1.25 Mt of sand and gravel over a period of up to 7 years in three phases. The scheme includes a load out area at about 57 m AOD that would contain an office, messroom and weighbridge, security area/vehicle parking and soakaway, along with wheel cleaner and wheel bath, linked to the B158 by an access road with a concrete surface.[27] The proposed bund in the south-western part of Phase 1 would be sited more than 100 m from properties at The Orchard. The load out area would be sited in an area that is shown on the site geology plan to be predominantly underlain by sand and gravel. The description of the proposal states that restoration would be to landscaped farmland at a lower level. The submitted drawings include a Landscape Restoration Strategy and the Progressive

[21] Plan No.1217/R/1.
[22] Reply dated 26 April 2018 to Inspector's question.
[23] Access Junction and Right Turn Lane (Vectos) 131124/A/04.1 Rev E.
[24] Plan No.1217/CS/1.
[25] Plan entitled "Topography of Chalk surface" Hafren Water (Drawing 2482/POE/03).
[26] Drawings 1217/1.75/UM/1 and 1217/1.25/UM/1 at ID31.
[27] The soakaway is annotated as "(indicative)".

Operations Plan shows the restored site.[28] No footpath diversion would be necessary in the 1.25 Mt scheme.

23. A summary of the main differences between the 1.75 Mt and 1.25 Mt schemes, submitted by the appellants, is at ID26. Differences in the size of bunds, and for how long they would exist during the respective phased operations, are set out at ID22. Similar planning conditions and controls have been suggested for the schemes. The 1.75 Mt scheme would affect 0.52 ha of agricultural land classified as the best and most versatile (BMV) agricultural land.[29] No BMV land would be affected by the 1.25 Mt scheme.

The site and surroundings

Locality

24. The application site has an area of 36.1 ha, and is situated within the Metropolitan Green Belt. At its nearest point the site is located about 2 km north of Hertford town centre, just beyond the northern edge of the town. The site is in agricultural use as arable land. Adjacent land use includes arable farmland and woodland to the north and east extending to the River Rib, a plant nursery and allotment gardens to the south near to residential properties in Bengeo and a primary school. To the west lies the partially restored Rickneys Quarry.[30]

25. The distances of dwellings and features in the locality from the nearest proposed bunds and operational part of the quarry are set out in ID95. For the 1.75 Mt scheme the nearest dwelling on Sacombe Road would be 10 m from the toe of the nearest proposed bund, and 28 m from the nearest operational part of the quarry. The corresponding distances for the nearest dwelling at The Orchard are 23 m and 43 m. Waterworks Cottage and Glenholm would be, respectively, about 68 m and 215 m from the operational area. St John's Wood would be 10 m from the proposed bund and 21 m from the operational area. Other features in the locality include; Bengeo Nursery (127m to bund/150m to operational area), the Playing Field (146m/167m), the allotments (256m/281m) and Bengeo Primary School (337m/360m).

26. Hertford Conservation Area is centred about the Hertford Castle grounds, but its northern limit extends along Bengeo Street to just north of the junction with Sacombe Road and Wadesmill Road, incorporating the allotments.

Landscape

27. The site lies within National Landscape Character Area 111: Northern Thames Basin, and falls broadly into the Hertfordshire Plateau and River Valleys sub-character area. This is a diverse landscape formed by a wide plateau dissected by a series of broad river valleys with extensive areas of broadleaved woodlands. The landscape has been extensively modified by current and reclaimed gravel pits, landfill sites, river realignments and canals. The site is near to the adjoining South Suffolk and North Essex Clayland

[28] Landscape Restoration Strategy (Liz Lake) 1571 01 H and Progressive Operations Plan 1217/PO/2 v4.
[29] ID92.
[30] An aerial photograph of the locality is at ID79.

Character Area 86, which is an area described as a broadly flat, chalky, boulder clay plateau dissected by undulating river valley topography.

28. In the regional typology of the landscape of the east of England, the site lies within the Wooded Plateau Farmlands, very close to the Settled Chalk Valleys as identified within the typology. The Wooded Plateau Farmlands is described as a settled, early enclosed landscape with frequent ancient woods, associated with a rolling, in places undulating glacial plateau, dissected by numerous shallow valleys. The Settled Chalk Valleys are described as settled, chalk valley landscapes, distinguished by their soft, rounded and sometimes steeply sloping topography.

29. In the *East Herts District Landscape Character Assessment* 2007 the appeal site is located within an interfluve of the rivers Beane and Rib, landscape character area (LCA) '069 Stoney Hills'. The landscape character is described as gently undulating light arable upland and valley slopes, widening to the north, with generally large irregular fields and woodlands on very light soils, with several blocks of ancient woodland in the south, and very rural, with few settlements but many mineral extraction sites.[31]

30. Key characteristics include active, disused and restored mineral extraction sites, with a mix of field sizes and variety of after uses. Distinctive features include an abrupt transition from urban to rural character on the edge of Bengeo, a conspicuous water tower at Tonwell, along with former mineral workings now developing heathland grass species with butterflies and skylarks. The local topography is described as undulating sloping land rising to a small plateau in the north, with a degree of slope from 1 in 30 to 1 in 50. This area of wooded farmland has experienced a high degree of disturbance from mineral extraction. The evaluation section refers to an open area, rising above the river valleys to either side and with wide views over the surrounding landscape, filtered in places by the woodland blocks, and a tranquil area, very clearly demarcated from the urban area to the south.

31. In terms of visual impact, most of the mineral extraction sites in this area are well screened, but there are some views of huge landfill sites on the skyline and evidence throughout the area of former workings, some of which are now restored for nature conservation interest. Reference is made to the extensive footpaths, and in terms of community views, that the area is not regarded as particularly distinctive.

32. Overall the area is judged to be in a poor condition, with high impact of land-use change, and of moderate strength of character, with the impact of landform and land cover considered to be apparent, the area open and locally visible, and unusual in terms of distinctiveness/rarity. The strategy and guidelines for managing change is to improve and restore, by amongst other things; safeguarding existing hedges and increasing hedged field boundaries; replanting and/or improving hedges along historic field boundaries, within arable areas rather than along roadsides, where open verges would reinforce the distinctiveness of this area; encouraging the creation of permanent grass strips around field margins; establishing new woodlands, especially around existing woodlands where this would create additional habitat and protection;

[31] HCC3 Appendix 4.

encouraging the reversal of habitat fragmentation and the creation and improvement of habitat links to create eco-corridors; and ensuring that the restoration of exhausted minerals sites is carried out in accordance with agreed restoration plans, amended where necessary to reflect current best practice in maximising nature conservation potential and to ensure that they reflect and enhance local landscape character and distinctiveness.

33. In the *Landscape Character Assessment, Evaluation and Guidelines for Southern Hertfordshire supplementary report on: The suitability of landscape character areas for mineral extraction* 2001 the landscape strategy for this area is 'improve and restore', reflecting the existing impact of mineral extraction. The site profile suggests that mineral extraction might be possible, but that extreme care would be required to ensure that there was no permanent damage to local landscape character, adding that it might be preferable to keep it within the centre of the plateau rather than on the edges, where it would be more visible and closer to settlements. Areas of ancient woodland should not be disturbed, and adequate buffer zones should be provided to ensure that there would be no detrimental effect from localised lowering of the water table. Restoration to grassland or woodland would both be appropriate after-uses, with the potential to contribute significantly to biodiversity over time. The report notes that it is unlikely that low level restoration would be appropriate.[32]

Hydrogeology

34. The site lies within the Upper Lee Chalk Groundwater Body. The sand and gravel deposits in the Kesgrave formation are classified as a Secondary A aquifer by the Environment Agency (EA). The sand and gravel overly chalk, which is designated as a Principal Aquifer. The chalk aquifer provides a significant source of water for public water supply abstractions in the area. The aquifer is part of a designated Drinking Water Protected Area. Parts of the site lie within a Source Protection Zone (SPZ). Phase 4, Phase 3 and part of Phase 2 of the proposed development are within the SPZ Inner Zone (SPZ1) for the Wadesmill PS, which is operated by Affinity Water (AW), and part of Phase 1 within the SPZ Outer Zone for the Amwell Hill Pumping Station (SPZ2). Nearly all of Phase 4 of the appeal scheme would lie within 300 m of the Wadesmill PS. The eastern extremity of the estimated limit of the sand and gravel proposed to be extracted in the 1.75 Mt scheme lies about 120 m to the west of the Wadesmill PS.[33] There are also private boreholes in the wider locality.

Rickneys Quarry

35. The location of Rickneys Quarry, operated by Hanson, is shown on the plan attached to ID78, which sets out the planning history of this quarry. An application for an extension along its eastern boundary, Rickneys Quarry Extension (RQE), was permitted in 2009, but was not implemented. Hanson is seeking a redetermination of this 'approval' and an extension of the implementation date to 31 December 2021.[34]

[32] HCC3 Appendix 3.
[33] Drawing 2482/POE/03.
[34] ID13.2, ID16.1-16.3 and ID102.

Biodiversity

36. The site does not contain or include any statutorily designated or non-statutorily notified sites of ecological interest. However, the site is located in close proximity to the Waterford Heath Local Nature Reserve and St John's Wood, a Local Wildlife Site.

Planning policy guidance and statutory requirements

Development plan

37. HCC's reasons for refusal refer to the East Herts Local Plan 2007, but East Herts District Plan (EHDP) was adopted in October 2018. The development plan also includes saved policies of the Hertfordshire Minerals Local Plan Review 2007 (MLP).[35]

38. MLP Policy 1 concerning aggregates supply states that planning permission for the extraction of proven economic mineral reserves will only be granted where it is necessary to ensure that adequate supplies are available to meet the county's agreed apportionment of regional supply. It also provides for the maintenance of an appropriate landbank of sand and gravel reserves. Policy 2 sets out factors to be taken into account in determining proposals for mineral extraction.

39. Specific sites for sand and gravel extraction are included in Policy 3. Land adjoining Rickneys Quarry is Preferred Area 2 (PA2). Mineral working within Preferred Areas will only be permitted when the application satisfactorily fulfils the requirements of the proposals for that area as identified with the inset maps. For PA2 this specifies "Access: Via the existing access from the B158, to/from the north" and "Specific Considerations: Working of this site would be considered as an extension to the existing Rickneys Quarry." It also provides that existing dwellings are in close proximity and that appropriate buffer zones will be required in order to minimise any impact of extraction. The requirements also refer to, amongst other things, additional planting at an early stage to strengthen existing hedgerows to Chapmore End and Rickneys/Rickneys Cottages, safeguarding ancient woodland, and ensuring that the PRoW network is maintained and kept safe at all times. Advice from the EA states that this is a sensitive site in terms of potential pollution of the groundwater resource, that restoration would be to a lower level than existing and that the need for landfill will be resisted.

40. Policy 4 provides that proposals for aggregate extraction outside Preferred Areas would be refused unless; i) the landbank is below the required level and there is a need that cannot be met from the identified areas, and ii) the proposal would not prejudice the timely working of Preferred Areas, or iii) the sterilisation of resources would otherwise occur. Mineral extraction is encouraged by Policy 5 where any significant mineral resource would otherwise be sterilised. Policy 9 concerns the contribution to biodiversity, and seeks long-term overall enhancement to local biodiversity through restoration or by conditions and obligations.

[35] Extracts from the MLP are included in HCC2 Appendix 1.

41. Policy 11 presumes against development that would have an unacceptable cumulative impact on the environment in relation to schemes occurring either concurrently or successively. Policy 12 deals with landscape and provides, amongst other things, that planning applications may be refused where there is significant local landscape intrusion and loss of important landscapes or distinctive landscape features. Policies 13 and 14 deal with reclamation and afteruse, respectively. Mineral development will only be permitted when the provisions for vehicle movement are such that traffic generated would not have an unacceptable impact on highway safety, the effective operation of the road network, residential amenity or the local environment (Policy 16). Criteria for the control and operation of mineral development are set out in Policies 17 and 18. Policy 17(iv) provides that development would not be permitted if it would have a negative quantitative and/or qualitative impact on groundwater resources, unless appropriate measures can be imposed to mitigate any harmful effects. Policy 18(ii) requires a satisfactory restoration landform, which has the appearance of one created naturally, set harmoniously within the surrounding landscape, and consistent with the character of the area. Policy 18(viii) concerns noise intrusion, (ix) air and water quality, and (x) PRoW.

42. EHDP Policy GBR1 provides that planning applications within the Green Belt would be considered in line with the provisions in the *Framework*. Policy HERT4 of the EHDP allocates land to the south of the appeal site for residential development to accommodate a minimum of 150 homes, with around 50 dwellings provided to the north of Sacombe Road by 2022; and, subject to the satisfactory previous phased extraction of mineral deposits on the neighbouring site, around 100 homes to the west of the B158 Wadesmill Road between 2022 and 2027.[36]

43. Consultation on a review of the Minerals Local Plan (eMLP) was undertaken by HCC between December 2017 and February 2018.[37] This consultation draft did not include the appeal site as a Preferred Area for sand and gravel extraction. HCC has considered the results of site selection work and the potential site options, and it is programmed to submit the plan to the Secretary of State in the winter of 2018/2019 and for it to be examined in the spring of 2019.

44. The designated plan area for the Bengeo Neighbourhood Area Plan (BNAP) was approved by East Herts District Council on 27 June 2017. There has been a questionnaire and public consultation. Bengeo Field is identified in a draft as an area of designated local green space.[38]

National policy and guidance

45. Aggregates are defined in the Glossary to the revised *National Planning Policy Framework* 2018 (hereinafter the *Framework*) as minerals of local and national importance, which are necessary to meet society's needs.[39]

[36] ID99.
[37] CD22.
[38] ID71.1, ID96, ID106 and ID107.
[39] This revision was published during the adjournment and the parties were given the opportunity to comment.

Paragraph 203 states that it is essential that there is sufficient supply of minerals to provide the infrastructure, buildings, energy and goods that the country needs. The *Framework* states that planning policies should provide for the extraction of mineral resources of local and national importance, along with setting out criteria or requirements to ensure that operations do not have unacceptable adverse impacts on the natural and historic environment or human health, taking into account cumulative effects of multiple impacts from individual sites and/or a number of sites in a locality (paragraph 204).

46. Mineral planning authorities should plan for a steady and adequate supply of aggregates by, amongst other things, preparing an annual Local Aggregates Assessment (LAA) on a rolling average of 10 years' sales data and other relevant local information, and maintaining a landbank of at least 7 years for sand and gravel, whilst ensuring that capacity to supply is not compromised, but noting that longer periods may be appropriate to account for types of aggregate, locations relative to markets, and the productive capacity of permitted sites (paragraph 207).

47. Paragraph 205 provides that great weight should be given to the benefits of mineral extraction, including to the economy.

48. Paragraphs 133,134,143,144 and 146 of the *Framework* set out relevant policy for Green Belts, which is considered in more detail later in this report.

49. Paragraph 170 provides that decisions should contribute to and enhance the natural environment by, amongst other things; protecting and enhancing valued landscapes, sites of biodiversity, or geological value and soils in a manner commensurate with their statutory status or identified quality in the development plan; recognising the intrinsic character and beauty of the countryside, and the wider benefits from natural capital and ecosystem services – including the economic and other benefits of BMV agricultural land, and of trees and woodland; minimising impacts on and providing net gains for biodiversity; preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution. Development should wherever possible, help to improve local environmental conditions such as air and water quality. Footnote 53 states that where significant development of agricultural land is demonstrated to be necessary, areas of poorer quality land should be preferred to those of a higher quality.

50. The principles for determining applications include refusing permission for development that would result in significant harm to biodiversity that cannot be avoided, adequately mitigated, or, as a last resort compensated for. In addition, paragraph 175 provides that development resulting in the loss or deterioration of irreplaceable habitats (such as ancient woodland) should be refused, unless there are wholly exceptional reasons.

51. Paragraph 180 provides that decisions should ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. It adds that potential adverse noise impacts should be mitigated and reduced to a minimum – and should avoid noise giving rise to significant adverse impacts on health and the

quality of life, having regard to the *Noise Policy Statement for England* (NPSE).

52. Planning decisions should, in accordance with paragraph 181, sustain and contribute towards compliance with relevant limit values or national objectives for pollution, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Paragraph 183 provides that the focus of decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes), and that these regimes should be assumed will operate effectively.

53. The *National Planning Practice Guidance* (hereinafter the *Guidance*) sets out guidance on planning for mineral extraction, including assessing environmental impacts, restoration and aftercare. It refers to a noise limit at noise-sensitive properties that does not exceed the background noise level by more than 10 dB(A). Where it would be difficult not to exceed that level without imposing unreasonable burdens on the mineral operator, the limit should be set as near to that level as practicable, and should not exceed 55 dB $L_{Aeq\ 1h}$. It adds that increased temporary daytime noise limits of up to 70 dB $L_{Aeq\ 1h}$ for periods of up to 8 weeks in a year should be considered to facilitate essential site preparation and restoration work and construction of baffle mounds where it is clear that this would bring longer-term environmental benefits.

54. The *Guidance* provides that some areas may have been subjected to successive mineral development (such as aggregate extraction) over a number of years, and the cumulative impact is capable of being a material consideration when determining individual planning applications. It also notes that where working is proposed on BMV agricultural land restoration and aftercare should enable the land to retain its longer term capability.

Other regulations and policy

55. The EA's *Approach to groundwater protection* November 2017 version 1.1 at N8, concerning the physical disturbance of aquifers, states that within SPZ1 the EA will normally object in principle to any planning application for a development that may physically disturb an aquifer.

56. The storage of fuel for mobile plant and machinery is regulated by the Control of Pollution (Oil Storage) (England) Regulations 2001. Fixed tanks and mobile bowsers must include certain design features that are specified in the Regulations.

The case for Hertfordshire County Council (HCC)

The following summary of HCC's case broadly follows HCC's closing submissions to the Inquiry, with additional reference where necessary to the evidence adduced.[40]

Overview [41]

57. On the appeal scheme (1.75 Mt) the appellants' main witness agrees that it is unacceptable.[42] His agreement is fatal to the appeal scheme. Given the lack of evidence in support of the appeal from the appellants' main witness, there is no need to assess it further – and it would be wrong in principle for the Secretary of State to consider granting it when its own promoter cannot support it. The appeal scheme was correctly abandoned in SoC1 and was then resurrected in order to allow the 1.25 Mt scheme to piggy back on it.

58. If this central submission is not accepted, the 1.75 Mt scheme is in plain breach of the key requirements of MLP Policy 3 and PA2, which are compliant with the *Framework*. Those breaches cause significant harm to areas specifically excluded from mineral development, and there are no other material considerations to outweigh the total harm, no very special circumstances (VSC) to justify the inappropriate development in the Green Belt, and the 1.75 Mt scheme should be refused. The same applies to the 1.25 Mt scheme.

59. The justification for the breaches of Policy PA2 in both schemes appears to be only that joint working with Hanson to deliver a PA2 compliant development was, and is, not possible in time consistent with delivery of Policy HERT4. But joint working is being pursued and can deliver a PA2 compliant scheme. Furthermore, there is no sterilisation effect and no timing problem.

Green Belt

60. HCC has correctly applied the judgment in *Samuel Smith* about visual impacts, and the judgment in *Europa Oil* about appropriate development. *Europa Oil* does not say that development which can be appropriate in the Green Belt will maintain its openness – nor does the *Framework*. Mineral extraction alone may not be inappropriate development in the Green Belt depending on its detail.

61. The development outside PA2 by virtue of its location on the slopes does not preserve the openness of the Green Belt. The bunds, the roads, the plant areas and associated activity are inappropriate development and impact openness. The bunds are far more intense and prominent in the 1.75 Mt

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[40] ID110 and ID4.
[41] HCC4.
[42] The Inspector's note of the exchange at the Inquiry referred to here is that Mr Symes was asked in cross-examination whether he was saying that the 1.75 Mt scheme was unacceptable. His reply was that this had been made clear from the start and that the 1.25 Mt scheme was proposed to address areas of concern. In re-examination Mr Symes was asked about the planning merits of the larger scheme. He replied that he would not have put in the application if it was not acceptable. He added that the larger scheme would have a greater impact, but is an acceptable scheme.

scheme than would be so in a PA2 compliant scheme. PA2 was carefully redrawn during the progress of the MLP to meet Green Belt and landscape concerns. Bunds greater than 4 m in height would be required for the stockpile area because of the sensitivity of the eastern slopes and the topography. SoC1 makes HCC's case for it on the 1.75 Mt scheme constituting unacceptable inappropriate development here.

62. The only matter here which could conceivably constitute VSC is need. The other "benefits" claimed by the appellants are required from any scheme and do not justify inappropriate development in breach of policy. There can be no VSC because there is no need, no significant risk of sterilisation, no urgency, and/or a policy compliant route is available.

Landscape [43]

63. The landscape harm from the 1.75 Mt scheme is obvious and significantly greater than any PA2 compliant scheme would generate. PA2 was pulled back to within the visually contained plateau.[44] That area could be acceptable, but the eastern slopes were excluded, primarily because of visual impact.

64. Even on the appellants' analysis there would be a substantial moderate adverse impact during the life of the extraction. Phase 4 and the stockpile area would have a major/moderate adverse impact by themselves. In visual impact terms, all the differences between the 1.25 Mt and 1.75 Mt schemes assessed by the appellants are a function of Phase 4 and the stockpile area, heavily influenced by the vastly increased and more prominent bunding, losing long views with the revised contours.[45] The bund schedule is stark as to the quantity of additional bund required outside PA2.[46] This is highly significant, and the fact that it would be temporary does not assist – that will always be the case with mineral extraction.

65. There is the added issue, on restoration, of the permanent unnatural contours – the bowl effect. That has been forced on the appellants by their refusal to amend the red line boundary of the appeal site. When the unnatural contours were highlighted, the appellants proposed smoothing the contours through Phase 4 and further east to "now mimic" the local topography.[47] This would have required some work outside the red line, but the appellants reverted to the unnatural contours to avoid having to resubmit an amended red line. The very fact it proposed a scheme to mitigate the unnatural contours proves HCC's case. In any event, the contour plans make HCC's case for it. It is not possible to revert to the v9 red line by condition, and there is no section 106 obligation on it. Thus the harm to contours and loss of views from the PRoW network is a result of avoiding red line fees.

[43] HCC3.
[44] CD31 paragraph 3.4.99.
[45] 135 m of extra bunds and 605 m of bunds of 4 metres or more in height.
[46] ID22.2.
[47] ID51 and CD3 Plans - Restored Landform No.1217/R/1 V9.

Noise and amenity [48]

66. The appellants have designed bunds and buffer zones to "just meet" the 10 dB increase limit in the *Guidance*. There is no room for the background noise assessment or noise modelling to be even slightly wrong.

67. For both schemes the baseline assessment at Sacombe Road is flawed because the device was in a hedge in windy conditions, where rustling leaves close to the microphone could have affected the results. This is the only realistic explanation as to why the background level there is higher than at The Orchard.

68. The appellants' assessment of the sound power levels (SPL) for plant does not confirm with standards regarding representative time periods for measurement, including a sufficient number of operating cycles during normal operations, and is inconsistent with data from the manufacturers of the plant. The height of the noise source is important to the calculations on propagation. But the dropping of sand and gravel from height, into a lorry at height, appears to have been wrongly modelled.

69. PA2 requires that appropriate buffer zones will be required in order to minimise any impact of extraction. The appellants' evidence is silent on this. The issue in both schemes could be resolved with 100 m buffer zones at Sacombe Road and The Orchard. PA2 already draws a 100 m buffer at The Orchard, but that has not been followed in the 1.75 Mt scheme, and is only 70 m at Sacombe Road.

70. If HCC's reservations about the SPL calculations and background levels are justified, there would be exceedance of the 10 dB level for a policy compliant increase at The Orchard for the 1.75 Mt scheme; and at Sacombe Road for both the 1.75 Mt and 1.25 Mt schemes. The 1.75 Mt scheme is simply too close to The Orchard, and in breach of the PA2 boundary location. The 1.25 Mt scheme is too close at Sacombe Road. The noise implications would be unacceptable. At the lowest, a condition would be required here.

Public Rights of Way

71. The importance of the existing PRoW network in and around the site has been the subject of consistent and overwhelming evidence from the public. The heavy leisure and sporting use of the site is a function of its physicality and ambience. It is the closest recreational resource to the urban area of Bengeo. The Byway and its links are away from roads, with wide and unimpeded vistas. The 1.75 Mt scheme would require a diversion of the Byway. Informal paths on the appeal site are already well used. These would be unavailable during the quarrying operation, or made more difficult and less attractive.

72. The policy requirement under MLP Policy 18(x) was the basis for the endorsement of PA2.[49] This requires that public rights of way are not adversely affected or, where this is not possible, that good quality, safe and convenient temporary alternative provision is made, and that proposals should enhance the public rights of way network through the creation of new

[48] HCC1.
[49] CD31 paragraphs 3.4.100 to 101.

rights of way. It is to be noted that the enhancement is to the PRoW network, which would not be met by the provision of permissive paths.

73. Securing the alleged “enhancements” is not dependent on accepting the significant harm to the PRoW network by breaching PA2, as it would be equally required under a PA2 compliant scheme.

Need

74. The appellants’ need case amounts to the following: (i) PA2 was allocated to meet a need; (ii) the appellants’ proposals to give effect to that allocation to meet the need are unacceptable; (iii) the appellants have thus failed to play their part in meeting the need here in an appropriate way; (iv) the appellants now rely on the shortfall to which they have contributed and which they can remedy by a PA2 compliant scheme. That approach to need drives a coach and horses through planning policy. Any owner of an allocated site could fail to comply with the terms of the allocation and then argue for a grant of planning permission because it is a needed site. This argument is circular and cannot rationally form the basis for granting planning permission. In any event, the need case is wrong and/or exaggerated.[50]

75. A reliable assessment of the landbank is, and can only be, annual. At the last annual review there was 7.5 years supply on the basis of a apportionment exercise (1.39 Mt pa), and much more on a *Framework*/*Guidance* compliant (10 years sales) approach. Since then Furze Field has been granted.[51] The claim of there being a problem in terms of the current situation is simply wrong. The apportionment approach is far more generous and creates far more flexibility. Fundamentally, that position has been reached without the two main PA sites allocated in 2007 yet coming forward and contributing to the supply. There is ample potential provision – it is just a case of the owners of those PA sites submitting PA compliant schemes (Ware Park), getting an extension of time (RQE) or completing section 106 agreements (BAE site).[52]

76. Even on a mathematical exercise there is no shortfall now and until the end of the year. There is no reason to doubt that RQE (1.24 Mt) will not be granted shortly.[53] The huge release at BAE (which will take supply to 13 years) will occur.[54] The issue is simply timing, as the section 106 on extraction is agreed and the only impediment to a grant is an issue not related to mineral extraction concerning a Country Park.[55]

Policy and planning balance

77. There is no case that MLP Policy 3 and PA2 are out of date in *Framework* terms, and they are broadly consistent with the *Framework*/*Guidance*.[56] MLP Policy 3 only applies within PA2, not outside its boundaries. PA2 requires applications to satisfactorily fulfil requirements for that preferred area as

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[50] HCC2.
[51] ID100.
[52] ID18.
[53] ID16.3 and ID102.
[54] ID25.
[55] ID18 and ID21.
[56] Except that the approach to 7 year land supply is not consistent with the *Guidance*.

identified with the inset maps. The ES is plainly correct that developing the application site as an extension to Rickneys Quarry has "many advantages in terms of planning and environmental impacts".[57] The access and extension points are essential attributes of any acceptable development here – as is compliance with the PA2 boundary. Conversely a failure to work as an extension would bring many dis-benefits, including an access road across the eastern slopes, a need for a new hub area, and development of the whole would not be co-ordinated. Thus the failure goes to the heart of the justification for the allocation in the first place.

78. The 1.75 Mt scheme would extend outside PA2 in four respects; Phase 4, the stockpile area, in the south-western corner of the site, and the road. Each of these elements would have to be justified under MLP Policy 4. The only justification for Phase 4 is that it would be sterilised if not extracted as part of this scheme. That was never claimed when the 1.25 Mt scheme was pursued (and is inconsistent with the 1.25 Mt scheme, which would then be in breach of MLP Policies 4 and 5). For the stockpile area, the highest it is put is that it would provide flexibility, but no details are given as to what that means. Furthermore, the 1.25 Mt scheme is promoted without any suggestion of such a need. The working area could be easily and appropriately accommodated within the phases. There is no reason why the existing access road could not be used. On the south-western corner, this area outside PA2 is not included in the 1.25 Mt scheme, so it is not clear what the need is for this breach.

79. Development outside PA2 cannot be justified under MLP Policy 4. There is no shortfall and/or no significant weight can be attached to any minimal shortfall in the context referred to above. There is no evidence that Phase 4 would be sterilised if this permission was not given now. Even if Policy 4 was met (which cannot be the case here) all the other planning issues would still be relevant.

80. The alleged benefits are nothing of the sort – they are policy requirements, which would have to be provided with any PA2 compliant development. The fact that required enhancements are provided can be no basis for justifying a breach of the specific policy governing applications here.

Justification for a non-compliant scheme

81. From the outset, the appellants have assumed that Hanson would not co-operate, but that assumption is wrong. Hanson and the appellants have made it entirely clear that they have an agreement in principle to co-operate to deliver a joint scheme using the existing access. Hanson "are having and continue to have" discussions with the appellants and the issues are resolvable.[58] There is now no possible basis to doubt that absent granting permission for the appeal scheme, the parties will endeavour to deliver a PA2 compliant scheme – as they should have done from the outset.

82. The appellants' new explanation that this is all dependent on the grant of planning permission for RQE is wrong. Since February 2018 there has been nothing to stop the appellants pursuing a joint scheme under the agreement

[57] CD2 paragraph 3.2.7.
[58] ID13.2.

in principle to deliver a PA2 compliant development. All parties have a clear incentive to secure a PA2 compliant joint scheme as soon as possible or the opportunity may be lost with progress of the eMLP.

83. The alleged urgent need to extract to allow HERT4 to come forward has been at the heart of the appellants' case since 2012, when there was a hope of a much larger housing allocation. The only possible sterilisation issue now relates just to the potential for conflict between HERT4 and mineral extraction at the southern boundary of Phase 1. The first attempt to demonstrate this possible sterilisation effect was in ID49, which relies on an arbitrary 100 m separation distance from the red line boundary of the appeal site. But the correct measurement is from the closest façade to the edge of the working on the inside of the bund.

84. The appellants' case is that the 1.75 Mt scheme is acceptable in terms of noise/disturbance/air quality with a separation distance of just 43 m from the nearest house at The Orchard.[59] The residents of HERT4 are not entitled to a greater separation distance than existing residents of The Orchard. On the appellants' own case the correct separation distance can be just 43 m. The 43 m could be achieved just by bunds and the existing masterplan arrangements for the HERT4 site without any sterilisation.[60] ID49 is wrong and misleading.

85. Even if the 70 m separation distance is used (for e.g. noise issues) there is no calculation of the area sterilised or plan showing the area sterilised. In any event, even if any weight could be placed on ID49, the "sterilisation" would amount to 49,000 tonnes, but the appellants are leaving 0.85 Mt in the ground to achieve the restored landform. Furthermore, there would be significant necessary "sterilisation" under the bunds. There is thus no sterilisation case.

86. Policy HERT4 is subject to "satisfactory previous phased extraction on the neighbouring site" before the 100 houses closest to PA2 could come forward between 2022 and 2027. If there were adequate separation distances then that would be satisfactory for the purposes of this policy. Policy HERT4 does not require the full extraction of PA2 or even just Phase 1. There is no case put by the appellants that a PA2 compliant scheme could not be carried out well within that timescale. If there is a requirement to make the new contours fit with the development at HERT4 that simply requires proper planning and would not be undermined by any timing issue. There is no timing problem.

Conclusions

87. The area of PA2 has been specifically and carefully pulled back to avoid intrusion on to the eastern slopes, and drawn to create an appropriate buffer zone to The Orchard, as well as ensuring that well-used PRoW to the east were not crossed or diverted. In doing so, PA2 has determined where mineral extraction may preserve the openness of the Green Belt, and thus conversely where mineral extraction would not preserve openness. Even within that PA2

[59] ID95.1.
[60] APP8 Appendix D.

area, whether mineral extraction should be permitted will depend on the specifics of the application, the impact on openness of the Green Belt and other policy requirements.

88. The 1.75 Mt scheme has the Stockpile, Phase 4, associated bunds and the access road outside the PA2 boundary, with all the consequences for the eastern slopes, the PRoW, the landscape, the Green Belt and character of the area. The 1.25 Mt scheme has a wholly unnecessary access road running straight down the eastern slopes in breach of PA2. There would be significant lorry activity in this countryside setting, a new junction and all the associated activity, with unacceptable impact on the landscape and harm to the openness of the Green Belt. It would be there for many years (even if ultimately removed) and is undoubtedly a significantly urbanising feature. It is inappropriate development in the Green Belt. The proposal also would have unacceptable impacts on the PRoW network. It is thus respectfully impossible for the Secretary of State to find VSC here, or other material considerations to justify a breach of PA2.

The case for Stop Bengeo Quarry Rule 6 party (SBQ)

The following summary of SBQ's case broadly follows SBQ's closing submissions to the Inquiry, with additional reference where necessary to the evidence adduced.[61]

Introduction

89. SBQ objects on two grounds. (1) The appellants acknowledge that, without mitigation, both the 1.75 Mt and 1.25 Mt schemes pose an unacceptably high risk of pollution to a vital groundwater source. But the measures proposed by the appellants to mitigate this risk are inadequate to protect the chalk aquifer. (2) The HIA has not demonstrated that the impact on vulnerable groups within the community as a result of exposure to short-term peak concentrations of particulate matter (PM) would be acceptable in the context of the policy framework.

Water pollution

90. Policy 17(iv) of the MLP and the *Framework* both put the burden on the appellants to prove that mineral extraction would not have a negative quantitative and/or qualitative impact on the water environment, including, groundwater resources, unless appropriate measures can be imposed to mitigate any harmful effects. While the eMLP is not yet part of the development plan, it can be given weight as a material consideration. It emphasises the balance between the need for mineral extraction and the potential impact on the local community and environment.

91. The appellants acknowledge a 'medium' risk, with a significance of impact of 'major', to groundwater quality from increased turbidity if workings mobilised and transported fine materials into the aquifer. Contamination of the aquifer as a result of accidental spillage of oil and fuel is acknowledged as a hydrocarbon 'high' risk, with a significance of impact of 'major'. The appellants' proposed mitigation relies on retaining a protective layer of

[61] ID108.

residual materials above the chalk, and a variety of measures to regulate the storage and use of fuel, along with training and protocols for any spillage.

92. Even if a 5 m protective layer of residual material was sufficient to act as a filter in a range up to 300 m from Wadesmill PS (which SBQ does not accept), there is no evidence to support the contention that a lesser layer would be adequate to perform the same function at greater distances. A purely distance based approach is not appropriate. Flow rates depend on the presence and extent of water-bearing fractures and karstic features in the aquifer.

93. Such features could exist across the whole of the appeal site, so the same thickness of overlay should be left across the entire site. If it is decided not to undertake further investigation of the chalk surface, which SBQ considers is necessary, a condition must be imposed to guarantee the highest level of protection possible.

94. The assumption that the residual thickness mitigation measure would be sufficient is based on inadequate data concerning the chalk including: the contours of its rockhead on which the residual layer would rest and from which its thickness would be measured; and, the location and nature of any fractures and karstic features.[62] The appellants' contours of the rockhead appear to have been created using a smoothing programme to determine its elevation between specific data points. However, due to the way in which the geology of the site was formed, it is unlikely that the rockhead is smooth.

95. Photographs taken in the 1990s during the quarrying at Rickneys show that the chalk had been exposed.[63] The most likely explanation is that this occurred because the chalk rockhead was uneven, which is highly likely to be so for the appeal site.

96. But the appeal scheme proposes using these contours to generate a 3D GPS model to guide excavation of the site. Applying the residual layer mitigation measure on the basis of flawed rockhead contours, with the likelihood of significant irregularities (i.e. up to a few metres high) in the depth of the layer of retained gravel, would negate its alleged protective qualities. This is apparent from the appellants' Isopachyte maps.[64] So this methodology is inappropriate here.

97. Exposure of the chalk would pose a risk of pollution, even if the exposed chalk was not fissured. Furthermore, it would not be sufficient to rely on the operator not wanting to expose the chalk because it would contaminate the aggregate. It is reasonably foreseeable that without further information about the chalk rockhead, accidental and potentially adverse exposure of the chalk would occur if the site was worked.

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[62] SBQ1 Edworthy Report cited in Prof Brassington's suppPoE.
[63] ID54.
[64] ID31.1 and ID31.2. The 1.75 Mt scheme shows the thickness of the retained layer could be anything from 5-4m in places, where at least a 5m protection layer would be required. In the 1.25 Mt scheme the thickness of the retained layer could be anything from 3-2m, in an area of the site which should be leaving at least a 3m protection layer. If there is a peak of up to 2m in the chalk at either of these points, the protective layers would be reduced, and in the 1.25 Mt scheme the protective layer could be rendered non-extant.

98. An appropriate geophysical survey could provide more detailed information concerning the contours and features of the chalk rockhead. But it would be technically difficult to detect and identify the fractures and karstic features within the chalk itself with the accuracy necessary to assess the adequacy or otherwise of the proposed mitigation measures. Due to this difficulty, the precautionary principle should be applied and permission for the development refused.

99. The HIA concludes that accidental spills can be considered to be a reasonably foreseeable consequence of quarrying activity. There is no evidence as to whether, in the event that the chalk aquifer was to be contaminated, AW would be able to source an output equivalent to that of the Wadesmill PS (which produces 60% of the local supply).

100. Various sources of, and pathways for, hydrocarbon and other pollution risks have not been considered. These include the use of a soakaway to an oil interceptor in the load out area in both schemes, where the trapping and temporary storage of oil underground would risk leaks going unnoticed. In the 1.25 Mt scheme, the soakaway would be in an area where the protective layer would be at its thinnest. Furthermore, the use of chemicals in weed control during restoration, boreholes as a potential pathway for pollutants, and the risk from an oil tanker accessing the site on a frequent basis to refill the site's storage tanker, have not been addressed.

101. A major spill would necessitate an immediate response. The standard leaks and spills mitigation measures proposed would be wholly inappropriate in the context of this site. Spill kits, building a bund of sand around a medium spill, or digging a hole in the ground to prevent further spread, would be useless as they would not prevent spilled contaminant from filtering down into the aquifer. The only effective mitigation measure would be immediately excavating the affected sand and gravel and removing it to a containment area from whence it could be securely removed.

102. As it is not possible to assess all development pollution risks at the initial stage, it is prudent to include in conditions a provision regarding hydrogeological impact assessments to be carried out after each phase of the development. This would be necessary to ensure that any new risks arising were assessed and mitigated as soon as possible.

103. Mineral extraction may have taken place at other sites underlain by the chalk aquifer, but no evidence has been provided about the hydrogeological and/or pollution risks assessed for these sites. There is no basis to make any comparison between these and the appeal site. A decision on compliance with MLP Policy 17(iv) must be made on the basis of the specific site and operational programme.

104. Comment by the EA and AW was on the basis of the documents then available about the scheme and its mitigation. The EA commented in November 2017 that it does not have in-house capability and competence to carry out non-intrusive geophysical surveys to estimate the thickness of the top soil layer, relief and heterogeneity of the top of the chalk.[65] The Inquiry

[65] CD13 Doc4.

has now heard more evidence about these matters, which provides cogent and compelling reasons to depart from the EA's advice.[66]

105.A precautionary approach should be taken and planning permission should be refused. Where there are no permitting and/or licensing regimes active on a site, all mitigation has to be dealt with and enforceable within the planning system. Permission should not be granted without highly prescriptive mitigation measures. It is important to be able to review and comment on the appropriateness of mitigation measures and possible conditions. Unfortunately, this cannot be done on the basis of the evidence before the Inquiry, resulting in doubt about the adequacy of the mitigation measures proposed to render the development compliant with MLP Policy 17(iv).

Air quality related health impacts [67]

106.The MLP is silent on the issue of health impacts, although it does state that the quality of the environment plays a key role in both maintaining and enhancing quality of life. The *Framework* requires that minerals extraction should not have any unacceptable adverse impacts on human health. Planning decisions should sustain and contribute to compliance with pollution limit values and objectives, but should also identify opportunities to improve air quality where possible or at the very least mitigate the impacts on air quality.

107.The HIA's evidence in relation to health impacts in the wider population is not in dispute. However, the HIA recognises that health effects are observed in the wider population when it is exposed to higher concentrations of PM, and it acknowledges that there is no lower threshold concentration of PM which is fully protective of human health. SBQ's concern is the extent to which air quality impacts from the proposed operation would be responsible for health effects on people in the local community, in particular on especially vulnerable groups within the site-specific population.

108.The HIA concludes that there will be an adverse impact on vulnerable groups when exposed to short-term peak concentrations of PM, which it categorises as 'minor' and assesses it as 'not significant'. But the HIA, in its treatment of this risk, has been unable to unequivocally demonstrate that there will be no unacceptable adverse health impacts on the vulnerable members of the site-specific community.

109.Health effects can occur even when a project is in compliance with relevant air quality limit values for pollutants. IAQM 2017 guidance comments that the assessment of health impacts is a matter for an HIA, and not an air quality assessment.[68] Whilst it is accepted that the likelihood of health impacts reduces in line with exposure to PM, it is not sufficient to rely on compliance with air quality limit values alone as evidence that there will be no adverse health impact. The fact that a site is compliant with air quality limit values is not determinative of the issue of health impacts. The Government's aspiration in the draft *Clean Air Strategy* is to reduce concentrations of PM

[66] *R.(On the application of Jones) v Mansfield DC* paragraph 54.
[67] SBQ2.
[68] CD35.2 paragraph 7.11.

over the next decade, so small contributions should not be treated as insignificant. This is especially the case in areas like Hertford where the $PM_{2.5}$ baseline is already at or above the WHO guideline of 10 $\mu g/m^3$.

110. The HIA does acknowledge the existence of an especially vulnerable sub-set of the site-specific population, but it does not attempt to quantify that population or give consideration as to its baseline health. The exposed population could run to hundreds or thousands of individuals, including many who would fall into the especially vulnerable category. The 496 children currently attending Bengeo School is an important sub-set of this vulnerable category, and the total 'population' of the primary school over the lifetime of the scheme would be much greater.

111. The HIA does not define 'minor', and the difference between 'minor adverse' and 'adverse' is entirely unclear. This uncertainty is important and suggests caution in making pronouncements as to the acceptability or otherwise of health impacts on small groups. There is statistical information available based on which it is possible to quantify the baseline health of even a small population, for the purposes of assessing likely health impacts. The asthma prevalence in the local population is 5.9%. Applying that percentage to the 'population' of Bengeo School would indicate about 30 asthma sufferers. In reality, there are currently 46 children at the school with the diagnosis, which is closer to 10%. There is, therefore, a basis on which to quantify health problems and therefore impacts on a small-scale population.

112. The HIA does not rule out health consequences for individuals with specific illnesses or conditions, and has done nothing to allay parents' distress and fear for their children's future safety, especially where children might be subject to multiple vulnerabilities. Evidence about individuals cannot be disregarded. If the health impacts mentioned in the HIA cannot be ruled out, this would be an unacceptable adverse impact and should preclude permission being granted.

113. The results of the appellants' air quality assessment are accepted uncritically in the HIA. The emission factor used within the ADMS model is based on the whole operational area of each Phase, rather than a smaller percentage of that area reflective of actual hourly quarry activities (such as 1 ha or 100 m^2). This has the effect of 'double-diluting' the pollutant emitted by the quarry. By spreading the PM generated by the site over an unrealistically wide surface area of the quarry, the emission is diluted at source before being diluted further as part of the modelling of the dispersion effects.

114. This inappropriate modification could lead to an underestimation in the figures modelled by at least a factor of 10. This might not be of significance when looking at the annual average concentration, but it could mask any significant short-term peak concentrations. It is these concentrations, rather than the annual average or long-term exposure that pose a risk to health as a result of this development.

115. The emission factors themselves are subject to inherent uncertainty, and the moisture content of the material would be variable, especially in hot weather conditions. It is therefore questionable whether a worst-case scenario has been modelled.

116. The distinction between an annual average and hourly or 24 hours average, in terms of the associated health impacts, is crucial in this context. The health risks identified to especially vulnerable groups arise from the short term averages. However, there is a complete absence of short-term modelling in the appellants' assessment, and no information concerning the very concentration levels on which the HIA confidently concluded a 'minor adverse' and 'not significant' impact.

117. Short-term peak concentrations could be associated with reduced quality of life effects for vulnerable individuals, such as reduced mobility and increased periods of staying indoors due to the need to avoid exposure.[69] Weather conditions producing these peak concentrations are consistent with hot summer days when people want to be outside. Such limitations on mobility would not be consistent with the high quality of life required to be protected by the MLP. This would also not be an acceptable health impact. Again, although this health impact was referred to obliquely in the HIA, the focus was on the actual exacerbation of symptoms and did not give any obvious consideration to this lower scale, but nonetheless unacceptable health impact. There is a wider range of health effects associated with PM exposure that has not been expressly addressed in the HIA.

118. The IAQM 2016 data set, which is one of the few UK data sets for quarry emissions, indicates an underestimation here of the effects of the quarry within a broad envelope of out to 400 m, which is a distance that would include Bengeo School.[70]

119. The appellants' assessment did not quantitatively assess respirable crystalline silica (RCS), nor was it dealt with in the HIA at all, despite the fact that it is agreed between Professor Sokhi and Mr Barrowcliffe that RCS is a hazard to health.

120. No Dust Management Plan was submitted with the applications. It would not be sufficient to produce this later, as it is necessary to determine whether any unacceptable impacts of the development could be rendered acceptable in planning terms by mitigation.

121. The HIA's assessment of significance and Professor Sokhi's conclusion of no material risk are undefined and unquantified, and entirely subjective. Given the lack of a commonly accepted framework, and the consequences of coming to a decision on significance in the planning context, this is not something that should be ascribed by an HIA. An HIA should comment on the magnitude of the risks identified and leave the attribution of significance to the decision maker.

Conditions

122. The absence of the details of specific mitigation relied on by the appellants in assessing risks from the site will be problematic in coming to a decision on the acceptability or otherwise of the proposed development. If permission was granted these details would be required and, given site-specific concerns

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[69] SBQ2 Figure 5.2 showing health pyramid of air quality related health impacts.
[70] CD35.1 Appendix 2.

here, it is not unreasonable to expect this information to be available so as to inform the decision-maker and to reassure the local community. The appellants need to show that the risks associated with the site have been properly and comprehensively assessed, that they can be mitigated, and that the mitigation can be put in place by way of planning conditions. On the evidence before the Inquiry, the appellants have failed to do so.

123.SBQ has submitted a proposal for water management conditions and regarding air quality monitoring, which in the event that planning permission is granted should be imposed to afford the groundwater resources and the local community the highest level of protection.

Conclusions

124.The development cannot be permitted unless the appellants can demonstrate that appropriate measures can be imposed to mitigate the impact. The mitigation measures proposed are wholly insufficient to mitigate the serious potential impact of pollution on the chalk aquifer. Planning permission for the proposed development, whether the 1.75 Mt or 1.25 Mt schemes, should therefore be refused. The HIA has been unable to demonstrate that the health impact for vulnerable groups of the local community arising from short term peak concentrations of PM would not be unacceptable for the purposes of the policy framework. On this basis, planning permission should also be refused.

The case for Cllr Stevenson Rule 6 Party

The following summary of case broadly follows Cllr Stevenson's closing submissions to the Inquiry, with additional reference where necessary to the evidence adduced.[71]

Summary

125.The appeal is unsound primarily for the loss of a landscape of outstanding value to the whole community of Hertford, and the absence of any real need for the sand and gravel. Secondary factors concerning the transport system, the risk to water supply and air quality, along with concern about the availability of financial assets to deal with any unforeseen problems, add up to further reasons why the proposal is unsound. It is unsound to locate any quarry so close to any densely populated area without more site specific and quantitative studies of the real risks.

The effect on housing development

126.The driving force for the timing of the application was to avoid an objection to an application for housing development on the HERT4 site due to sterilisation of minerals. It is claimed that the HERT4 allocation is important to the EHDP. But it would only provide 150 dwellings in the context of the 20,000 or so homes in the plan. The contribution from HERT4 would be insignificant in the context of the County wide obligation for 120,000 homes, and would only amount to about 5% of the obligation for Hertford, where infrastructure limitations restrict the allocation for the town. There are also

[71] ID109 and AS1.

landscape issues with the development of the HERT4 site. EHDP simply recognises that if the land were to be subject to mineral extraction, thereby changing the landscape, then it would be suitable for 100 homes. There is no urgency for mineral development so as to meet housing obligations, as this is driven by the larger schemes in the plan, especially Gilston garden town development and Bishops Stortford North.

Landscape significance

127.The landscape at Bengeo Field is of outstanding local significance and a valued resource that is used extensively by Hertford residents, including for health walks. The emerging BNAP recognises the importance of this green space. The appellants' restoration plans have no credibility. The existing gentle hill would become a depression. The open vista from the Byway at its current elevation, which gives the landscape its special appeal, would be permanently destroyed. Turning a convex shape into a concave shape would not restore the land to its previous state.

128.The local community has already lost landscape due to gravel extraction, at what is now Waterford Marsh and at Rickneys. The latter lies abandoned and only partially restored. The cumulative effect on the community over the past 40 years needs to be taken into account. Bengeo Field is the last and best of the sites available for landscape and accessibility, and it is an historic link between the settlements of Hertford and Chapmore End. The special significance of the site makes the proposal especially damaging to the community.

Comparison with BAE Hatfield site

129.There is no comparison between the appeal site and the former BAE Hatfield site in terms of their suitability for mineral extraction. Hatfield aerodrome was part of a heavy industrial complex, from which the public was excluded whilst a military site, and which now needs remediation. It is now unsuitable for any other purpose. It is relatively remote from Hatfield and there have been no similar objections from Hatfield residents to those that have been raised at Bengeo Fields. Plans for a Country Park have broad local approval, and notwithstanding the temporary delays in signing section 106 agreements, the site looks certain to be developed for sand and gravel extraction in due course.

Effect on Bengeo Primary School and neighbouring community playing field

130.The school, along with the nursery, which is used as a drop-off area for the school, and the playing field, are located close to the appeal site. Parents have reported that this long drawn out decision process has already had a negative impact on the school, with a decline in application numbers due to publicity about the threat of the quarry. Parents do not want to put their children at risk.

Impact on local transport

131.There is a recognised need in Hertford for transport schemes to relieve acute traffic congestion. The B158 is heavily congested at peak times, leading to rat-running through residential roads, especially when the A414 is blocked. The 2018 local transport plan includes a major shift towards sustainable transport.[72] This will change the way HCC considers new development. Its response to the appeal scheme was based on the former local transport plan, which predates more recent increases in traffic volume.

132. The MLP clearly stipulates, for good reason, that the existing access to Rickneys Quarry should be used. The proposed access is unacceptably close to the Sacombe Road roundabout compared with the existing access to Rickneys Quarry. The appellants have, for many years, had the option of commercial negotiations for use of this access. Their inability to do so should not weigh in favour of allowing the appeal.

133. Mixing HGVs with other vehicles worsens road safety. Line of sight for other road users would be impaired by queuing HGVs. There would be nothing to prevent HGVs in convoy during peak hours, which could block the B158 or the A602. Averaging out HGV movements over the working day ignores the fact that the highway impact of an HGV is much greater than that of a passenger vehicle. HGVs should be disallowed into or out of the site during peak hours, and at other times restricted to no more than one vehicle every 15 minutes. The impact of HGV traffic would be severe and would conflict with the sustainable transport aims of the new local transport policy.

134. The Byway is already a sustainable transport route between Chapmore End and Hertford, and it makes no sense to destroy its acceptability.

Quality of public consultation

135. Public consultation has been a bare minimum, and the appellants have sought to blame the community for a lack of engagement. There has been no engagement by the appellants with the BNAP process.

Risks to water supply

136. There is a clear risk to the water supply that serves local farms and a brewery.[73] The perception of the potential risk to the brewery's water quality may affect the continuation of the business. In the longer term there is a risk to the public water supply because of a growing shortage of water in East Anglia, but resultant changes in strategy have yet to be reflected in a new regulatory approach. In the absence of a site specific study the true risks have not been quantified.

Risks to air quality

137. The appellants have followed the industry recommended minimum requirements. But pollutants cause an increase in the rate of loss of lung tissue, which may take years to manifest as a disability. Past experience with other pollutants indicates that it has taken time for legislation to catch up with medical science and to introduce protective measures. Current requirements were designed for smaller quarries in more remote locations, with protection for quarry workers, not neighbouring urban populations.

[72] ID104.
[73] ID85.

138. In the context here, where there are already high levels of pollutants from traffic congestion, it is untenable to claim that the contribution from the quarry would be insignificant. This misunderstands the likely effect on vulnerable groups within a population. SBQ has cited peer reviewed evidence about the medical effects of incremental increases in pollution.

139. No site specific study has been undertaken about the local Kesgrave geological formation, but there is evidence that this formation does produce fine particles when disturbed, which may carry in the air. Wet sand can dry out. There is an unquantified air quality risk to population health, especially within 400 m of the proposed quarry.

Financial bond

140. There is a long track record of HCC being forced to engage in prolonged enforcement battles with quarry operators. The appellants' employees seem to be doing their best to operate responsibly, but the financial resources available as a contingency for restoration have not been clarified. An evasive response to questions about this at the Inquiry adds weight to the likelihood of financial failure, and to the financial risk to the community and HCC. There is very clear evidence that a £2 million bond is justified in this case.

The case for interested persons opposing the scheme

The following persons appeared at the Inquiry objecting to the proposed development, and a summary of their submissions is included below, which in some instances includes extracts from written submissions made in commenting on the HIA. Some of the submissions refer to the health conditions of individuals, but for confidentiality reasons the following summaries omit these particular references, whilst still making the general points about health impacts raised in evidence.

141. Andrew Smith (local resident) [74] Some 40 properties in the Dell at Chapmore End are accessed from the B158 by a drive that is located near to the summit of a hill. Visibility from the drive is restricted by the curved road to the south and by the summit of the hill to the north. The B158 is used by commuters to avoid congestion on the A414. It is a fast and dangerous road. Accident statistics show nine collisions over the past five years along this part of the B158, including a fatality involving a vehicle turning into the drive. Drivers will attempt to overtake slow moving HGVs, especially when they are climbing the long gradual hill from the proposed quarry entrance. They would also spill mud and gravel to add to the risk, as occurs on the A602.

142. Residents of the Dell and Crouchfields have no access to public transport, and the walk along the B158 is dangerous and unpleasant. The north-south Byway is the only pedestrian connection with Hertford for some 200 properties. The Byway is currently a wonderful experience, but that would not be so if it was hemmed in by bunds and crossed by lorry traffic. The permissive path offered along the eastern field boundary would not connect to any footpaths to the north, and so is an empty gesture.

[74] ID61.

143. Aska Pickering (local resident and chairperson of SBQ) [75] Many local residents enjoy this beautiful landscape, with its lonely oak tree and views across to Hertford and the Three Lakes. The footpath is recognised as a community asset. A survey of 269 respondents found that 17% use the footpath three or more times a week, and 85% would find it less attractive with a quarry. The results of the survey are included in ID35. The local community has good reasons to be concerned, given the harmful dust pollution, increased heavy traffic and noise, the risk of pollution to the water supply, and irreversible damage to the beautiful landscape. Nearly 1,500 people signed the two HCC electronic petitions against the applications. Over 1,300 letters and emails were sent during the most recent public consultation. SBQ website has on average 600 visits per month and its Facebook page has an audience of around 4,000 subscribers. HCC has recognised the importance of the appeal site and proposes to remove it from the list of preferred areas in the eMLP.

144. Dr David Adam PhD (local resident and parent governor of Bengeo Primary School) [76] There is concern about the threat to the health of schoolchildren from dust. The HIA assesses this risk as low, but this is based on an environmental impact assessment which argues that fugitive dust emissions would not be significant. The assessment does the minimum suggested by the IAQM, in modelling theoretical particulate emissions in annual mean exposure beyond the site boundary. The schoolchildren next to the site deserve more than this minimum effort. The IAQM also says that other ways of assessing risk should be considered where there is particular sensitivity on neighbouring land.

145. Children at the school would not be exposed to an annual mean amount of dust. The working hours of the quarry would be similar to the school day. When dust was produced it would be breathed in. On hot and dry days, when more dust would be produced, children are more likely to be outside. The assessments do not mention RCS. Industrial activity grinds silica down small enough to be inhaled. This is why the Health and Safety Executive (HSE) requires quarry workers to be issued with protective equipment. RCS is a carcinogen. By definition, any increase in exposure increases the risk of ill-health. RCS comprises tiny fragments which are easily carried on the wind. An advance paper for *Atmospheric Environment* measured RCS in a rural location downwind of four working sand quarries in the UK and found levels 150 times greater than ambient levels. The HIA does not assess the effects of this on schoolchildren. The HSE study found that 6% of the samples contained fugitive ambient concentrations of 10 $\mu g/m^3$ of air. The US Environmental Protection Agency calculates that if 500 people were to breathe in 8 $\mu g/m^3$ for long enough then 12 could develop silicosis. The decision about this quarry is a matter of balancing risk and benefit.

146. Libby Mountford (local resident and school governor for 13 years) [77] The school is 350 m from Phase 1, and The Wick is even closer, with some elderly residents living about 100 m away. The quarry would damage the mental

[75] ID35 includes photographs of the lonely oak tree.
[76] ID44.
[77] ID37.

health of local residents, by reason of irritating and intrusive noise, dust and the loss of the beautiful field with its open views and path to the pub at Chapmore End. Silica dust inhalation is of particular concern, especially for children and those with respiratory diseases. A paediatric consultant recently advised that lung damage in childhood was likely to have a lifelong impact. The youngest children at the playgroup spend much of their time playing out-of-doors. Some 43 of the 500 children suffer from asthma and use inhalers. The quarry would put at risk the safety of these children. The appellants' HIA says that there would be minimal risk, but this is not convincing. The risk is unquantified. Worried parents will vote with their feet.

147.The children have learnt a lot about geology, economics, archaeology and wildlife because of the quarry applications. They are also learning about local democracy and the planning process. Schoolchildren attended the planning committee meetings and saw Members reject the application.

148.Julie Starkiss (head teacher Bengeo Primary School) [78] The school has 61 staff and 496 children. It occupies a large site with three playgrounds and a playing field, and enjoys particular success in outdoor sports. The school is currently oversubscribed.

149.Suzanne Bray (local resident) Expressed concern about the proximity of the school and playing field, allotments and housing. Children would be exposed to dust and pollutants for longer than those operating the quarry. Local residents are scared about the health implications of the proposal. This is open countryside used for recreation and not a site for an urban quarry.

150.Tanya Needham (local resident and governor of Bengeo Primary School) There was persistent noise from Rickneys Quarry when it was operating. Dust was also a real and constant problem. That site is now a blighted landscape, notwithstanding the planned progressive restoration. Restoration is a real issue. There is nothing to indicate that the appellants have the funds to make good on their restoration commitments.

151.Thalia Watson (local resident) [79] There is local concern about the health effects of the quarry on vulnerable children, the elderly and anyone with a respiratory condition. This includes the ability of children to play outside in the summer. Dust and diesel emissions would mean that they would have to move away from the area, the school, family and support networks, and local businesses. Any increase in air pollution, no matter how small, would be of concern.

152.John Howson (local resident) [80] People love this field. It is part of the community. It has a waveform relief with two distinct undulations and a perfect example of rolling Hertfordshire countryside. There is a beautiful vista from the central path across to Ware Park Manor. Views from this central path are not mentioned in any of the landscape documents. A monitoring exercise on 3 December 2017 logged 55 people on a cold and wet day between 1000 and 1500 hours. All the paths are heavily used, many since

[78] ID45.
[79] ID90.
[80] ID34.1.

the 1970s or longer, and so meet the 20 year rule for an application as PRoW. Different groups use the field for walking, cycling and running. ID34 includes a selection of comments from users. This is a landscape worthy of preservation for future generations.

153. The field is home to skylarks. St John's Wood is an important ecological resource. The Woodland Trust says that any quarrying would be likely to alter the hydrology, and introduce dust, changes in land use, along with potentially non-native species. The Trust recommends a 100 m buffer zone.

154. Robert Chandler (local resident) [81] Chairman of a local bicycle club with 25 members. Cyclists generally ride north of Bengeo, across the appeal site, which provides a calming view before heading off on a 20 mile ride. The view is one of the finest in Bengeo. The proposed quarry with its effects on noise, dust, air quality and views would mean that cyclists would no longer be able to enjoy the safe environment and beauty of this area. The quarry would also be a factor for other cycling clubs considering visiting Hertford.

155. The B158 is a narrow road that would be more hazardous for cyclists with HGVs from the quarry. The increase in traffic on Wadesmill Road would lead to vehicles choosing to take Sacombe Road as an alternative route, so making this a hazardous route for cycling. The accident statistics indicate that most cycling casualties are aged either 0-14 years or between 45-49 years, with most fatalities or serious injuries in the 50-59 age groups.

156. Anu Palmer (local resident) [82] Horse riders regularly choose Bengeo field because it is one of the best hacking routes in the area. Cyclists, runners and walkers, with or without dogs, also enjoy the beautiful views all year round. The field has paths that conveniently connect places. An oblique aerial photograph shows the proximity of the school, housing development and the playground in the Wick. The appellants have presented the impacts and risks as minor or insignificant inconveniences with control measures. This ignores the true, detrimental and irreversible impacts of putting a quarry in a wrong place – above a water borehole, next to housing and in the Green Belt.

157. The effects would be immediate. The landscape would become alien. People would not walk through a torn land with dust and noise. Rickneys Quarry is still awaiting restoration after ceasing operation 17 years ago. The attractive entrance to Hertford would become an eyesore. Local residents have concerns about safety from dust and road traffic. The opportunity for schoolchildren to learn and play outdoors would be severely compromised, especially for allergy sufferers. Allowing this development would create stress and worry. The restoration would not leave the area with improved quality as the landscape would be irreversibly changed.

158. Mark Lynch (local resident and chairman of the Bengeo Neighbourhood Area Plan Steering Group) [83] There is local concern about noise and dust, but the true value of the area that would be ruined by this development should be highlighted. Bengeo field is a central feature of the north Hertford landscape.

[81] ID89.
[82] ID36.
[83] ID43.

It is a highly important amenity for many people. The route has been recognised as an Asset of Community Value by the district council. 635 people signed an e-petition asking for protection of rights of way and views. A recent survey for the BNAP rated the importance of protecting Bengeo field from development on a scale of 1-5. The mean response was 4.62 from 735 responses.

159. Should the quarry be permitted the natural rolling landform and openness would be lost forever. While the quarry was operational walkers would have to contend with dust, HGV traffic and industrial noise. The proposed restoration would leave the Byway lined with trees and perched on a rim of a deep, artificial crater with tree covered sides. This would be very different to the open, rolling, natural landscape that local people currently enjoy. The appellants' proposed landscape benefits, in the form of new planting and byways, totally miss the obvious point that the field is open. The hedges would interfere with views.

160. A new western loop byway would run largely behind a screen of trees. The public already use an informal route on this higher ground with some of the best views on the field. A new western route might be beneficial for the less abled, but none of the users would experience the openness and views as they are today. Not many people would use the eastern loop running behind a hedge alongside the B158.

161. The HIA recommends the formation of a community liaison group as a means of mitigating the negative health impacts of the community reaction about the quarry, and to reassure the community about phasing and restoration, so as to avoid the scenario of a medium-to-long-term dormant, unrestored quarry, as has happened at both Waterford Heath and Rickneys. Given the history of these two quarries, the community are unlikely to have much faith that any extraction and restoration at Bengeo field would go to plan. It therefore seems reasonable that some additional mechanism of ensuring compliance with conditions was in place, possibly a bond in escrow.

162. Dr Bryan Lovell OBE CGeol (Senior Research Fellow in Earth Sciences University of Cambridge) [84] Dr Lovell endorses the findings of Professor Brassington. The pumping station is located on the flank of the valley because that is where the chalk is most fractured and the flow of water is greatest. The enhanced fractures in the chalk mean that any pollution entering the groundwater in Bengeo field would travel rapidly to the boreholes. It is critical for safe quarrying to know the route that the water would follow, but at present there is no information about this.

163. The proposed residual protective layer of sand and gravel is based on the unlikely assumption that the upper surface of the chalk aquifer is smooth. Research in southern England has shown that the top-chalk surface is rough, and Dr Lovell is confident that the same applies at Bengeo. Peaks in the rough surface may result in unplanned exposure of the chalk during quarrying, as occurred at Rickneys Quarry in the early 1990s. There are also hollows, which in some cases will mark the surface expression of fissures penetrating deep into the chalk. Significant pollution would travel so rapidly

[84] ID32.

into the aquifer through the largest fissures that even the speediest response at the surface of the quarry would be ineffective.

164. The advice given by the EA and AW is geologically inadequate. Top chalk could be mapped to identify low spots that might indicate major fissures, but no survey has been carried out by the appellants. Assessment of the risk of pollution requires details about the size and orientation of fissures and fractures within the chalk aquifer. But there is little information to decide if quarrying here is even feasible. Quantified risks should be covered by explicit guarantees of financial and technical competence from the operator. There are none here.

165. The sand and gravel resources from Bengeo fields would yield, in each year of operations, a mere 0.1% of the UK onshore supply of aggregate. Whereas some 6 m litres per day of good quality water has been flowing from the Wadesmill PS since 1936. Boreholes would not be drilled in chalk at the edge of a working quarry to supply a town with vital water, so a quarry should not be put by Hertford's boreholes.

166. Peter Norman (Hertford Civic Society, which has 330 members) [85] Neither of the 1.75 Mt scheme or the 1.25 Mt scheme is acceptable in policy terms. The proposals would not be extensions to Rickneys Quarry and would not be accessed via the existing access. There is insufficient proven need/demand to justify working the area, especially given the approval for the Furze Field site. The cumulative impacts of the appeal scheme together with a permitted RQE would be unacceptable. A new quarry should not be opened up before the adjacent previously worked areas have been fully restored. Quarries are often worked on a stop/start basis reflecting market conditions, leading to extended periods of operation, with operators seeking to modify permissions to prolong operations or restoration, resulting in long-term despoliation of land, which is something the MLP seeks to avoid.

167. The history of mining in the area over the past 50 years is shown on a map included at ID39. Hertford is ringed by past and present workings. Each one of which has changed the natural landscape forever, and when in operation resulted in lorry traffic, mud on roads, dust, and damage to hedges, verges and road surfaces. The Civic Society has argued for years that Hertford has already contributed more than its fair share of the County's supply of gravel. The eMLP no longer includes the appeal site or any other area close to Hertford as a Preferred Area. It can no longer be assumed that the reserves north of Bengeo are bound to be worked at some time in the future. The eMLP is at an early stage, but the evidence base which informed the choice of options is a material consideration.

168. John & Carmen Wiggett (local residents) [86] There is concern about the loss of amenity value, especially the footpaths, and the views from the top of the field across to the Three Lakes and Westmill Farm. The footpath across the site is a regular running route. The finished land would be at a lower level and the views would be lost. Rerouting the path around high bunds would mean it was less likely to be used. The potential impact on the health of

[85] ID39.
[86] ID33.

children, especially those with asthma, is of concern as the HIA acknowledges that asthma suffers may experience some exacerbation of their condition.

169. Cllr Steve Cousins (Hertford Town and District Council, Chair of Community Services, which is responsible for allotments) [87] The allotments near the site are well used by people of all ages. The long term effects of dust would be catastrophic. The need for extraction sites outside those proposed by HCC is questioned. The scheme would be inappropriate in the Green Belt, and would result in a major and irreversible loss of amenity space. Both applications have been rejected unanimously by HCC.

170. The B158 is heavily used, particularly at rush hour and school times. There is local concern about noise, dust and safety from lorries and mechanical plant associated with extraction. The B158 drops out of Bengeo to an 'S' bend, then winds to a blind bend near to the existing Rickneys Quarry access, and on up to a blind summit at Chapmore End. The increase in traffic would severely compromise road safety.

171. Terry Mansfield (Chapmore End Association) [88] Chapmore End comprises about 30 houses, and the local residents have been living with the problem of gravel for the past 30 years, when a mega-pit was proposed. Rickneys Quarry could be heard when it was operational, with the loading of gravel sounding like thunder. Conveyor belts made a continuous sound. The noise was horrific and carried on the wind. Residents were told that in 20 years the Rickneys gravel pit would be so beautiful, but it is now a moonscape. The promises have not been fulfilled. The proposal would put at risk the water supply for the area, when AW has indicated an increase in demand for future housing. The appellants have not talked to the local community.

172. Dr Mike Howarth (local resident) [89] A particular concern is the time lag between factual evidence of health issues being acted upon in practice. He referred to asbestos in Rochdale. Silicosis could be the new asbestos dust. The HSE Guidelines say that exposure to RCS over a long period can cause hardening of the lung tissue. Airborne particles are of concern. These are a risk. The very idea of Hertford's urban quarry by a school should be stopped before the silica trouble really starts.

173. The proposed restoration would not be an improvement in landscape and conservation terms. The deep holes left behind would be avoided by wildlife because of easy observation by predators. The holes would be too deep to return to farmland and slopes may be unstable and so retaining topsoil would be difficult. Furthermore, all open views would be destroyed.

174. John Barnes (local resident) [90] It is not fair and reasonable to continue opening new pits when so many old pits have not been restored. Promises given when planning permission was granted have not been fulfilled. For example, at Panshanger a country park was proposed 30 years ago, but the first part only appeared 5 years ago, and no new paths have appeared on the

[87] ID46.
[88] ID47.
[89] ID40.
[90] ID41.

definitive map of PRoW. At Tyttenhanger, paths were left obstructed after mineral extraction. This was discussed with the operators in 1993, but no new paths were created. Legal action has also been taken at Ware Park to keep paths open. It seems that when permission is granted there is no compulsion on the operators to restore the area and its rights of way. HCC is overwhelmed by the work to restore the land ruined by gravel pits, and should be given the chance to catch up with the backlog before any new pits are opened.

175. Alan Burgess (local resident) [91] The noise from heavy machinery at Rickneys Quarry when it was operational was particularly noticeable when the wind was from the north, but it could also be heard on calm days. The machinery was 1.2 miles away and some of it was below ground level. This indicates that noise from the proposed quarry could be a major problem for those nearby, including the school, and a significant nuisance for the wider area.

176. Kelly Martin (local resident) There is concern about the proximity of the school and local housing. The quarry would be a danger for residents 24 hours a day 7 days a week, and for the rest of their lives. Children would not be able play outside or use the playing field. Common sense should see past the financial interests of the appellants.

177. Dan Griffiths (local resident) HCC has not objected on health grounds, but the risk is for the future – there may be none or it may be severe. The risk is unacceptable and avoidable. Local children should not be guinea pigs in a study. The landowners are a trust, it is not known who they are, and their approach to this proposal feels like bullying.

178. Lee Nicholson (local resident) [92] The appellants' HIA, which was submitted at a late stage in the appeal process, says that the air quality effects of the proposal would not be significant to public health. But that would not be so for the vulnerable in the community, such as those with COPD. The British Lung Foundation states that lung disease is one of the biggest killers in the UK, with rates the same as those that existed 10 years ago, whereas heart disease has decreased by 15%. Asthma deaths in the UK are the worst in Europe. Lung disease in children is increasing. The knowledge does not yet exist to say that there is no risk. Mr Nicholson would not use the path across the site while excavation was taking place because the risk would be too much.

179. Alexandra Daar (local resident and chair of East Herts Green Party) [93] The whole walk across this field to Chapmore End is full of interest and charm from the rolling hills and lonely oak, to St John's Wood, and creates a lovely sense of space. The Bengeo Beavers complete this walk as one of their last events of summer term. All sections of the population need easy ways to exercise. There is no good reason to use this local lung for a quarry when it is so close to children in school and to people's homes. The community needs this space right on their doorstep in all its current loveliness, not a noisy, dusty eyesore.

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[91] ID38.
[92] ID48.
[93] ID42.

180. Ben Penrose (Chairman Molewood Residents' Association) [94] The association covers some 700 households. There is concern about the impacts to the health and wellbeing of residents by reason of dust, noise, dirt and loss of valuable green space. Parents are already worried about whether Bengeo School will be right for their children. Older residents remember the noise disturbance from Waterford Quarry when it was operational. The proposal is already damaging health and wellbeing, and threatening to cause further impacts on the quality of life of residents. Traffic impacts would put pressure on the road network. There is also concern about the absence of any pro-active consultation with an active and visible residents' association during the planning process.

181. Graham Nickson (local resident) Planning permission should not be granted now because; 1. health impact because of RCS and COPD, 2. the precautionary principle should apply regarding possible contamination of the water supply, 3. the effects of HGVs on am and pm peaks in traffic especially in relation to the school, 4. the effects on the Green Belt adjacent to a nature park with trees close by, 5. there is no need given the supply of sand and gravel available at Hatfield.

182. Veronica Fraser (health walks leader) [95] The field is used for health walks, sometimes twice per week. The benefits of green spaces are important for the health of the community. People travel to the fields from a wide area, and its importance as a much loved area is clear from the emerging BNAP. The quarry would result in the loss of a favourite walk. There would be no beneficial changes as a result of the quarry. Previous quarrying has left a blot on the landscape.

183. Cllr Margaret Eames-Peterson (Hertfordshire County Council and a consultant in public health intelligence) [96] A HIA was requested in 2017, but was not available until Saturday 21 April 2018. There was little time for consideration and consultation prior to HCC's committee meeting on 26 April about the 1.25 Mt scheme application. Air quality issues were raised at the meeting. Air quality could be monitored outside the school, but a desk-based HIA can under-estimate harmful health effects. The HIA states that predicted levels of PM_{10} and NO_2 would be below WHO thresholds, but not so for $PM_{2.5}$, which is more dangerous to children's lungs.

184. At paragraph 9.2.10 the HIA states that the 'without project' scenario already exceeds the WHO guide value and that the predicted increase of up to 0.33 $\mu g/m^3$ suggests that further mitigation is not warranted. But this is not protecting the health of the population. The true effect would depend on wind speed and direction, and so is less predictable, and margins for the peaks of $PM_{2.5}$ and NO_2 should also be estimated. There is an emerging health policy in the eMLP. However, the framework for HIAs for quarries is not yet published. But other hazards to health, including noise, the mental health effects of noise, and the effect of reduced access to green space for physical activity on the mental health of nearby residents should be considered.

[94] ID58.
[95] ID59.
[96] ID60.

185. Cllr Mari Stevenson (East Herts District Council) [97] The Council has developed a plan which acknowledges the need for a small housing development in Bengeo. But it also has a commitment to promote health and wellbeing for its residents. Accessible green space is an important part of that remit. Bengeo field is an important green space asset. The quarry should also be rejected because of an unacceptable increase in an already heavy traffic flow on the B158. HERT4 could be seen as a lower priority in relation to the larger proposed developments in Sele and Mead Lane.

186. Steve Halsey (local resident) [98] Defra and the EU have set a legally enforceable limit on PM_{10} of 40 $\mu g/m^3$ averaged across a full year. But this is of concern because of published articles that state that there is no threshold below which health effects do not occur, that a four-year study found an increase of 4.3% in childhood asthma admissions for every 10 $\mu g/m^3$ increase in PM_{10}, and another found a 2.5% increase in the level of school absenteeism for every 10 $\mu g/m^3$ increase in PM_{10}. In addition, a 2013 WHO report stated that all-cause daily mortality is estimated to increase by 0.2%-0.6% per 10 $\mu g/m^3$ of PM_{10}. A 2014 paper concerning proximity to a cement plant in Italy found epidemiological evidence of the acute health effects of PM_{10} in areas with annual concentrations that are lower than the legal EU limit of 40 $\mu g/m^3$, which supported the need to establish more restrictive legislative standards.

187. The appellants modelling predicted 1.25 $\mu g/m^3$ of PM_{10} for the closest receptor to the proposed quarry. This figure seems to be based on an average across the 20 months that Phase 1 would be in operation, and not the 12 months used by Defra and the EU. It cannot, therefore, be used for comparison with the EU limit of 40 $\mu g/m^3$. The graph in the 2016 IAQM guidance shows a large number of quarries result in between 5-10 $\mu g/m^3$ of PM_{10} and over a range of 0-300 m. Dust emissions from the proposed quarry may not be entirely safe for those attending the school and living close by.

188. Laura Wyer (local resident) [99] The field and footpath are a massively important local amenity. Children walk *en-masse* to school during the Bengeo walk to school week, and on other occasions when the weather is good. The path is an essential link between two communities. The proposal for a path along the B158 is ridiculous, as vehicles sometimes leave the road, and in winter runoff from fields results in ice. A Facebook Opinion Poll started on 5 May found that 96% of the 194 respondents said that they would stop using the footpath. The view is stunning from the existing footpath. The scheme would result in the ugly remains of a quarry as a reminder to residents of the devastation that it brought to Bengeo.

189. Parents now have mixed emotions about accepting a place at the school. The potential for damage to people's health and wellbeing has resulted in over two years of anxiety. The WHO states that health is a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity. The HIA refers to mitigation measures, monitoring and

[97] ID62.
[98] ID63.
[99] ID64.

procedures. But residents cannot be sure that these would be correctly followed. The author of the HIA is asking the community to put their faith in the appellants, when they have failed to engage with the community over the past two years.

190. Simon Pickering (local resident) [100] A large part of the past two years has been dominated by the exhausting business of opposing the proposed quarry. The scheme would affect an area of beautiful countryside. Other quarries in Hertfordshire are evident from the tell-tale signs of dust on the road and in the hedgerows, but they are hidden from view, situated away from residences. That would not be so for a quarry at Bengeo field, which is the 'back yard' for this community, and far too close and precious to turn into a gravel pit. The most attractive part of the site is the higher slopes up from the central path towards St John's Wood. It is the part most under threat from the proposal, and the part proposed by HCC to be removed from the preferred areas in the eMLP. Not surprisingly, people do not choose to walk on the lower slopes next to the B158.

191. The Rickneys site is an ugly moonscape, which prior to the Inspector's recent site visit contained decaying and dangerous industrial plant. Local residents are not interested in future benefits and enhancements to the landscape from the proposed excavation at Bengeo because, in the unlikely event that these did materialise, it would be too far into the future to be of any benefit to them. After the experience with Rickneys Quarry local residents do not believe the appellants in this regard.

192. Nadine Cleland (local resident) [101] There has been a lack of good quality public engagement by the appellants. Public participation and consultation are required and good practice. HCC has published its Statement of Community Involvement. Neither of the applications has been accompanied by a dedicated Statement of Community consultation, setting out the public engagement strategy. Reference is made to a drop-in event held on Saturday 28 November 2015 at the Scout Hut. This was advertised in the Parish Magazine, which only prints 350 copies for over 3,000 households in this and the surrounding wards. No further attempt was made to engage with the wider community or SBQ.

193. The HIA refers to environmental change and social change associated with the strong local reaction to the development, e.g. affecting understanding of risks, local pride, community influence and community identity. It adds that both may affect physical health and mental wellbeing, and notes that the extent to which a significant health effect may occur would depend on the future level of information sharing and trust establishment. The HIA also refers to the need for certainty about the timing of Phase 1 and restoration.

194. But the HIA was only submitted a week before the committee date for the 1.25 Mt scheme application, and these recommendations have yet to be taken on board by the appellants. The updated ES September 2017 states that the revised proposals are in accordance with the development plan for

[100] ID65. This includes an oblique aerial photograph showing part of the site in relation to the urban area of Hertford.
[101] ID66.

the area, can be carried out without any unacceptable impacts, are in line with Government policy and should be supported.[102] This is simply incorrect when a number of significant risks remain. To claim that none of the local concerns are justified shows very little, if any, consideration for the community. The appellants have so far failed to fully inform the public, have an open and transparent dialogue, and address all relevant concerns, contrary to the *Framework*, which requires that development should ensure that there are no unacceptable adverse impacts on the natural and historic environment, human health, and take into account the cumulative effect of multiple impacts from individual sites and/or from a number of sites in a locality.

195. Russell Norris (Chapmore End Association) [103] In addition to the technical evidence it is important that sufficient time has been allowed for objectors to formulate their objections without the goal posts being moved during the consultation period. There is a shortage of time for busy people to respond. The appellants have overwhelmed the community by submitting two applications in quick succession, submitting confusing documentation, producing a 90 page HIA three days before the committee meeting, and consultations/meetings have been arranged over three holiday periods. Furthermore, the date for the Public Inquiry has been changed twice.

196. Taken together, these are a strategy to make it as difficult as legally possible for objectors to make a case. This is designed to eclipse the appreciation of the many risks inherent in the proposals. The threats and fears of the community are well founded, because HCC would not have adequate resources to monitor the quarry, the decision would not be taken for the greater good, and this quarry might be one piece in a bigger jigsaw. The community has 30 years of unhappy past experience of the quarry industry.

197. Restoration to farmland would be constrained by the underlying aquifer. Past experience has shown that quarries that cannot be filled with water or turned into nature reserves, are used as refuse tips, or are just neglected.

198. Wheel cleaning plant is never entirely effective and other quarries have resulted in windscreen damage and mud on the road. Lorry movements would be likely to be concentrated at the start of the day rather than averaged over the whole day, and so would conflict with peak traffic flows. Quarry owners are not limited to using their own fleet of lorries and control of free-lance operators could be an issue. Cumulative effects with the re-opening of Rickneys quarry should be considered.

199. Heston Attwell (local resident) [104] HCC should have objected on road safety grounds. It is dangerous to overtake on the B158 because of its topography and screening. Additional lorry movements, with mud, sand and gravel on the road, would at peak times lead to road accidents. Pedestrian safety at the junction of Byway 13 and Wadesmill Road is of concern. This is already dangerous and turning HGVs would make it worse. The farm track between Byway 1 and Byway 13 completes a circular walk through Bengeo field, and

[102] CD15.
[103] ID67.
[104] ID68.

provides a link to Chapmore End. The proposal would ruin this route and split communities.

200. The appellants refer to the need for the mineral, but their real need is to sell the HERT4 site for housing. The site has been left unquarried for years, when it should have been worked earlier in the plan period.

201. Apart from four hours in the Scout Hut two and a half years ago no one has engaged with SBQ or other parts of the community. This is unacceptable. The scheme is unacceptable because of the continuing damage to the mental and physical health of residents due to noise and RCS. It would risk contamination of local drinking water, have a negative impact on the school, and undermine local democracy. This is a beautiful place and the field would never look the same again. It would not be enhanced, as the restoration would leave a crater surrounded by finger-thick tree planting. The open views either side of the footpath would be lost, and people would stop using it. If the quarry goes ahead children would be taken out of the school and families would move away from the area.

202. Amber Waight (local resident) [105] Long term exposure to even modest increases in dust and PM_{10} has been evidenced to have a negative impact on children with breathing difficulties. The IAQM states that dust impacts will occur mainly within 400 m of the operation. There is no safe level for $PM_{2.5}$ silica particles, which are invisible. The potential mental health impact on children is also important. Children are worried about being in a school so close to a risk, and potentially surrounded by dust monitors. Unnecessary stress and anxiety should not be added to children at a vulnerable age. Ecotherapy is being used to treat mental health. This includes taking part in physical activities in green spaces of beauty and woodland. Bengeo School has this on its doorstep. Children should not miss out on this opportunity because of the quarry.

203. Cllr Bob Deering (Hertford County Council, East Herts District Council and Hertford Town Council) There is widespread concern about this proposal across Hertford and outside the town, not just the immediate area. This is apparent from the number, and nature, of representation Cllr Deering has received. Given the use and amenity value of Bengeo fields many are concerned about any disruption. Dust from working the quarry would be coincident with the hours children were at school, therefore calculation of effects based on 24 hour averages are dubious and of great and genuine concern for local residents.

204. Even with professional drivers HGVs on narrow lanes result in damage to kerbs, verges and hedgerows. There is concern that the number of truck movements has been played down by the appellants. There is no overlap of this proposal with residential development of HERT4. They are separate matters and each should be dealt with on its own merits. HERT4 should not predetermine the application for a quarry.

[105] ID69.

205.Nigel Braggins (local resident) [106] Children using Bengeo field for healthy activities is a priceless benefit. Aside from the health and amenity benefits provided by the rolling open landscape, the site is a water catchment area. Such an essential resource should not be put at risk. Children play football at the After School Club everyday on the school playing field.

206.Rickneys Quarry ceased extraction in 2001. Seventeen years later it is an unrestored, scarred and polluted wasteland. The track record for restoration after quarrying is abysmal. The appellants have not convinced local residents about applying high standards and best practice if permission were to be granted for a quarry at Bengeo fields.

207.There is an objection in principle to the proposal. HCC not only refused the two applications, but was so concerned that it declared its intention to remove this entire area from the Preferred Area for minerals working.

208.The HIA highlights the need for trust, but after two years it is still not known who the applicant is, there is a total lack of transparency, no information sharing and no clear chain of accountability.

209.Dr Laura Horsfall (local resident and Senior Epidemiologist University College London) [107] During the time children spend at school (from 2 to 11 years) their lungs will double in size. This is a critical window of respiratory development, where even small environmental insults, such as chest infections, can have significant short and long-term impacts on health and wellbeing. Dust and particulate matter, including carcinogenic silica would increase as a result of the quarry and there are no known safe levels of these pollutants. The HIA refers to sufficient evidence to establish the potential for the activities to affect health, but the IAQM states that there is little peer-reviewed published literature on the impacts of dust from UK mineral sites. The HIA includes no studies that can guarantee the safety of mineral extraction on the immature lungs of children or vulnerable people. Almost all the data on silicosis is from young physically fit male workers and cannot be generalised.

210.The appellants' modelling suggests that the quarry would be unlikely to breach UK regulatory levels of pollutants. But these rely on meteorological data and point estimates for pollution. There is nothing to show the predictive accuracy of models using real data, which is common practice in evidence-based medicine. The appellants concede that during hot spells dust levels could contribute to health risks in vulnerable groups. One in six children are diagnosed with asthma, others suffer from recurrent chest infections. It is highly plausible that exposure to small average increases or repeated sudden changes in dust/pollution due to unpredictable meteorological events over the course of eight years would negatively impact these children. The appeal site is just one street from the urban area, whereas the IAQM states that air quality objectives are rarely exceeded close to most mineral sites as they are typically located in rural areas.

[106] ID74. This includes photographs of Rickneys Quarry.
[107] ID70.

211. The HIA notes that $PM_{2.5}$ levels already breach WHO guide levels. Both the WHO and Scotland have recently halved their PM_{10} target. Scotland has reduced the permitted number of breaches to 7, as opposed to 35 in the rest of the UK. The quarry would not be permitted this close to an urban community in Scotland. As a high-income democratic country with a political emphasis on the big society, we must not prioritise short-term private profit over the risk to the public health of our most vulnerable members of society.

212. Mark Prisk MP Member of Parliament for Hertford and Stortford highlighted matters raised in his written submissions, which are summarised later in this report. He emphasised three points at the Inquiry. The proposal is strongly opposed because of its likely effects on air quality, the local roads and the natural environment. The site is adjacent to Bengeo Primary School and family housing, and so the scheme is a significant threat. The risk to the local water supply cannot be dismissed. Secondly, the footpaths across the open space of Bengeo fields provide a meeting place for local residents on the top of a hill separate from the town. The loss of these assets to an industrial quarry would be contrary to public health policy. Thirdly, there is no need for the sand and gravel. The landbank exceeds the actual need.

The case for the appellants

The following summary of the appellants' case broadly follows their closing submissions to the Inquiry, with additional reference where necessary to the evidence adduced.[108]

Introduction

213. Some of the operations previously undertaken by RJD Ltd have been taken on by Ingrebourne Valley Ltd. However, RJD Ltd continues to trade and is not a dormant company. Both the appellants named in the appeal documents have legal capacity to lodge an appeal.[109]

214. Groundwater and air quality health considerations are not an issue for HCC.[110] However, the Rule 6 parties raise concerns about the implications of the development on the hydrology of the area, and about potential health impacts as a result of changes to air quality. These concerns are not shared by the statutory experts, the EA and the Director of Public Health.

215. Sand and gravel are minerals of local and national importance, necessary to meet society's needs, to support sustainable economic growth and to support our quality of life. Even where there is a 7 year landbank, the winning and working of those minerals attracts great weight.

Landscape [111]

216. HCC concerns are solely about the landscape impacts of Phase 4 and the stockpiling area during the operational period and the restoration landform. The only GLVIA3-complaint landscape and visual impact assessment before

[108] ID111.
[109] ID77 paragraphs 30 and 31.
[110] SoCG3.
[111] APP8.

the Inquiry is that prepared by the appellants.[112] The appeal site is not part of a designated landscape, and the landscape experts concur that it is not a 'valued landscape' within the meaning of paragraph 170 of the *Framework*.

217. HCC accepts that mineral extraction would be acceptable not just on the plateau, but also on the undulating sloping valley sides that drop down from the plateau in the central and southern sections of the appeal site (Phase 1 and Phase 2). So the north-eastern part of the site should also be acceptable. The stockpile area would be located in the lowest part of the site, and largely screened by the vegetation along Wadesmill Road. New hedgerow and tree planting along the Byway and Wadesmill Road would further screen the area.

218. During operations, the landscape and visual effects would be substantial/moderate adverse, but that would be likely for all mineral sites. Following restoration, the landform proposed in Phase 4 would appear as a gentle undulation in the landscape, not as a contrived "distinct linear mound" along the eastern edge of the Phase 4 area, as claimed by HCC.[113] The appeal site forms part of LCA '69 Stoney Hills', which is characterised by gently undulating land. It is clear from the cross-sections prepared by both HCC and the appellants that it would not read as an alien feature in the landscape, but would sit comfortably within it.[114]

219. HCC has failed to have regard to the significant landscape benefits that would be secured through the proposed restoration scheme. The quality of the landscape in the Stoney Hills LCA is poor, and the strategy is to "improve and restore". The restoration proposals deliver almost all of the measures identified in the LCA. There is no evidence to indicate that those benefits would be secured absent the proposed mineral development. The long-term landscape benefits should be accorded significant weight in the planning balance. They include: The restoration of historic hedgerows, native woodland edge planting with rides and glades, species-rich agricultural buffer strips along field margins, and new wetland areas.

220. New planting would be phased, with much of it implemented at an early stage of the operational period. The landscape management plan would set out an initial 3 to 5 year establishment period for new planting, with a medium-term strategy of mitigation, monitoring and longer-term management. As the proposal is to return the majority of the land to agriculture the need for a detailed agricultural classification was scoped out.[115]

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[112] APP8. [Inspector's note: GLVIA3 at paragraph 5.51 on duration states that medium term is 5 to 10 years and long term 10 to 25 years, but adds that there is no fixed rule.]
[113] HCC3 paragraph 5.29.
[114] ID29.
[115] Reply dated 26 April 2018 to Inspector's question.

Green Belt [116]

221.There is a "threshold question" to determine whether development is appropriate or inappropriate in the Green Belt.[117] Given that mineral extraction is capable of being appropriate, the decision-maker must start from the premise that there is nothing inherent in that type of development that would necessarily compromise the openness or purposes of the Green Belt. Were it otherwise, the proviso in paragraph 146 of the *Framework* would always negate the potential appropriateness of mineral extraction.[118]

222.The court found in *Europa Oil* that "structures, engineering works, and associated buildings…generally encountered in mineral extraction*"* or "the common structural paraphernalia for mineral extractions cannot cause the development to be inappropriate*".* The elements of development to which HCC objects here are all features that are generally encountered in mineral extraction. They are no more than is necessary to facilitate the extraction of minerals from the site. Furthermore, they are all temporary in duration and the openness of the Green Belt would be restored following the operation, up to 10 years in the 1.75 Mt scheme and up to 8 years in the 1.25 Mt scheme. The temporary nature of development and the restoration of a site to beneficial Green Belt use may well be important to the judgement of whether the development was appropriate or otherwise.

223.Green Belt policy is essentially a long-term policy. A key feature of the Green Belt is its permanence. In fracking cases it has been accepted that with mineral exploration, some degree of operational development has to be expected. Where all of the proposed elements of development would be normal, appropriate to the type of operation and reversible, there will be no harm to openness and the development will be appropriate.[119] The Secretary of State is required to have regard to his own decisions.[120] Consistency is a general axiom of rational behaviour.[121] It would be quite wrong and set a dangerous precedent if the Secretary of State took a different approach in this case from that which he has consistently taken where the mineral under consideration is shale gas.

224.In this case there would be no permanent harm as a result of the proposed development – the long-term openness of the Green Belt would be maintained. Given that the works and structures are no more than those generally associated with mineral development; are proportionate in size and temporary in duration, even those parts outside of PA2 would not constitute inappropriate development in the Green Belt.

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[116] APP10.
[117] *R (Lee Valley Regional Park Authority) v Epping Forest DC* [2016] EWCA Civ 404 per Lindblom LJ at [26].
[118] *Europa Oil and Gas Ltd v SSCLG* [2013] EWHC 2643 (Admin) per Ouseley J at [64], as endorsed by the Court of Appeal in [2014] EWCA Civ 825 at [41]
[119] See, for example, appeal decision APP/U1050/W/17/3190830 for a temporary permission for 5 years for a wellhead assembly; comprising access tracks, bunds and fences, site cabins of 5.5m high and a drill rig of 60m high near the top of a ridge of sloping ground that would be visible from some 10 km from the site.
[120] *DLA Delivery Ltd v Baroness Cumberledge of Newick* [2018] EWCA Civ 1305.
[121] *Matadeen v Pointu* [1999] 1 AC 98.

225. Even if they did, any harm to openness or to Green Belt purposes is justified by VSC sufficient to outweigh any temporary harm to the Green Belt and any other harm. These include; the benefit of mineral extraction; the temporary nature of the works; the long-term landscape and ecological benefits; permanent enhancements to the PRoW network; and the benefits of extracting the minerals to allow the delivery of houses on the northern part of the HERT4 site.

226. The 1.25 Mt scheme falls, with the exception of its temporary access road, entirely within PA2. If the temporary access road was removed following the extraction of minerals, there can be no landscape or visual reason for refusal. The openness of the Green Belt would be restored after 7 years. The access road would be flush to the ground; would occupy a limited spatial area and would be only likely to be visible from the Byway and in fleeting views from vehicles on Wadesmill Road where there is no pavement or provision for pedestrians. The temporary access road would not result in landscape harm sufficient to merit refusing permission, and would not render the scheme inappropriate in the Green Belt. Even if it did, the importance of extracting sand and gravel, and the need to win and work minerals where they lie, would comfortably satisfy the VSC test for inappropriate development in the Green Belt.

Noise [122]

227. Some noisy short-term activities, which may otherwise be regarded as unacceptable, are unavoidable to facilitate mineral extraction. Noise levels below the *Guidance* limits should not be treated as unacceptable or as weighing against a proposed mineral development.

228. The upper working limit of 55 dB(A) would not be exceeded, excepting for work on bunds, at any noise sensitive location at any time during operations, even if the appeal site was worked simultaneously with Rickneys Quarry. However, the noise experts disagree about possible exceedances of the normal working noise limit level of 10 dB above background.

229. The normal working limit at The Orchard should be 48 dB(A). HCC considers that this level would be exceeded by just 1.7 dB(A) under the 1.75 Mt scheme but would not be exceeded at all in the 1.25 Mt scheme. The appellants are satisfied that the noise produced by the operation of the site would not exceed that level in either scheme and is content to accept a noise limit of 48 dB(A) at this location.

230. At Sacombe Road the parties disagree as to the background noise level and therefore the appropriate normal working limit. HCC considers the limit should be set at 48 dB(A); the appellants consider that it should be set at 52 dB(A). If the appeal site and Rickneys Quarry operated simultaneously, the combined noise levels at Sacombe Road could reach 50 dB(A). Notwithstanding its proposed normal working limit of 52 dB(A), the appellants are confident that the site could be operated without exceeding 50 dB(A) and are content to accept a condition to that effect. It would place an unreasonable burden on the operator not to be able to extract minerals in the

[122] APP2.

event that permission is granted for Rickneys Quarry and it is worked for minerals.

231. With a limit on noise of 48 dB(A) at The Orchard and 50 dB(A) at Sacombe Road, there can be no reason to refuse the application on noise grounds. Any breach of the conditions would be picked up in regular monitoring and subject to enforcement. Noise conditions are not impossible to enforce, if that were so there would be no point in ever imposing them. In reality they are imposed on every mineral operator and are recognised by the Secretary of State as serving a worthwhile purpose.

232. The Secretary of State can be satisfied that it is possible for those limits to be met, based on numerous noise levels measured for the type of plant proposed for this site, operating in comparable sand and gravel quarries. Reliance on manufacturer's specifications, which set out the maximum permitted SPLs from static tests on full power under EC Directive 2000/14/EC, is not appropriate. The plant would not operate to its maximum potential with its engine revving at full capacity on site, and so BS 5228 explains that obtaining actual noise measurements of the proposed plant is likely to provide the most accurate prediction of noise levels.

Public Rights of Way

233. In the 1.75 Mt scheme the Byway would be crossed by the access road for a temporary period of 10 years, and for a period of 2 to 3 years temporarily diverted around Phase 4. This would increase walking time by some 2.5 to 3 minutes across the site. The Byway would be crossed by the access road for a temporary period of 7 years in the 1.25 Mt scheme. But the crossings could be made safe.

234. HCC did not recognise any benefits to the PRoW network as a result of the proposed development. The creation of a new, permanent bridleway joining Byway 1 to Byway 13 would be an enhancement to the PRoW network and would facilitate a circular route. The creation of a lawful PRoW to replace an unlawfully used route would be beneficial. So too, would be the creation of two permissive footpaths for the duration of the works, adjacent to Wadesmill Road and Sacombe Road. Upgrading footpath 14 to a bridleway would be an enhancement of the network.

Hydrology [123]

235. An Environmental Permit is not believed to be necessary as the site would be excavated dry without need to dewater or discharge water, and water for wheel washing etc. would be from a private borehole extracting less than 20 m^3 per day, which would be allowed without the need for a permit.[124] The EA is the statutory consultee with responsibility for the protection of groundwater, and does not object subject to the imposition of a number of stringent conditions. The EA was aware of Dr Lovell's concerns as to the roughness of the surface of the chalk aquifer. The view of statutory consultees should be given "great" or "considerable" weight in planning

[123] APP1 and APP4.
[124] Reply dated 26 April 2018 to Inspector's question.

decisions: a departure from those views requires "cogent and compelling reasons", which are absent in this case.[125]

236.The aquifer is vulnerable to contamination due to the presence of the fracture network, which permits very rapid flows. Once contamination enters the chalk matrix it is difficult to remove.[126] However, the risk of hydrocarbon pollution can effectively be addressed through the imposition of prescriptive mitigation measures to deal with any spillage on site, requiring the affected sand and gravel to be excavated following a spill; stored in a safe location and them removed from the site. The risk of turbidity is of less concern. Both could be satisfactorily addressed, such that even on a precautionary basis, the development can safely be allowed to proceed. As the level of standing groundwater is below the base of the sand and gravel, the trees in St John's Wood and on-site are dependent on rainwater, and no adverse impact is indicated by the proposed mineral extraction.[127]

237.AW is the operator of the Wadesmill PS and the body with most to lose from any pollution of the aquifer. It has past experience of a pollution event from a chemical site, and so is likely to be particularly wary of pollution risk, but does not object to the proposed development. It considers the appellants' proposal to leave up to 5 m, 3 m and 1 m of undisturbed material on top of the chalk to be more-than-adequate protection, and accepted much less at Rickneys Quarry, which is also in a SPZ1.

238.There is no evidence of a mineral site ever having polluted a groundwater source. Rickneys Quarry operated without incident and there is no reason to believe that mineral extraction in the appeal site, subject to the EA's conditions, would pose any unacceptable risk to groundwater.

Air quality and health [128]

239.The Director of Public Health agrees that the findings of the HIA are reasonable and that the development would not give rise to any unacceptable health impacts.

240.The HIA proposed, after its conclusions as to likely effects, some recommendations to enhance the position further. But those matters do not affect the conclusions and are not necessary to render the development acceptable. SoCG3 makes it clear that the difference between the proposed separation distances in the two schemes would have no bearing on the likely health impacts of the development.

241.Limit values for PM_{10} are set in international and national law at an annual average of 40 $\mu g/m^3$. The *Framework* requires planning decisions to sustain and contribute towards compliance with relevant limit values. There is no risk that those limits would be exceeded as a result of this development. At the worst affected receptor, concentrations of PM_{10} would be below 19 $\mu g/m^3$: less than half of the limit values. The vast majority of that PM_{10} is already present

[125] *Shadwell Estates Ltd v Breckland DC* [2013] Env.L.R D2 at [72].
[126] APP1 paragraph 3.13.
[127] APP9 paragraph 3.2.3.
[128] APP3, APP6 and APP11.

in background levels. At the worst affected receptor, the quarry activities would contribute just 2.20 µg/m^3 of PM_{10} to the annual mean. Changes of this magnitude are 'negligible'.[129] For the 1.75 Mt scheme all air quality impacts at sensitive receptors would be negligible, with the exception of one slight impact.[130] For the 1.25 Mt scheme all impacts would be negligible.

242. Air quality impact will often be used as a proxy for assessing effects on health.[131] While it is never possible to demonstrate unequivocally that a development would give rise to no adverse health effects, a negligible air quality impact is likely to equate to a negligible health effect. The HIA concludes that the health impacts on the population in the vicinity of the site would be negligible. During certain weather conditions very short-term elevated air pollution concentrations may pose an increased health risk for particularly vulnerable groups, but given the very minor increase in PM as a result of the development, this would not have a significant effect.

243. The HIA is informed by the findings of the Redmore air quality assessment, which relies on the well-recognised ADMS model. The emission factors selected are taken from the EMEP/EEA air pollutant emission inventory guidebook, which is technical guidance used to prepare national emission inventories. If anything, they are likely to overestimate impacts because they include dust emissions from a variety of mineral sources which generate more dust than the moister sand and gravel that would be excavated from the appeal site.[132] Any change in $PM_{2.5}$ and PM_{10} concentrations would be expected to be exceedingly small and would only be experienced by a relatively small number of people. As such the health risk would be negligible.[133]

244. There are no material risks associated with RCS as a result of this development. RCS is a component of PM_{10}. Increases in PM_{10} concentrations would be exceedingly small and increases of RCS would be even smaller. The Stacey et al paper relied upon by SBQ reveals that for sand extraction sites RCS comprises some 2.6% of PM_{10} concentrations. That means that at worst this development would contribute 0.06 µg/m^3 of RCS and that together with background levels, there would be a maximum RCS concentration of 0.49 µg/m^3. The US Environmental Protection Agency uses a benchmark of 3 µg/m^3 of RCS as a level at which there is little or no risk to the wider populous. The level around the appeal site would be less than 20% of that threshold. In those circumstances there is no unacceptable risk posed by RCS as a result of the proposed development.

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[129] CD35.2 at p.25, table 6.3.
[130] Redmore Air Quality Assessment, April 2018, table 53 (p78-80) and table 55 (p84–86).
[131] CD35.2 para 7.10 page 30.
[132] CD35.1 Table A2-6 on page 36, which reveals that many of the minerals sites emit greater PM_{10} levels than sand and gravel sites, which are shown in the table as producing close to zero emissions of PM_{10}.
[133] HCC5 Appendix 3.

Highway safety [134]

245.The Highway Authority does not object to either scheme on highway safety or capacity grounds. There is no reason for refusal relating to highway safety. The Transport Assessment submitted with the planning applications includes detailed analysis of road safety and it did not reveal any cause for concern.

Biodiversity [135]

246.There are no objections from statutory authorities or consultees on ecological grounds. The proposal would result in some minor temporary impacts on the foraging activity of badgers, but any temporary harm would be more than compensated for by the proposed ecological enhancements resulting in a net biodiversity gain.

247.Ecological benefits would include; new and reinforced hedgerows and woodland habitats, hibernacula features and log/brash piles, bat and owl boxes in retained trees, new wetland areas, and small-scale fields bounded by new hedgerows with species-rich buffer strips and woodland planting. The new habitats would be subject to an intensive three year period of establishment maintenance, followed by a regime of routine habitat maintenance for 3 to 10 years, and then longer-term conservation maintenance secured by way of a landscape and nature conservation management plan.

248.There is no reason to believe that these ecological benefits would be delivered by some other means, without the prior extraction of the minerals. This scheme provides an opportunity to secure long-term ecological benefits which accord with the published strategy for the LCA. This is a consideration that weighs in favour of the proposal in the planning balance.

Need [136]

249.If the Government's growth agenda is to be met and the housing crisis is to be resolved, a steady and adequate supply of aggregates is essential. At December 2017 the aggregate landbank in Hertfordshire was 7.5 years. Since that date, one new planning permission has been granted at Furze Field, which equates to just 3.88 months of additional supply. The fact that the LAA shows 7.5 years of supply does not mean than the actual landbank position can be ignored for the rest of the year.

250.With an annual apportionment of 1.39 Mt per year used to calculate the landbank throughout the year the landbank in May 2018 was 7.1 years. At the end of October 2018 the landbank sits at 7.1 years. Absent any further grants of permission, by the time the next LAA is prepared in December 2018 the landbank will be below 6.85 years. If landbanks fall below 7 years at any time, there will be an urgent need for aggregates which cannot be ignored if Government policy is to be given effect.

[134] APP5.
[135] APP9.
[136] APP10.

251.The *Framework* only requires the update of LAAs annually, but the obligation to plan for a steady and adequate supply of aggregates does not end with the preparation of a LAA. In order to maintain a steady and adequate supply of aggregates, landbanks should maintain at least 7 years for sand and gravel or longer, having regard to the productive capacity of permitted sites. In Hertfordshire productive capacity is dwindling as a number of quarries close.[137]

252.HCC claims that the landbank is likely to increase with the grant of permission for the BAE Aerodrome site, but there can be no guarantee. The BAE site is in the Green Belt, would adversely affect PRoW, would result in landscape and visual harm over a 30 year period, and falls to some degree outside the Preferred Area.

253.The appeal proposal provides a concrete opportunity to increase Hertfordshire's perilously low mineral supply and provide the aggregates that are urgently needed. That is a benefit to which very great weight should be given.

Alternatives

254.HCC's case focused not on the alleged harm caused by the scheme, but on comparing the appeal proposal with a theoretical scheme involving the joint working of Rickneys Quarry and the appeal site. That scheme is not before the Secretary of State: indeed it does not exist as a credible alternative and it is not a matter that should carry any weight against the appeal scheme.

255.It is only in exceptional circumstances that an alternative proposal will be relevant. The court has held that consideration of alternative sites would only be relevant to a planning application in exceptional circumstances and that generally; "such circumstances will particularly arise where the proposed development, though desirable in itself, involves on the site proposed such conspicuous adverse effects that the possibility of an alternative site lacking such drawbacks necessarily itself becomes…a relevant planning consideration upon the application in question*."* [138] For such an alternative to be a candidate for consideration there must at least be a likelihood or real possibility of them eventuating in the foreseeable future.[139]

256.HCC relies on a potential joint working between the Rickneys Site owned by Hanson and the appeal site, as a potential alternative. The only harm of which HCC complains that would be avoided by such working is the temporary access road. There has been no objection to any of the other infrastructure within the PA2 area. The access road would be temporary and it would not be enough to justify a refusal of planning permission. It would not affect the permanence of the Green Belt or indeed its openness because it is a necessary and proportionate element of the mineral extraction. Those are

[137] Excavation ceased in December 2017 at Westmill quarry; at Panshanger around December 2017; at Water Hall Quarry around Autumn 2017; and Pynesfield is shortly to cease.
[138] In *R (oao J (A.Child) v North Warwickshire BC* [2001] PLCR 31, Laws LJ, having reviewed the authorities including *Trusthouse Forte*, said at paragraph [30].
[139] *Mount Cook v Westminster City Council* [2003] EWCA Civ 1346 at [35].

not conspicuously adverse effects. This is not one of the exceptional cases where an alternative scheme is relevant.

257. Hanson and the appellants are working together to promote the allocation of their respective sites in the eMLP, but that does not mean that there is any prospect of them promoting a joint scheme at the present time. Currently neither site is proposed for allocation.

258. Unless Hanson secures planning permission for their Rickneys site, they have no interest in reaching an agreement with the appellants that would allow the use of their access.[140] But it is wholly uncertain whether planning permission will be granted, and without it a PA2 compliant scheme is not possible. There can be no confidence that the working of the appeal site as an extension to Rickneys is a realistic prospect in the foreseeable future. Vague alternative schemes should be given little or no weight, and do not constitute a valid reason for refusing the proposals.

Development plan [141]

259. For the 1.75 Mt scheme Phase 4, the stockpiling area and the temporary access road, a total of about 8 hectares of land, would be outside of PA2. But the vast majority of the site lies within PA2, where MLP Policy 3 provides that permission would be granted if the development contributes to maintaining the county's appropriate contribution to mineral needs, and where the site specific requirements are met.

260. PA2 explains that the access is via the existing access from the B158. However, it is not possible for the appellants to use that access as it falls outside of its ownership and its attempts to reach agreement with Hanson (who themselves are not the landowner but have an exclusive option over the access) had not proved to be fruitful.

261. For the BAE site HCC officers were satisfied that the proposal was 'largely compliant' with MLP Policy 3, notwithstanding the fact that 7.5 ha of land fell outside the PA1 boundary.[142] HCC is required to apply its development plan policies consistently.

262. MLP Policy 4 applies to proposals outside the Preferred Areas, which will only be allowed where the landbank is below the required level and there is a need for the proposal to maintain the county's contribution to need, and it can be demonstrated that the proposals would not prejudice the timely working of the Preferred Areas. There is no suggestion that this scheme would prejudice the timely working of other PAs.

263. Absent any other grants of permission, the landbank will be below 7 years by the next LAA in December 2018 and aggregates extracted from this site would plainly assist the county in making an appropriate contribution to local, regional and national need. Therefore, the appeal proposals comply with Policy 4. Even if they do not, they should be allowed as an exception to that

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[140] ID102. Until Hanson has secured planning permission for Rickneys, they are "dead in the water".
[141] APP10.
[142] HCC2 Appendix 5, page 49, paras 10.51 – 10.52.

policy, as were the BAE and Furze Field sites, when the landbank stood in excess of nine years.

264. Given the landscape, ecological and PRoW benefits and the absence of any unacceptable traffic impacts the appeal scheme complies with MLP Policy 9 (biodiversity); Policy 12 (landscape); Policy 13 (reclamation scheme); Policy 14 (afteruse); Policy 16 (transport) and Policy 18 (operational criteria).

265. EHDP Policy HERT4 makes the provision of 100 houses contingent upon the removal of minerals from the appeal site. Without the removal of the minerals, the delivery of the housing is in jeopardy. The potential allocation of HERT4 provided an impetus to extract the adjoining minerals quickly so as to enable that housing development to come forward without interference from quarrying activity. This influenced the timing of the application, but that is not the sole or even the principal justification for the proposed mineral development.[143]

266. Even if there is some limited conflict with MLP Policies 3 and 4, development plan policies often pull in different directions, and given the compliance with a raft of other policies in the MLP, and with Policy HERT4 of the EHDP, the proposal accords with the development plan read as a whole. The *Framework* makes it clear that great weight should be given to the benefits of mineral extraction, including to the economy, and that sustainable development should be allowed. The principle of mineral extraction on the land within PA2 is accepted on the basis that it constitutes sustainable development and HCC does not object to those elements of the scheme within the PA2 area, either on landscape or Green Belt grounds.

267. The 1.25 Mt scheme would have lesser impacts and the appellants would be content to proceed with that scheme. But the evidence about temporary harm to landscape, noise, air quality, water and planning must be weighed against the additional benefits compared to the smaller scheme of extracting more mineral, and would not justify a refusal. The purpose of the Inquiry was not to trick or badger a witness into concessions by repeatedly asking them the same question until they give a different answer. Unfortunately, Mr Symes was subjected to just that.

268. In both schemes noise impacts would be limited in geographical extent, degree and duration and would be well within the *Guidance's* upper limits for mineral working. Air quality impacts would be slight – negligible and would not give rise to any significant health effects, and the chalk aquifer would be adequately protected through the stringent conditions required by the EA. Some temporary harm to PRoW would be inevitable if the PA2 area is to be worked and those harms would be more than compensated for by the long-term benefits to the network. All of the potential harms raised by the parties would be temporary and reversible. The scheme would provide considerable long-term benefits to the PRoW, the local landscape and ecology of the site, and would provide minerals that are so needed to deliver the infrastructure that the country needs.

[143] APP7.

269. The benefits of both schemes, but particularly the 1.25 Mt scheme, clearly outweigh the temporary harms and the planning balance falls decisively in favour of the allowing the development.

Written representations

Pre-application community consultation

270. An insert about the proposal was included in the Parish Magazine in October 2015, and an exhibition held in November at the Bengeo Scout Group HQ. This was attended by about 80 people. A leaflet was provided summarising the scheme. Only a limited number of comment forms were completed. The principal matters raised are summarised in paragraph 7.4 of the ES.[144]

Application stage

271. A petition, dated 25 April 2016, with 806 signatures was submitted to HCC objecting on the grounds that the proposed gravel, sand and mineral extractions would have a profound negative impact on the local community, environment and wildlife. The signatories were concerned about the possible direct health effects of extraction works, and believed that the noise, dust and air pollution would be a nuisance, and almost certainly unavoidable. They strongly rejected any suggestion that there has been any consideration for the impact that lorry movements would have on local roads and infrastructure. Extracting 2.6 Mt of sand and gravel so close to the Wadesmill borehole would have a negative impact on the aquifer and HCC was urged to carry out an independent environmental assessment and hydrogeology study.

272. HCC received over 1,300 written responses objecting to the application for the 1.75 Mt scheme. The main objections are summarised as follows:[145]

- Impact on air quality/dust
- Impact on health
- Impact on highways affecting pedestrian/cycle use of Wadesmill Road
- Adverse impact on landscape and the Green Belt
- Impact on Byway No.1 and loss of recreational area used by the public
- Impact on ecology
- Noise.

273. HCC received over 1,000 written responses objecting to the application for the 1.25 Mt scheme. The main objections are summarised as follows:[146]

- Proximity to existing dwellings and a primary school
- Impact on air quality/dust
- Impact on health
- Impact on highways affecting pedestrian/cycle use of Wadesmill Road/road safety
- Impact on visual amenity/landscape and the Green Belt
- Impact on Byway No.1 footpaths and loss of recreational area used by the public

[144] CD2 document 1.
[145] CD5 paragraph 8.5.
[146] CD18 paragraph 8.2 and 8.7.

- Impact on ecology/habitat destruction
- Noise impact on occupiers of nearest residential properties
- New Minerals Plan does not include the site
- No urgent need to quarry
- Loss of historic value/impact on archaeology
- Concern regarding risk to groundwater and water supply.

274. Two e-petitions were received entitled "Hertford is worth more than gravel – petition against a new quarry in Bengeo Field" and "Protect our public rights of way and views from quarrying on Bengeo Field (Land at Ware Park)".

Written representations submitted prior to the opening of the Inquiry

PINS received five other written representations in the lead up to the Inquiry.[147] The views expressed are summarised as follows.

275. Mark Prisk MP Member of Parliament for Hertford and Stortford supports HCC's refusal of the application. The proposal is opposed by the vast majority of local residents. The scale and location is inappropriate. The impact on the environment and potential risk to the health of local school children is unacceptable. An extra 100 HGV movements a day would have a considerable impact on already congested local roads and road safety at the school, especially if concentrated around working day peak hours. There has been no independent environmental assessment of the impact on local wildlife and ecology. Dust will impact up to 400 m from the site and the *Framework* states that there should be no unacceptable adverse impacts on human health. There is a potential risk to the local water supply and no independent assessment of local geology has been undertaken. There is no need for the gravel as HCC has a current landbank of suitable sites which will provide at least 15 years supply. Upholding this appeal would be irresponsible given the risk to the health of thousands of local people.

276. Rt Hon Sir Oliver Heald QC MP Member of Parliament for North East Hertfordshire fully supports the campaign group, Cllr Stevenson, Cllr Crofton and Cllr McMullen in their objection to this proposed quarry, and would be grateful for these concerns to be taken into account.

277. Watermill Estate Residents' Association restated its opposition to sand and gravel extraction. The association does not believe that the extra information provided by the appellants is sufficient to justify quarrying in this area for the reasons put forward by SBQ. Of utmost importance is the fact that HCC is not recommending this to be a Preferred Area in the eMLP.

278. Roger Bardle (local resident) strongly objects to the appellants' second application. Nothing has changed regarding its total unsuitability as a quarry site due to its proximity to a primary school and housing developments, along with the many other environmental concerns regarding increased lorry traffic on a pleasant rural road, increased all day noise and its proximity to water supplies.

279. Laura Wyer (local resident) by email dated 19 March 2018 sought clarification about which scheme was being considered. She considered the

[147] Appeal file.

matter to be very confusing, especially as it had been re-confirmed that the appeal would be against the original 1.75 Mt scheme. Members of the public will have responded to an appeal against the 1.75 Mt scheme and have not had the chance to respond regarding the amended 1.25 Mt scheme.

Inquiry stage

280. The Planning Inspectorate received more than 500 written representations at the appeal stage objecting to the proposal.[148] In some cases the submissions made it clear whether the objection was to the 1.75 Mt scheme or to the 1.25 Mt scheme, but this was not evident in many cases. Some commented on whether the 1.25 Mt scheme would address the objections to the 1.75 Mt scheme. The views of all those who made submissions are summarised below.

281. The effects on air quality and health were raised by about 90% of the objectors. Many consider that the scheme would have a detrimental impact on air quality and would pose health issues for local residents, especially for children at Bengeo School and using the playing fields. The proposed quarry site is 350 metres away, opposite the primary school with a large staff supporting more than 500 three to eleven year olds. Dust from the quarry would contain tiny crystal particles. Research based on the monitoring of workers in a quarry digging up the same sand and gravel has found it to contain carcinogens. There is an undoubted risk of exposure to fine particles of silica dust. This is a fact that is acknowledged by numerous bodies and is indeed referenced in the consultation document for the eMLP. Inhalation of silica dust is known (UK HSE) to cause health issues, including lung disease, silicosis, chronic obstructive pulmonary disease (COPD) and lung cancer.

282. Damp material will quickly dry out as Hertfordshire is one of the driest parts of the country. Mobile dry-screening at the point of extraction would bring additional risk of airborne dust. Stockpiled supplies would dry out and generate dust on loading. During dry weather the mobile plant, both on-site and leaving the site, would generate dust as it moved around and was loaded. The hazards of quarry dust include respiratory silicosis, COPD, lung cancer, chronic bronchitis and emphysema. While admittedly those at greatest risk would be quarry staff, there is sound risk that vulnerable residents with respiratory issues and children with developing lungs would be affected through airborne disbursement; airborne dust would also have impact on eyes and skin. The precautionary principle should be adopted concerning the effects of $PM_{2.5}$. The appellants have used meteorological data from Luton airport, which does not provide for a local microclimate. Some expressed concerns about the ability of HCC to enforce controls, where the risk zone for dust is 1,000 m according to Technical Guidance.

283. Concern that the main aquifer supplying water to Hertford would be affected was raised by 80% of the objectors. It was considered that the aquifer would be placed at high risk of irreversible contamination should quarrying be permitted at the proposed site. Fractures in the subterranean materials would allow pollution to reach Wadesmill PS swiftly. There is a need to survey the size and orientation of fractures within the chalk. This is not a

[148] Two blue folders.

case for monitoring but for prevention. The risk of damaging a water supply seems too great for a county abundant in sand and gravel.

284.Some 70% of objectors commented on the likely effects of the additional quarry traffic for highway safety. The B158 is a country road that is already congested at peak times by people accessing or leaving Bengeo. There have been deaths and serious accidents on the B158 and queueing lorries, as well as lorries coming and going, would have a serious impact on road safety and the ability of residents to come and go. It would simply be too dangerous to use the B158, and local residents would have no alternative but to drive the opposite way into Hertford, to leave the area, adding to an already congested route at peak times. The right hand turn into the site would be dangerous.

285.About 65% of the representations raised concerns about the loss of amenity and recreation value. Many noted that the Byway that runs through the middle of the proposed quarry is registered as an Asset of Community Value. Local residents want to continue using Bengeo field as a local amenity for families, ramblers, runners and cyclists. Many commented on the walk, or walking their dog, from Bengeo over to Chapmore End/Tonwell through the beautiful countryside. Others recorded that the continuation of Herts health walks is an important consideration for the whole community in Bengeo and Hertford, adding that the scheme would impact on their ability to walk and unwind with family and friends in the area. The loss of this amenity would be further impacted due to the plant operation being adjacent to the footpath. Lorries would have to cross the footpath for site access/egress onto the B158. Quarrying the land in this area would have severe and detrimental effects to residents' health and a notable loss of community, since children would be less likely to ride their bikes, play in the park and spend time outdoors with family and friends, due to the noise, increase in traffic and air pollution.

286.About 60% of objectors referred to the effects of noise from the operation in a quiet local area. Some described this as a semi-rural area and valued its tranquillity. Others added that quarry noise is one of the major complaints in nuisance cases against existing quarries. Investigations for health and safety reasons show that plant work (e.g. gravel) was the second noisiest industry for workers to be involved in. The houses sited within a few metres of the quarry and the school within 500 m would both be seriously affected. It was noted that there is now a newly proposed mobile dry-screening process to add to the original noise damage.

287.Some 50% of objectors raised concerns about the effects of the proposal on the local landscape. Many considered it to be a beautiful and valued landscape, with unique views across the River Rib to Ware Park and to Three Lakes, with views back to the site from the Three Lakes Restaurant. It is the entrance to the historic county town. The quarry would spoil the rural landscape, and it would not be possible to screen the development in any meaningful way because of the contours. The bunds would be ugly, especially if not effectively managed. The bank near to the edge of St John's Wood would affect a local beauty spot and the local hydrology. Many commented on the proposed restored landform, noting the drop in the level of the field. Some considered that it would leave a gigantic hole in the countryside. The landform of the proposed site would be irreversibly degraded, leaving a landscape irreparably damaged. The site is surrounded by gravel pits that have left a long term scar on the landscape.

288. The eMLP was cited by 40% of the objectors. Some considered the proposal to be premature. The eMLP has already been approved by the HCC Environment Panel and this goes against any quarrying in Bengeo Fields. It recommends that Bengeo Field should not be a Preferred Area for quarrying. This is expected to be approved in 2018.

289. Harm to the Green Belt was cited by about 40% of objectors. Some commented that the buildings, bunds and equipment would impact adversely on the openness of the Green Belt. Others considered that the quarry would destroy a valuable piece of Green Belt land.

290. Some 25% of objectors pointed out that the appellants are proposing to work outside the current Minerals Preferred Area (Phase 4 and stock piling, along with the site area adjoining Sacombe Road, the Wick and The Orchard). This MLP area was agreed as a Preferred Area only as an extension to Rickney's quarry. The appeal is not, therefore, compliant with the current MLP.

291. Others commented on the effect on the Green Belt and impact on the landscape, both of which were considered to be vital to health and wellbeing in modern-day life. Reference was also made to this area enduring years of gravel extraction at Waterford, Stapleford, Rickneys Quarry, Westmill and Panshanger Park, which have all left scars behind. None of this land would be returned to the original farmland for growing food crops. With Brexit agricultural land will be more important to the long term economy.

Written representations about the HIA submitted during the adjournment

The views expressed about the HIA in the 156 written submissions received are summarised as follows.[149]

292. Many considered that the HIA is flawed and discredited because it is based on assumptions, average data or research that is out of date. The desk-based HIA is selective in the examples used in drawing its conclusions and lacks empirical data, especially about the site and its locality. The HIA is based on uncritical acceptance of the ES and the appellants' evidence, and so its impartiality and objectivity are questionable, with some describing it as subjective speculation. By ignoring the evidence from other stakeholders the HIA has ensured that every contributor to it has a commercial interest. There should be reference to the research that underpins the HIA's conclusions. Furthermore, there is ambiguity about whether the HIA is referring to the 1.75 Mt scheme or the 1.25 Mt scheme, particularly with regard to the ES.

293. The HIA was not done at the outset of the project and so was not done as an informative tool, but as a tick-box exercise. It did not invite participation from the people most affected or give weight to local knowledge. Some questioned whether the HIA should be accepted because it was produced for Ingrebourne Valley Ltd and not the appellants. The HIA's conclusion that the quarry "is unlikely to have significant adverse effects on population health" is not reassuring given that 'unlikely' and 'significant' are undefined and the

[149] ID93. Annex B to this report includes a list of those who made the written submissions.

community is concerned not only about population health, but also about sensitive and vulnerable individuals.

294.The air quality model used should not be relied upon because the emission rate is not identified and emission rates were modelled as a point estimate, without any sensitivity analysis to investigate best and worst-case scenarios. The IAQM recommends against quantitative modelling due to a high level of uncertainty over emission rates. Air quality observations should have been taken at similar quarries in the area.

295.The WHO guidelines must be taken into account in dealing with the UK's poor air quality. The HIA acknowledges that local levels already exceed WHO guideline levels, but bafflingly goes on to state that air quality in Bengeo is "generally good". Defra's *Clean Air Strategy* consultation 2018 refers to cutting public exposure to PM levels above WHO guideline levels (10 $\mu g/m^3$). Recent studies have associated a loss of brain ability with air pollution. The HIA's assumption that the higher potential for dust in dry conditions is balanced by the supposition that wind speeds are lower in warmer months is ludicrous. Stockpiles would dry out and generate dust on loading, as would mobile plant. The HIA is based on 2017 data, but this is insufficient given the long dry spell of the summer in 2018, where an increase in levels of ground dust was evident.

296.Dust and particulates from diesel vehicles can exacerbate and trigger symptoms for asthmatics. Given the proximity of the school and houses it would be inevitable that there would be cases of respiratory illness attributable to the quarry workings. The 2015 consultation document for the eMLP states that sensitive sites can be affected by dust up to 1 km from the source. The 2005 MPS2 states that PM_{10} may travel 1,000 m or more and is widely recognised as being associated with effects on human health.

297.The WHO Health Effects of Particulate Matter 2013 set out the health effects of inhalable PM due to exposure over both the short term (hours, days) and long term (months, years), including aggravation of asthma, respiratory symptoms and an increase in hospital admissions. It states that exposure to PM affects lung development in children, and added that "There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur." There is a clear risk to the health of residents and school children from quarry dust, especially those with pre-existing conditions.

298.Vulnerable children would be restricted to their home with all windows closed and not able to enjoy much valuable time outdoors, either in gardens or using local amenities. There is evidence that air pollution results in higher blood pressure, and research at Queen Mary University of London found that even 'safe' levels of air pollution are linked to heart abnormalities similar to those seen in the early stages of heart failure. There is evidence that outdoor particulates may have been shown to infiltrate indoor school environments. It might take years to find out the actual impact on health from irreversible damage, such as silicosis and lung cancer.

299.The HIA applies the UK/EU $PM_{2.5}$ threshold of 25 $\mu g/m^3$ which is higher than more recent thresholds established by WHO (10 $\mu g/m^3$, 2014) and in other countries. The appellants' modelling shows that sites surrounding the appeal site exceed 10 μg/m^3 without a quarry. Any increase cannot be justified. Furthermore, there is uncertainty about the projected base line figures derived from Defra's model, and it seems appropriate that actual baselines are determined by monitoring at sensitive sites to inform a more accurate risk assessment. Annual PM figures cannot be used to assess health risks for children attending Bengeo School. This approach hides daily fluctuations in particulate levels, particularly as quarry working hours would mirror times of school attendance. In addition, children are more likely to be outdoors in dry weather when dust risk is higher. The risk assessment should account for the 24 hour variation. The HIA averages emissions across all phases of the project, which would take many years to complete. However, different results would be obtained by calculating the average across the year in which activities would be closest to the nearest receptors.

300.The modelling used in the HIA is not sufficient to give an accurate idea of dust emission rates over time, and key information about how bad dust would be when work is happening close to receptors is missing.[150] Based on 1 in 11 of the UK population having asthma, an estimated 43 children at the school have a diagnosis of asthma. There is evidence that the health of this group would be likely to be compromised by even a small increase in PM.[151] A study has found that for every 10 μg/m^3 increase in PM_{10} the number of asthma cases increased by around 4%. Another study about school absenteeism found that for every such increase there was an increase in absences of 2.5%.

301.IAQM data indicates that properties within 300 m of the quarry could be exposed to between 5-10 μg/m^3 extra PM_{10}.[152] The WHO report confirms that this would have a measurable effect on mortality. The evidence on the health impact of poor air quality is rapidly advancing and even small increases in PM of around 1 μg/m^3 in the long-term average can have a significant health effect. Recent research shows that small short-term increases in $PM_{2.5}$ of around 6 μg/m^3 averaged over three days also has statistically significant and clinically meaningful impact on the health of vulnerable groups. The elderly and children are, depending on the pollutant and health outcome, more susceptible to changes in air quality.[153] Both these groups are over-represented in the population around the appeal site. Despite this the HIA does not attempt to quantify the health risks in relation to the predicted decline in air quality for the general population or vulnerable groups. The WHO has an online tool to perform this calculation (AirQ+). The quarry would further burden the NHS in the long term.

302.There is no reliable evidence on how much silica dust would pollute the air around the quarry. On average it forms 15% of PM_{10} dust for a lot of quarries. Details about the size-distribution and composition of the material in the Kesgrave formation would be needed to do so, but is absent. The HIA should be based on relevant observational science not models and

[150] ID93 (130) provides more details about the modelling method.
[151] ID93 (21) cites 8 peer reviewed studies and (130) includes extracts from WHO and research in New Zealand.
[152] CD35.1 page 35.
[153] ID93 (132) states 3-48 times more sensitive compared to adults.

regulations. Carcinogenic RCS dust is a hazard, but the HIA relies on dust not being generated, which has not been the experience at other sites. Personnel working at the quarry under HSE regulations would need to wear protective clothing, but such stringent rules would not apply to the general public in the locality. It only takes a very small amount of airborne RCS dust to create a health hazard. Some US states have set stringent silica exposure guidelines, which would be exceeded if the proposed quarry resulted in 1.5 $\mu g/m^3$ of silica per 10 $\mu g/m^3$ increase in PM_{10}. The residents of Bengeo should not be exposed to this obvious risk. Site specific observations should have been taken to exclude the risk of exposure to this highly toxic and carcinogenic material. Defra limits do not give a level at which there can be confidence that no health effects would result.

303. The HIA takes no account of previous sand and gravel extraction in the wider area, with its resultant environmental disruption, degradation and breaches of undertakings. The legacy of mistrust remains and the community has no confidence about the undertakings on which the findings of the HIA rely. The late submission of the HIA has not fostered a trusting relationship with the community. Given past experience with the tobacco industry, asbestos, inflammable cladding, illegal engine emissions, and accelerated climate change, the community is unconvinced about reliance on regulations and controls. There are also concerns about the enforcement of dust control measures, such as securing loads and wheel washing. Local people have no confidence that essential and appropriate care would be taken to mitigate the risks. The loss of trust has a significant negative effect on the health and well-being of the community. The local community's legitimate fears are based on knowledge.

304. The long-term risk to Hertford's water supply in the HIA ignores the expert evidence adduced at the Inquiry, and no ground survey has been carried out to assess the roughness of the underlying chalk surface. Without the latter the use of excavators with GPS could not be implemented with any confidence. Removal and disturbance of the existing protective layer would permanently increase the vulnerability of the underlying chalk aquifer. Mapping top chalk techniques have yet to be established with confidence, and so the precautionary principle should apply. Promises cannot prevent equipment failure or human error.

305. Spill kits and notifying relevant authorities would not prevent transmission of pollutants through the highly permeable residual Kesgrave formation. Spraying water to dampen dust would permeate the chalk beneath causing permanent damage to the aquifer. Pollution of the low-permeability chalk lying between the fractures and fissures would be long lasting and very difficult to remove. The HIA contains no long term analysis of the consequences of water pollution during or following the proposed quarrying. The possible serious and irreversible health consequences of pollution of the aquifer and a loss of water supply have not been assessed.

306. There is no reference in the HIA to the Acoustics Associates Noise Assessment.[154] The noise levels at the nearest properties would breach policy

[154] HCC1.

guidelines. Starting at 0700 hours and working on Saturday would cause unacceptable additional noise. The distressing noise level would adversely affect human health.

307. The HIA is misleading about the effects of the proposal on the use of local footpaths. The quarry would not create health benefits for the community as it would have a negative effect on physical activity participation rates. Health walks would not be organised next to a working quarry. The quarry would be a danger for horses and equestrians riding nearby. The proposed permissive paths are already well used by the public because it is a very pleasant open landscape with views across the Rib Valley. The value of new footpaths would be much diminished in a landscape that was no longer as beautiful and safe as it currently is.

308. The proposed eastern footpath loop close to the B158 would not be well used and so would be unlikely to be a significant health benefit. Dust and noise pollution from the quarry could deter use of the allotments and so reduce the health benefits of this recreational activity. The role of countryside, trees and open spaces is becoming recognised to have positive effects on people's health, state of mind and productivity. Overall, the scheme would result in less recreational use of the area, and so would have a negative effect on health and well-being.

309. Some respondents have no faith that the quarry would be put back to agricultural use or renovated at all. There is also concern that it might become a refuse waste site. The HIA recommends that certainty should be provided on the duration of Phase 1. However, extraction would depend upon demand unless a maximum duration was certain and could be enforced with some penalty.

310. The proposal over the last three years has already resulted in stress and anxiety for the local community. The time, resources and mental anguish expended on opposing the quarry has also had an adverse economic impact on the local community. The assertion in the HIA that the project has contributed to community empowerment and self-efficacy with potentially beneficial effects on population health is risible. Not enough weight has been given to the mental impact that a quarry nearby would have on all generations.

311. The HIA recommends a minimum stand-off for dwellings at The Orchard, but ignores the presence of other closer properties.[155] There is no equivalent stand-off recommended for the properties in Sacombe Road, which would be closer to Phase 2 than would The Orchard to Phase 1, or for properties on Wadesmill Road. The HIA focuses on populations, but loses sight of the individual and the fact that some lives might be devastated, especially those living so close that they would be directly affected.

312. The effects of queuing HGVs during the rush hour, and lorry collision data has not been analysed. The baseline for traffic may be too low because of

[155] In paragraph 11.2.3 of the HIA the recommendation for air quality is that the Phase 1 boundary should be revised to ensure a 100 m buffer between the closest residential property and the earth bund.

consented quarries in the locality which are not currently operating. The HIA recommendation that no traffic would enter or leave the site during school opening and closing times is meaningless as it is not part of the proposal. Increased road traffic and noise would take a toll on the health of the community, including deterring cycling, with associated adverse health effects. There are no street lights along this part of the road. Pedestrians using the local footpath already find it difficult to cross the B158 near to the entrance to the proposed quarry access, and additional HGVs would make this worse. Those using the proposed footpath parallel to the B158 would have to cross the quarry access, and those using the Byway would need to cross the haul road, which would be hazardous. Mud and gravel from quarry vehicles on wet roads is a safety hazard. Wheel washing is proposed, but the HIA states that there is no water available for licensing.

313.Many commented that for the reasons set out above, the HIA does not represent a true and complete picture of the likely health impacts of the quarry, and that the scheme is not worth the risk to public health. There is little in the HIA that reassures the residents, other than monitoring, which would be too late. The proposal should only be supported if there was no risk to health. This has not been categorically and clearly demonstrated. The HIA does not meet these requirements.

Written representations from other consultees

The following sets out the views of other consultees, where these are not summarised elsewhere in this report.

314.East Herts District Council raised no objection in principle, but noted that the landscape in part comprised elevated open land, which was publicly accessible in the immediate surroundings of Hertford. The council cited the concerns of local residents and recommended an independent noise assessment. Concern was also expressed about additional HGVs on Wadesmill Road, and that highway safety improvements should be considered.

315.The proposed bunds were considered by the Council to be alien elements in the landscape that should not be permanent features. The impact on the landscape in the longer term was highlighted because the sloping land on the eastern side of the site is the most visually sensitive. Byway 1 offers attractive high-level views eastward over the River Rib valley. The Council suggested possible opportunities to improve the PRoW network in the longer term as part of the restoration.

316.Hertford Town Council objected to the application and considers that the location is completely inappropriate because of concerns about noise, traffic, visual impact and dust. Should the proposal go ahead strict controls would be necessary on hours of working (with no weekend working), vehicle movements (including prevention of vehicle access into Bengeo), monitoring noise, maintenance of road surfaces and drains.

317.Public Health England noted that it is clear that air pollution, from a range of sources, not solely from the proposed quarry, is a potential threat to the health of the wider community. It acknowledged that those with pre-existing respiratory conditions, such as cystic fibrosis and asthma, are considered a sensitive population if exposed to airborne pollutants, such as particulate matter. Reference was made to the provisions of the *Framework* concerning unacceptable adverse impacts, and that the developer of the quarry would be required to satisfy relevant authorities and the community that its operation would not result in additional emissions which could adversely affect the local community.

318. The Environment Agency (EA) has commented on the 2.6 Mt, 1.75 Mt and 1.25 Mt schemes.[156] In April 2016 the EA stated that the site lies in a highly sensitive groundwater area within a SPZ1. It noted that the proposal would be located very close to a public water supply abstraction, and that it is essential that there is no harm to the water environment as a result of the development. The EA considered that planning permission could be granted subject to the imposition of five planning conditions. These concerned; 1. long-term ground water monitoring in respect of contamination and turbidity, and any necessary contingency action, 2. no importation of waste, 3. a remediation strategy for any contamination, 4. controls on the infiltration of surface water drainage, and 5. a scheme be approved for the disposal of foul water. The EA advised that the effluent discharge rates expected from the development and its location within an SPZ1 means that a non-mains foul drainage solution would require an Environmental Permit.

319. In the same consultation response the EA recommended that conditions be imposed, wherever possible, that would make the development air quality neutral. It added that the site is located in an area of significant concern regarding air quality and that there are already high levels of PM_{10} and NO_2. Robust conditions were recommend to address mineral screening, road sweeping, road surfaces, wheel washing, vehicle and plant emissions, reducing vehicle idling, construction logistic plans, diesel or petrol generators, chutes/conveyors and skips, covering vehicles, along with advice on using dust suppressants.

320. In January 2017 the EA advised that as the amended plans did not alter the groundwater protection measures the EA had no additional comments to make. Following discussion with AW the EA in March 2017 requested an additional condition to repair borehole OBH 1A.

321. The EA in April 2018 reiterated the above response when consulted about the 1.25 Mt scheme, but revised the wording of the condition about boreholes to include approval of a scheme for future maintenance, schedule of repairs and a contingency action plan, along with how redundant boreholes would be decommissioned and those retained secured, protected and inspected. The condition concerning foul drainage was amended to include approval of a scheme to dispose of foul and surface water, and to agree pollution prevention measures for the storage of pollutants in SPZ1.

322. The Lead Local Flood Authority accepted the approach and detail set out in the appellants' Flood Risk Assessment. It has no objection in principle, subject to pre-commencement conditions on drainage details.

323. Hertfordshire Ecology noted that although the site is arable farmland it adjoins Waterford Heath Local Nature reserve and St John's Wood, Rickneys

[156] CD13.

Quarry and Waterford Heath (North and South) Local Wildlife Sites. Adverse effects on these protected areas cannot be ruled out. There is uncertainty about the impact of the depression on surface and sub-surface flows of water. Prevailing winds may increase the threat to the ancient woodland from dust. There is also uncertainty about whether a 20 m buffer would prevent harm to protected sites. The proposals for a calcareous grassland area around the balancing pond are not compelling. The proposed aftercare period would be inadequate to establish semi-natural habitats. An alternative and more appropriate mitigation strategy could provide real and sustainable gains in biodiversity.

324. Herts and Middlesex Wildlife Trust endorsed the comments by Hertfordshire Ecology and the need for more information to demonstrate that the proposal would comply with the aims of the *Framework*.

325. Bengeo Rural Parish Council objected to the proposal raising concerns about highway safety given that the B158 is a fast and dangerous road on which there have been fatalities. Any conditions imposed should be at least in line with, or more stringent than, those imposed for Rickneys Quarry.

326. Affinity Water (AW) stated that after a site visit with the appellants it was agreed that the following would be implemented; "300 m zone of unworked basal layers from the Wadesmill PS of 5 m thickness; 500 m zone of unworked basal layers from the Wadesmill PS of 3 m thickness; rest of site unworked basal layer 1 m thickness". AW proposed that the above be made conditions to ensure that the Wadesmill PS was protected from any potential pollution that could be initiated from the proposal. It was also agreed that borehole 1A should be repaired. AW noted that the construction works may exacerbate any existing pollution and that if pollution was found then appropriate monitoring and remediation works would need to be undertaken.[157]

327. The Woodland Trust objected on the basis of likely damage to St John's Wood because of an inadequate buffer. It is concerned about the cumulative impact of fragmentation as a result of the separation of semi-natural habitats, the proposed development being a source of non-native plants, noise and light pollution, and changes to hydrology. An undisturbed buffer of at least 100 m would be necessary, allowing for a total distance to the ancient woodland edge of 30 m. The ancient woodland is sensitive to dust, particularly epiphytic lichens. Noise would potentially have an adverse effect on woodland species.

328. The Council for the Protection of Rural England (CPRE) objected to the scheme on the grounds that it would not comply with the specific considerations of the adopted plan concerning working of this site as an extension to the existing Rickneys Quarry. Land south of Rickneys cannot be independently worked without major disruption to the use of Byway 1 and that the land to the east of the Byway would be in a much more exposed landscape. The proposed stockpiling, plant storage, and other operational areas of the site heavily used by mobile plant and haulage vehicles, is within the area considered to be vulnerable to potential pollution of a major water

[157] ID103.

supply aquifer. Phase 4 would be within 100 m of the Wadesmill PS. CPRE commented, regarding the emerging plan for housing to the south of the site, that either all the sand and gravel resource identified in the adopted minerals plan should be extracted in accordance with the provisions of the statutory plan or the proposed quarry should not be granted planning permission.

Conditions and obligations

Conditions

329.HCC and the appellants largely agree about the imposition of planning conditions in the event that planning permission was granted for either the 1.75 Mt scheme or the 1.25 Mt scheme, but two issues remain in dispute.[158] These concern; (1) whether permissive rights of way should be available for cyclists and horse riders in addition to walkers, and (2) restrictions on the number of certain plant on-site at any one time, and specifying a maximum SPL for plant. SBQ suggested additional conditions about air quality and hydrology.

330.SBQ suggested that Condition 9 should include an approved routeing plan and/or management scheme to include a booking system for HGVs. SBQ also suggested that Condition 16 should require a stretch of level ground of at least 5 m from the edge of the right of way, and that any steep banks should be fenced. A more detailed condition was advocated by SBQ to deal with the maintenance of boreholes. Concern was expressed by SBQ and others about the proposed hours of operation.

331.SBQ agrees with the need for a comprehensive dust management plan (Condition 34), but considers that the minimum requirements would be inadequate to address SBQ's concerns regarding air quality related health impacts. Measurements of hourly average concentrations of PM_{10}, as opposed to the daily average limit value for PM_{10}, should be the basis for further mitigation and/or cessation of operations in SBQ's submission.

332.SBQ agrees with the need for a comprehensive air quality monitoring scheme (Condition 35), but considers that one monitor would be insufficient. SBQ added that the data should be made available to the public in 'real time', so that vulnerable members of the public in particular could use it to manage their exposure to any heightened short-term concentrations that may arise.

333.Reference to SBQ's involvement in the Community Liaison Group was requested.

334.Condition 41 is agreed in principle by SBQ, but the time period for noise monitoring at three monthly intervals should be extended to cover at least Phases 1 and 2 of the extraction process. Afterwards, there should be a maximum interval of 6 months between each monitoring exercise for the remainder of the development.

335.Cllr Stevenson considers that the true traffic morning peak time in this location is 7.30 am to 9.30 am, and that the restriction on HGV movements to 8 vehicles should apply throughout this time.

[158] ID97.

336.The suggested planning conditions were considered at a without-prejudice discussion about possible planning conditions, which took place towards the end of the Inquiry. In addition, the parties made written representations about revisions to the suggested conditions prior to the close of the Inquiry.[159] The written list of suggested conditions endorsed by the appellants includes pre-commencement conditions.

Obligations

337.The section 106 obligation includes a clause that if the Secretary of State concludes that any of the obligations are not compatible with any of the tests set out in Regulation 122 of the Community Infrastructure Regulations 2010 (CIL Regs) and attaches no weight to that obligation then that obligation shall cease to have any effect and there shall be no obligation to comply with it.

Consideration of an amended scheme at the appeal stage

Interested persons

338.In commenting on the HIA two respondents objected to being denied the opportunity to object to an appeal against the refusal of the 1.25 Mt scheme at a formal inquiry. If the current appeal was to be determined on the basis of the 1.25 Mt scheme this would neutralise and confuse any opportunity for comment or objection to an appeal against the refusal of that scheme, effectively inhibiting objections to any such appeal.[160]

Stop Bengeo Quarry

339.SBQ considered that it is for the appellants to satisfy the Secretary of State that a condition could lawfully be imposed to effect the change from the original to the amended scheme. The 1.75 Mt and 1.25 Mt schemes differ in multiple significant planning aspects beyond the comparative volumes of aggregate proposed to be extracted. For example, the proposed relocation of the load out area would heighten the risk of groundwater pollution. The appellants failed to properly clarify which evidence and which plans/drawings were submitted in respect of each scheme. The appellants' case for consideration of the amended scheme is weak and is not assisted by the lack of clarity in the appellants' conduct of the Inquiry proceedings.[161]

Hertfordshire County Council

340.The legal test here appears to be; (a) is the development in substance that applied for, or instead "substantially or significantly different" or a "fundamental alteration", and whether the procedural requirements have been complied with, without "sidestepping" the rights of others which must be fully protected. This includes principles of procedural fairness.[162] The combination of the fact that the schemes are different, along with the procedural unfairness, which has arisen from the way the appeal has been

[159] ID97, ID98, ID112 and ID113.
[160] ID93.
[161] ID75. This is dated 16 May 2018. SBQ's closing submissions made no reference to this issue.
[162] *Holborn Studios v Hackney LBC*.

dealt with, mean that the Secretary of State should not consider the 1.25 Mt scheme via a substitution by condition.[163]

341. There are no severable or divisible parts of the 1.75 Mt scheme. It is not just a case of omitting the stockpile and Phase 4, because the 1.25 Mt scheme has all different plans for operational phases and restoration, a different ES and supporting reports, different location of plant, different noise impacts, different bunds, along with different buffer zones.

342. The chronology here is confusing because the procedure adopted by the appellants is so out of kilter with any accepted or statutory practice. The 1.75 Mt scheme was refused and appealed before the 1.25 Mt scheme had been submitted to HCC. But SoC1 pursued only the 1.25 Mt scheme, for which at that stage there was no ES. When asked to clarify this the appellants confirmed on 7 March 2018 that permission was sought for the 1.25 Mt scheme, and that all the representations on the 1.75 Mt scheme could be taken into account in considering the 1.25 Mt scheme. But that is no substitution for the ability to make representations to the Secretary of State on the 1.25 Mt scheme in the appeal. There are two stages for public comment and the second stage has been bypassed. The adjournment of the Inquiry to October to enable comment on the HIA has not cured any unfairness, as HCC presented its evidence in May and the resumed Inquiry was not an opportunity to go over that ground.

343. The 1.75 Mt scheme was abandoned in SoC1, but was resurrected in order to allow the 1.25 Mt scheme to piggy back on it, causing a procedural morass. This is unacceptable in principle and the Secretary of State should not countenance or endorse this approach, which would be contrary to the Planning Inspectorate's guidance.[164] This guidance provides that the appeal process should not be used to evolve a scheme, and that what is considered should essentially be what was considered by the local planning authority, on which interested people's views were sought. It adds that where exceptionally amendments are proposed they would have to comply with the *Wheatcroft* principles. The 1.25 Mt scheme should not be substituted. The appellants should be required to go through the normal appeal process for the 1.25 Mt scheme.[165]

Appellants

344. The Planning Inspectorate's Procedural Guidance refers to the *Wheatcroft* principles. The power to amend a scheme in this way is subject to two constraints: one substantive and one procedural. Neither applies here. Permission should not be granted for a development that would be substantially different (when viewed in context) from that which the application envisaged. It is in the public interest to adopt a liberal approach to this consideration as it may enable permission to be granted without the need for a further application, delay and additional cost to those involved.[166]

[163] ID76.
[164] *Planning appeals: procedural guide*, Annexe M, last updated 26 September 2018, Planning Inspectorate.
[165] ID72, ID76, ID4 paragraphs 28, 34 and 40; and ID110 paragraph 2b.
[166] *Holborn Studios v Hackney LBC*.

In the context here, the 1.25 Mt scheme is not substantially different to the 1.75 Mt scheme. HCC did not consider the 1.75 Mt scheme to be substantially different from the original 2.6 Mt scheme. The differences set out in ID26 relate to the removal of Phase 4 and the stockpiling area, along with a revised landform following restoration. There are no procedural constraints to granting permission for the 1.25 Mt scheme as it has been subject to consultation by HCC and all the representations are before the Inquiry. Both schemes have been subject to EIA.[167]

345. No real prejudice has been identified. No new issues arise in the 1.25 Mt scheme. None of the witnesses to the Inquiry identified any matter upon which they would have given evidence had they been allowed more time, or suggested that there was uncertainty arising from the changes. It is entirely unsurprising that the amended scheme relied on different supporting documents. No fee was payable for the planning application for the 1.25 Mt scheme, so HCC must have concluded that the 'character and description' of the amended scheme was the same. Unfairness under the *Holborn Studios* procedural test cannot possibly have arisen because the 1.25 Mt scheme was subject to consultation by HCC, and a substantial proportion of Inquiry time was given to hearing evidence from the public.[168]

[167] ID77.
[168] ID88.

Conclusions

Preliminary matters

346. The following conclusions are based on the written submissions, the evidence given by those who appeared at the Inquiry, and inspections of the site and its surroundings. In this section the figures in parenthesis [ ] at the end of paragraphs indicate source paragraphs from this report. [11]

347. The application was for the extraction of 2.6 Mt of sand and gravel, but Hertfordshire County Council (HCC) considered a revised scheme for the extraction of 1.75 Mt. This is the appeal scheme. HCC refused the application on six grounds. Reason (3) concerning impact upon air quality, and the absence of a Health Impact Assessment (HIA), was subsequently the subject of a statement of common ground, and these matters were not pursued by HCC at the Inquiry. [2,3,7,147]

348. The appeal scheme would extract 1.75 Mt of sand and gravel over a period of up to 10 years in four phases, with phased restoration to agriculture and woodland thickets, and aftercare for five years. It includes an office, messroom and weighbridge, along with a fuelling area with tank, wheel cleaning facility and water attenuation area. Bunds would be constructed around excavated and operational areas. Access would be via a new junction on Wadesmill Road (B158), with visibility splays and a segregated right turn lane, which would replace an existing field entrance. HGV movements would be limited to 50 in and 50 out in any working day. A restricted Byway that traverses the appeal site would be diverted for 2 to 3 years, and other provisions made for local footpaths. The application form states that the scheme would be operated by six full-time employees. [14-21]

349. The appellants proposed a second scheme, which would omit Phase 4 and the stockpile area from the 1.75 Mt scheme, and reduce the tonnage of sand and gravel extracted to 1.25 Mt over a period of up to 7 years. The scheme includes a load out area containing an office, messroom and weighbridge, security area/vehicle parking and soakaway, along with wheel cleaner and wheel bath, linked to the B158 by an access road with a concrete surface. The proposed bund in the south-western part of Phase 1 would be sited more than 100 m from properties at The Orchard. No footpath diversion would be necessary in the 1.25 Mt scheme. ID26 is a summary of the main differences between the 1.75 Mt and 1.25 Mt schemes. The 1.25 Mt scheme was the subject of a separate planning application, which was refused by HCC at a committee meeting held in April 2018. [4,22-23]

350. The appellants would like the appeal to be decided on the basis that the 1.75 Mt scheme be considered first, and if found to be unacceptable, that a condition limiting the scheme to 1.25 Mt be imposed. [4]

351. There is some criticism about the way the appellants dealt with EIA for the 1.25 Mt scheme. The approach here may have been confusing to some. However, at the end of the Inquiry process, I am satisfied that the ES and FEI submitted for the 1.75 Mt and 1.25 Mt schemes, which were available for comment during the appeal proceedings, reasonably comply with the requirements of the EIA Regulations. In considering the appeal, and in making my recommendation, I have taken into account the Environmental

Information, which includes all the evidence adduced at the Inquiry. In doing so I have come to a different view about the significance of, and weight to be given to, some environmental effects from that set out in the ES and FEI. [1,2,5]

352. Some of the operations previously undertaken by RJD Ltd have been taken on by Ingrebourne Valley Ltd, but both the appellants named in the appeal documents have legal capacity to lodge an appeal. The appeal should therefore continue in the name of the applicants. [213,293]

353. There is local concern about the identity of the appellants, but this should not be an influential factor in determining the appeal. It was made explicit throughout the Inquiry that any planning permission granted would not be a personal permission, and so would run with the land. [177,208]

354. Some objectors commented on what they considered to be inadequate consultation about the proposal, and a lack of engagement by the appellants. But even if this was a relevant consideration it is not a matter that should be given much weight in determining the appeal on its planning merits. [135,180,189,192-194,201,270,271,274]

355. The Inquiry was advised, and proceeded on the basis, that the proposed development would not require any permit or licensing under the pollution control regime, and so all necessary controls would need to be imposed via the planning system. [18,105,235,318]

356. HCC's case draws comparisons between the appeal scheme and a "PA2 compliant development", which would need to be worked up jointly with the operators of Rickneys Quarry. However, there is no indication what an acceptable PA2 compliant scheme might look like, especially concerning the requirement for appropriate buffer zones in order to minimise any impact of extraction on the existing dwellings in close proximity. Furthermore, there is insufficient evidence to show that if such a scheme did exist that there is a real possibility of it coming to fruition in the foreseeable future. This is not a case where consideration of a less harmful alternative development becomes a material planning consideration. I do not consider that comparing the appeal scheme to a notional PA2 compliant scheme is very helpful in determining this appeal on its planning merits. [39,59,81,82,254-258,260]

357. Exchanges at the Inquiry resulted in a submission by the appellants about tricking or badgering a witness into concessions. However, Mr Symes is an experienced mineral planning consultant, and I do not consider that HCC's line of questioning was unreasonable given the appellants' case as set out in SoC1. Irrespective of any concessions which may, or may not, have been made at the Inquiry, the appeal should be determined on its planning merits having regard to all the relevant evidence adduced. [4,57,240,267]

Main considerations

358. The Secretary of State's reasons for recovering the appeal state that it involves proposals for significant development in the Green Belt, and major proposals involving the winning and working of minerals. However, the direction did not include details about any matters about which the Secretary of State particularly wishes to be informed for the purposes of considering this appeal. The evidence indicates that the main considerations here are as follows. [6]

(1) The effects of the proposed development on the openness of the Green Belt and upon the purposes of including land within it, and whether the development conflicts with policy to protect the Green Belt.
(2) The effects of the proposed development on the character and appearance of the area, including cumulative effects.
(3) The effects of the proposed development on the local amenity of the area and the living conditions of nearby residents, with particular reference to noise, dust, air quality and health.
(4) The effects of the proposed development on Public Rights of Way.
(5) The effects of the proposed development on hydrogeology.
(6) The effects of the proposed development on highway safety.
(7) The effects of the proposed development on biodiversity.
(8) The effects of the proposed development on agricultural land.
(9) The effects of the proposed development on employment and the economy.
(10) The effects of the proposed development on the supply of housing in East Herts District Council.
(11) The need for sand and gravel, having regard to likely future demand for, and supply of, these minerals.
(12) The planning balance.
(13) The extent to which the proposed development would be in accordance with the development plan for the area.
(14) The extent to which the proposed development would be in accordance with the revised National Planning Policy Framework (the *Framework*) and the National Planning Practice Guidance (the *Guidance*).
(15) Whether any permission should be subject to any planning conditions or obligations and, if so, the form that these should take.

359. The remainder of this report addresses the matters outlined above, using the following approach. For each of the main considerations 1-11 above the report considers the likely effects of the proposed development. Impacts are described and significance assessed, taking into account the nature and duration of operations, along with restoration and aftercare. This analysis takes into account, where appropriate, necessary planning conditions and obligations.

360. The significance of effects is a matter of judgement, and for consistency a rating scale is used for negative and positive effects (harm and benefits), increasing from negligible, minor, moderate, substantial and finally major significance. In considering the relative weight to be given to various considerations a scale is used increasing from negligible (little or no weight),

slight, moderate, substantial, and finally great weight. However, there is scope within these bands for varying degrees of fit, and reference to these categories implies no mathematical or objective basis for analysis across the range of considerations involved in this case.

361. My recommendation is based on these findings.

(1) Green Belt

362. The appeal site lies within the Green Belt as defined in the development plan for the area. The *Framework* states that the Government attaches great importance to Green Belts. It adds that the essential characteristics of Green Belts are their openness and their permanence. Paragraph 141 provides that in planning positively to enhance the beneficial use of the Green Belt authorities should look for opportunities to provide access and sport/recreation, and to retain and enhance landscapes, visual amenity and biodiversity. [48]

363. When located in the Green Belt inappropriate development is, by definition, harmful to the Green Belt and should not be approved except in very special circumstances (VSC). The *Framework* provides that substantial weight should be given to any harm to the Green Belt, and that VSC will not exist unless the potential harm to the Green Belt by reason of inappropriateness, and any other harm resulting from the proposal, is clearly outweighed by other considerations. Paragraph 146 provides that mineral extraction and engineering operations are not inappropriate development in the Green Belt provided that they preserve its openness and do not conflict with the purposes of including land within it. These purposes include; to assist in safeguarding the countryside from encroachment, and to preserve the setting and special character of historic towns.

364. The proposal for the site; including the facilities, plant, access and bunds, are part and parcel of the proposed mineral extraction here for the purposes of applying Green Belt policy. If there is any doubt about the bunds, these would be engineered structures, and their construction would be an engineering operation in applying Paragraph 146 of the *Framework*. This paragraph must mean that some level of operational development for mineral extraction in the Green Belt would preserve its openness and would not conflict with its purposes, and that beyond that level the development would become inappropriate in the Green Belt, and so the exception would no longer apply. Determining the tipping point would depend upon the particular circumstances, as a matter of fact and degree, but relevant considerations could include the siting, nature and scale of the operational development in its local context, along with its visual effects, duration and the reversibility of any adverse impact upon the openness and purposes of the Green Belt. This approach would accord with the judgments in *Europa Oil* and *Samuel Smith*. [60,221,222]

365. In terms of openness the appeal site comprises open agricultural fields, which offer expansive views from elevated vantage points over the River Rib valley. Openness as a feature of this part of the Green Belt is apparent from the local description of the one tree located towards the centre of the site as "the lonely oak". Within the site there are only three other trees, which are located near to its western boundary. The openness of the area was cited in

many representations to the Inquiry, as an important element of this part of the Green Belt, and a factor that contributed significantly to the appreciation and enjoyment of the area. [127,143,146,149,159,160,173,179,185,201,205,272,273,289,314]

366. Plant, equipment, access and activity associated with mineral extraction here would, to some extent, impair the openness of the area. But not enough in my view to exceed the threshold or tipping point for the purposes of applying paragraph 146. However, the proposed bunds would have a greater adverse impact on the openness of the Green Belt. The scheme would include substantial lengths of bunds up to 3 m high to screen views of the operational phases of mineral extraction. These would be constructed and removed as required for each phase, but at times the engineered structures would truncate open views from PRoW within this part of the Green Belt. [61]

367. The bunding around the stockpile and attenuation area would have a greater impact on openness because it would be between 4 m to 7 m high, and could exist for up to 10 years. This is a significant period, which for GLVIA3 in landscape terms, marks a boundary between medium term and long term effects. The bunds would surround a stockpile area that could provide for up to 50,000 m^3 of sand and gravel stored up to 5 m high. These bunds and stockpiles would be located on the eastern slopes of the valley facing towards a busy road. The bunds would be prominent structures in close up views from the B158, especially where roadside vegetation was removed to provide the visibility splays for the access junction. Replacement planting would take time to provide some screening, and views would remain through the widened access. [14,15,61,216,272,273,289]

368. The adverse effects of the bunds on openness would be fully reversible in time. Nevertheless, the harm for up to 10 years could be considered as a long term effect. In my judgement, bunds of the length, height and duration proposed in such an open area would have a substantial adverse effect on the openness of the Green Belt.

369. Furthermore, screen planting as it matured would foreshorten views across the site, and so would diminish the openness of this part of the Green Belt. Additional planting is proposed on restoration of the site. Overall, the planting would have a long-term effect by closing off views of the wider open countryside, creating enclosure that would harm the openness of the Green Belt. In those circumstances the tree in the centre of site could no longer be described as "the lonely oak". [159,169,173,181,222,224]

370. Taking into account the temporary effect of the bunds, along with the long-term impact of tree planting, I consider that the proposed development would exceed the paragraph 146 threshold for mineral extraction/engineering operations concerning the preservation of the openness of the Green Belt.

371. Turning next to the purposes of the Green Belt, the proposed development would not be of a type and scale that would conflict with the Green Belt's purpose to assist in safeguarding the countryside from encroachment. However, the southern and eastern parts of the site are near to the northern boundary of Hertford Conservation Area. The local topography provides for views from this area towards historic parts of Hertford. The proposed high bunds and tree planting would adversely affect this relationship from some

vantage points. The bunds would be temporary, but the proposed tree planting would be more enduring. Even allowing for the intervening development at the nursery, along with the proposed housing on the HERT4 site, the proposed mineral extraction would, to some extent, harm the setting of historic Hertford. The proposal would, therefore, conflict with one of the purposes of the Green Belt. [26,157,221,287]

372. The appeal decision cited by the appellants for a well site is not directly comparable to this scheme for the extraction of sand and gravel. In particular, the wellhead assembly was permitted for a temporary period of five years, which is half the duration of the proposed 1.75 Mt scheme. [223]

373. For these reasons, the appeal scheme would not preserve the openness of the Green Belt. It would also conflict with one of the purposes of including land within the Green Belt. So the exception for mineral extraction would not apply. Therefore, the proposal would be inappropriate development in the Green Belt, which is by definition harmful to the Green Belt. The following sections of this report consider whether the proposal would result in any other harm, and then has regard to other considerations, so that the Secretary of State can undertake a balancing exercise to determine whether VSC exist.

374. However, if the Secretary of State were to find that the proposed mineral extraction was not inappropriate development in the Green Belt, then the proposal would not result in harm to the Green Belt, and there would be no conflict with local or national Green Belt policy. In this scenario, the planning balancing exercise would be a straightforward weighing of the benefits and the harm, having regard to relevant policy considerations. This is considered in more detail in section (12) of these conclusions.

(2) Character and appearance

375. The 36.1 ha appeal site is located just beyond the northern edge of Hertford. It is arable land. Adjacent land use includes farmland and woodland to the north and east extending to the River Rib, a plant nursery and allotment gardens to the south near to residential properties in Bengeo and a primary school. To the west lies the partially restored Rickneys Quarry. The site lies within National Landscape Character Area 111: Northern Thames Basin, and falls broadly into the Hertfordshire Plateau and River Valleys sub-character area. This is a diverse landscape formed by a wide plateau dissected by a series of broad river valleys with extensive areas of broadleaved woodlands. [24,27,28]

376. In the *East Herts District Landscape Character Assessment* 2007 the appeal site is located within an interfluve of the rivers Beane and Rib, area '069 Stoney Hills'. The landscape character is described as gently undulating light arable upland and valley slopes, with key characteristics including active, disused and restored mineral extraction sites, with a mix of field sizes and variety of after uses, along with an abrupt transition from urban to rural character on the edge of Bengeo. Overall the area is judged to be in a poor condition, with high impact of land-use change, and of moderate strength of character, with the impact of landform and land cover considered to be apparent, the area open and locally visible, and unusual in terms of distinctiveness/rarity. [29-32]

377. In the *Landscape Character Assessment, Evaluation and Guidelines for Southern Hertfordshire supplementary report on: The suitability of landscape character areas for mineral extraction* 2001 the landscape strategy for this area is 'improve and restore', reflecting the existing impact of mineral extraction. The site profile suggests that mineral extraction might be possible, but that extreme care would be required to ensure that there was no permanent damage to local landscape character, adding that it might be preferable to keep it within the centre of the plateau rather than on the edges, where it would be more visible and closer to settlements. The report notes that it is unlikely that low level restoration would be appropriate. [33,219]

378. The appeal site is not the subject of any of the designations given to landscapes whose character and appearance justifies either a statutory status or recognition of their quality in the development plan. But neither is a large part of the English countryside, which is nonetheless much appreciated for its open views and the sense of space it provides. These landscapes are especially important as a foil to urban settlements. There is considerable anecdotal evidence about the role the appeal site plays in this regard, which is borne out by the evidence about the actual use of the formal and informal footpath network. I consider that the appeal site is a landscape resource and visual amenity of considerable importance because of its proximity to the urban area. [127,146,152,154,156-159,168,179,180,185,188,190,205,216,272,273,285,287]

379. Previous mineral extraction, including the partially restored Rickneys Quarry, which adjoins the appeal site, is a strong influence on the overall character and appearance of the area. But the fact that the appeal site retains its natural landform makes it important in its local context. It is more difficult here to sustain an argument that the altered configuration of the landscape in the wider area is a factor that presumes in favour of more extraction and restored landform. On the contrary, the local context bolsters the case in favour of retaining what is becoming something of a scarce resource around Hertford. [35,128]

380. On this basis, I consider that during the operation the proposed development would have a harmful effect on the landscape character of the area. But during this time its visual impact would be more significant. The bunds would, to some extent, screen views into the working area of the quarry, but it is unlikely that they would obscure all activity within the operational area because of the site contours. However, they would themselves be intrusive features in this attractive open countryside. The bunds would be prominent features from public vantage points because of their siting, length and height. [15,64,287,315,316]

381. The stockpile area would be sited on a level platform with a base of about 50 m AOD, with stockpiles up to 5 m high, behind bunds some 4 m to 7 m high. The access would be located at a low point along Wadesmill Road, at below 48 m AOD. So the stockpile area and surrounding bunds would be prominent in views from the road, whether from passing vehicles or those emerging from the public footpath opposite to the proposed junction. This would be especially so where roadside vegetation was removed to provide visibility splays, and before screen planting matured. The bunds and

stockpile area would be incongruous features within these eastern slopes down from the plateau. [17,63,217,315,328]

382. During the operation of the site, for up to 10 years, I consider that the proposed development would have an adverse effect on the visual amenity of the area of major significance.

383. The proposal to restore the site to primarily agricultural land would not be out of keeping with the character of its surrounds. However, the restored landform and tree planting would have important consequences for the visual amenity of the area.

384. The Restored Landform (Plan No.1217/R/1) indicates that in the northern part of the appeal site the restored ground level would in places be a considerable distance below the existing level. The way in which the excavated land would join up with the existing contours along the eastern side of Phase 4 would create a long shallow ridge line cutting across the natural fall of the land down to the road. Such a feature would sit uncomfortably with the existing slopes down this side of the valley. I consider that the restored landform would give the landscape an artificial crumpled appearance. This is apparent from the submitted cross-sections, and would appear as a jarring feature in the rounded hill sides on the edge of this valley. The proposed low-level restoration would not be appropriate in the landscape context which applies here. [33,65,127,159,168,173,188,191,201,218,287,309,315]

385. The proposed tree planting for screening and restoration, would gain some support from the 'improve and restore' strategy and guidelines for managing change in the *East Herts District Landscape Character Assessment* 2007. The measures specified might generally be appropriate for the '069 Stoney Hills' area. But these are guidelines, which should be applied having regard to the particular site circumstances. I consider that the appellants' hedgerow and tree planting would be the wrong landscape strategy for the appeal site. There is considerable evidence that the site is appreciated for its open views over the Rib Valley. An appropriate restoration strategy should aim to maximise this as a feature in the restored landscape. Not only would the proposed restored landform conflict with this aim, but planting trees and vegetation would also screen out distant views. [32,127,143,152,168,197,201,217,219]

386. Given the local topography and separation distances, I concur with the appellants' assessment that the appeal scheme would be unlikely to have any significant adverse cumulative landscape effects with other quarries operating in the area at the same time. However, the sand and gravel formations around Hertford have been quarried extensively over many years. The *Guidance* provides that in areas subjected to successive aggregate extraction over a number of years the cumulative impact is capable of being a material consideration when determining individual planning applications. [54]

387. The appellants' landscape assessment does not give this adequate consideration. It seems to me that repeated extraction/restoration on different sites around Hertford over time has a temporal cumulative adverse impact on the local landscape. Any proposed scheme should be assessed in that context, and not just on the harm attributable to each incremental

addition to the process of landscape change over time. I find that the cumulative impact of the appeal scheme, over time, should be taken into account, and adds to the overall harm to the landscape resource. [128,166,167,174,191,196,206,287,291]

388. The operational development to extract, screen, stockpile and transport sand and gravel would have an adverse effect on the character and appearance of the area of major significance, albeit for a limited duration. On restoration, I consider that the scheme, by reason of the restored landform and tree planting, would have an adverse effect of moderate significance. It would not accord with the 2001 guidelines for *The suitability of landscape character areas for mineral extraction* because large bunds would be sited on the edge of the plateau, and the proposed low level restoration would not be appropriate here. Given the history of mineral extraction in the area, cumulative landscape harm over time is also a relevant consideration. Overall, I find that the appeal scheme would have an adverse effect on the character and appearance of the area of substantial significance.

(3) Local amenity and living conditions

389. There is considerable local concern about noise, dust, air quality, and the associated effects on the health of those living in the area, attending the school, and using the allotments or local footpaths. The nearest dwelling on Sacombe Road would be 10 m from the toe of the nearest proposed bund, and 28 m from the nearest operational part of the quarry. The corresponding distances for the nearest dwelling at The Orchard are 23 m and 43 m. Waterworks Cottage and Glenholm would be, respectively, about 68 m and 215 m from the operational area. Bengeo Nursery would be 150 m from the operational area, the playing field 167 m, the allotments 281 m and Bengeo Primary School 360 m. [8,25,143,146,148,150,151,154,169,171,175-177,179-185,272,273,275,276,281,282,286,313,314,316]

390. The submission of the HIA enabled HCC in SoCG3 to agree with the appellants that the potential for a significant adverse population health effect would be unlikely provided that the mitigation, monitoring and response mechanisms described in the appellants' revised air quality assessment were secured by conditions and adhered to, including an appropriate dust management plan. However, HCC disputes the appellants' noise assessment. [7,240]

391. A restricted working zone would be created within 70 m of properties at The Orchard, within which operations would not take place when the wind direction was from the north-eastern quadrant. The screener and loading shovel would not be operated within 250 m of any residential premises. Noise limits are proposed for nearby residential properties, but not agreed by the parties. The upper working limit in the *Guidance* of 55 dB(A) would not be exceeded, excepting for work on bunds, at any noise sensitive location at any time during operations, even if the appeal site was worked simultaneously with Rickneys Quarry. However, the noise experts disagree about possible exceedances of the normal working noise limit level of 10 dB above the background level. Nevertheless, the appellants are satisfied that the noise produced by the operation of the site would not exceed 48 dB(A) at The Orchard, and are content to accept this as a noise limit. [16,227-229]

392. HCC considers the limit at Sacombe Road should be set at 48 dB(A); the appellants consider that it should be 52 dB(A), but are confident that the site could be operated without exceeding 50 dB(A), and are content to accept a condition to that effect. The disagreement arises from differences in recorded background levels from which the limit is derived. I share HCC's concern about the appellants' L_{A90} measurements. Background levels are not affected by raised sound levels for short durations. So it is difficult to explain the difference between the appellants' L_{A90} measurements for The Orchard and Sacombe Road, unless it was affected by the positioning of the microphone close to a hedge with rustling leaves. I concur with HCC that any noise condition imposed should specify a limit of 48 dB(A) at Sacombe Road. This could be exceeded if the appeal site was worked at the same time as Rickneys Quarry. [67,230,311]

393. The noise experts also disagree about the assessment of the sound power levels for plant likely to be used in the minerals operation. But irrespective of whose analysis is preferred, the evidence indicates that at times the operation would be likely to generate noise levels close to the acceptable limits set out in the *Guidance*. In certain weather conditions noise could exceed acceptable limits for short periods. In addition, the character of noise emitted by operational development would be distinctive. If this resulted in complaints, these could take time to monitor, and to devise and implement mitigation measures. During such times noise could be intrusive for local residents, especially given the proximity of dwellings at Sacombe Road. [66,231,232]

394. I am not convinced, given the separation distances between the proposed excavation and nearby dwellings that there would be sufficient headroom here, between likely noise levels from the operation and acceptable noise limits, to be confident that the proposed development would not, at times, result in an adverse noise impact that would harm the living conditions of nearby occupiers and the amenity of the area. On the available evidence, I am unable to find that the proposal would accord with MLP Policy 18(viii) or with the aim of the NPSE to avoid significant adverse impacts on the quality of life. I find in these circumstances that noise is a consideration which weighs against granting planning permission. [68-70,231,306]

395. Air quality and health is not an issue for HCC, but is a major concern for residents and for parents of children attending the school, and particularly so for vulnerable members of the local community. This was an issue raised by objectors with HCC during consultation on the application, and in many written and oral submissions to the Inquiry. The findings of the HIA were accepted by HCC, but vigorously contested in the 156 written submissions received during the adjournment, and by expert evidence adduced at the Inquiry. SBQ's concern is the extent to which air quality impacts from the proposed operation would be responsible for health effects on people in the local community, in particular on especially vulnerable groups within the site-specific population. [10,107-112,138,168,178,190,194,203,209-212,239]

396. Local fear and anxiety about air quality and health effects is not irrational. The concerns of residents and parents is understandable given that the EA, when consulted about the 2.6 Mt scheme in April 2016, recommended that conditions be imposed, wherever possible, that would make the development air quality neutral. The EA added that the site is located in an area of

significant concern regarding air quality and that there are already high levels of PM_{10} and NO_2. Robust conditions were recommend to address mineral screening, road sweeping, road surfaces, wheel washing, vehicle and plant emissions, reducing vehicle idling, construction logistic plans, diesel or petrol generators, chutes/conveyors and skips, covering vehicles, along with advice on using dust suppressants. In addition, Public Health England advised that air pollution, from a range of sources, not solely from the proposed quarry, is a potential threat to the health of the wider community, and acknowledged that those with pre-existing respiratory conditions, such as cystic fibrosis and asthma, are considered a sensitive population if exposed to airborne pollutants, such as particulate matter (PM). Published articles also state that there is no threshold below which health effects do not occur. [137,144,145,149,177,186,189,201,292,297,298,310,317,319]

397. Visible dust and the heavier airborne emissions from the operation would settle out quickly, and so would largely be contained within the site or by the vegetated bunds around the excavated area. Measures that could be included in an approved dust management plan were discussed at the Inquiry. Properly implemented, these would ensure that dust leaving the site would not put existing development at an unacceptable risk from the larger airborne emissions from the minerals operation. This is a matter that could be adequately addressed by the imposition of a planning condition.[169] [120]

398. Smaller particulate matter, PM_{10} and $PM_{2.5}$, would be more widely dispersed. These would include particulate emissions from diesel vehicles and plant operating on the site. IAQM data indicates that properties within 300 m of quarries could be exposed to between 5-10 $\mu g/m^3$ extra PM_{10}. However, this was for all the mineral types surveyed, and the limited data available for sand and gravel quarries does not indicate significant additional PM_{10} at any of the distances surveyed. [118,139,202,296,299,301]

399. The appellants' air quality assessment follows accepted practice. But as with all modelling, the outcome must necessarily reflect its underlying assumptions and limitations, some of which were challenged by SBQ. Nevertheless, the modelling provides some confidence about likely compliance with national air quality objectives/limit values for suspended PM, with respect to 24 hour and annual averaging periods. However, it is not able to allay the fears of local residents about the likely occurrence of short-term peak concentrations of air pollution, and the resultant impact on vulnerable receptors. Epidemiological studies focus on health effects for populations, and so it is often difficult to draw meaningful conclusions about the likely effects on vulnerable people, such as the young, old, those with asthma, COPD or other respiratory conditions. Concern for particular individuals and vulnerable groups within the local population, in these circumstances, is not unreasonable.
[113-117,121,137,151,183,184,186,187,209-211,241-243,293-296, 299,300,310,311,313]

400. The HIA applies the UK/EU $PM_{2.5}$ threshold of 25 $\mu g/m^3$ which is higher than more recent thresholds established by WHO (10 $\mu g/m^3$, 2014) and

[169] Suggested Condition 34.

applied in other countries. Objectors argue that the appellants' modelling shows that in areas surrounding the appeal site $PM_{2.5}$ exceeds 10 µg/m^3 without a quarry, and so any increase cannot be justified. This should not be a decisive consideration because it has not been demonstrated here that any increase in $PM_{2.5}$, irrespective of its size, would result in an unacceptable level of air pollution. Nevertheless, the WHO threshold adds to local consternation about the health implications of the appeal scheme. [109,202,299]

401. A proportion of PM_{10} emitted from the proposed development could comprise respirable crystalline silica (RCS), which is a known carcinogen. There is no evidence about what proportion this might be, or how likely working the Kesgrave formation would be to generate RCS emissions. There is evidence that RCS risk is increased where a source material is crushed, whereas the appeal scheme only proposes screening. However, RCS is a recognised hazard for personnel working at quarries, and an emotive issue for worried parents of children who live in the area or attend the local school. The lack of reliable data here about RCS fuels the local community's legitimate fears about adverse health outcomes in the long term. [119,130,139,151,172,202,244,298,302,303]

402. I consider that dust could be controlled by condition, but noise would be likely to be intrusive at times because of the proximity of dwellings. In addition, there is considerable local fear and anxiety about air pollution and health risks from PM and RSC, which is sufficient here to be a material planning consideration in its own right. Taking all the above into account, I consider that the appeal scheme would have an adverse effect on the living conditions of residents and on the amenity of the area of moderate significance.

(4) Public Rights of Way

403. The route across the site has been recognised as an Asset of Community Value, which is used for health walks. The proposed temporary diversion of the PRoW around Phase 4 and the provision of permissive paths would be necessary mitigation during the operation. Even so, the scheme would render the local PRoW network less attractive whilst the site was being worked. I consider that for the duration of the operation the proposed development would have an adverse effect on the PRoW network of minor significance. [21,71,142,143,156,158,160,168,178,182,188,233,273,285,]

404. Proposed additions to the PRoW network following restoration would be beneficial in terms of providing some more routes for users. However, the restored landscape would not be as open as it currently is, and so it might not be used in the same way as it is today. The advantage of additional routes in those circumstances may not result in more people using and benefitting from the local footpath network. This would be especially so for those seeking open countryside outside the urban area. [134,152,158,188,201,234,307,308]

405. Nevertheless, the additions to the PRoW network would be permanent, and so of some advantage in the long term. Overall, I find that the scheme would, in terms of PRoW, offer a benefit of minor significance, which should be given some slight weight in the planning balance. In this regard the proposal would gain some support from MLP Policy 18(x). [72,73,234,315]

(5) Hydrogeology

406. The risk of groundwater pollution was not cited by HCC as a reason for refusal, but potential harm to the aquifer and to the public water supply is of great concern to local residents, and was an issue taken up by the Rule 6 parties at the Inquiry. [89,136,143,162,171,181,201,205,212,214,273,275,276,278,283,304,328]

407. The sand and gravel overlie chalk, designated as a principal aquifer, which provides a significant source of water for public supply abstractions in the area. Phase 4, Phase 3 and part of Phase 2 of the proposed development are within the Inner Source Protection Zone (SPZ1) for the Wadesmill Road Pumping Station (PS), which is operated by Affinity Water (AW). [34,99]

408. If the proposed operation mobilised and transported fine materials to the aquifer there would be a risk to groundwater quality from increased turbidity. Accidental spillage of oil and fuel would result in a higher risk to water quality. Hydrocarbon pollution of the aquifer would result in an adverse impact of major significance. The proposed mitigation relies on retaining a protective layer of residual materials above the chalk, measures to regulate the storage and use of fuel, along with training and protocols for any spillage. The fuelling area would be sited in an area that is shown on the site geology plan to be underlain by clay. Plant would be refuelled only in a bunded fuel storage area, and there are regulations which control fuel storage. These are relevant factors in assessing the likely risk of groundwater pollution. [17,56,92,236]

409. In accordance with its adopted policy, the EA would normally object in principle to any planning application for a development that may physically disturb an aquifer. The EA notes that the appeal site lies in a highly sensitive groundwater area, very close to an abstraction for a public water supply, and that it is essential that there is no harm to the water environment as a result of the development. The EA was aware of local concerns about the roughness of the chalk surface, but concluded that planning permission could be granted subject to the imposition of planning conditions. These included groundwater monitoring in respect of contamination and turbidity, along with any necessary contingency action. [55,104,235,318,320,321]

410. This condition would detect pollution after it had occurred, and provide for some remediation. But neither this condition, nor any of the others suggested by the EA, would provide an appropriate safeguard for the aquifer by preventing or minimising the likelihood of groundwater contamination before it occurred. This is particularly important here where it is accepted that the aquifer is vulnerable to contamination due to the presence of the fracture network, which permits very rapid flows, and that if contamination entered the chalk matrix it would be difficult to remove. [55,91,97,136,235,236,318,320]

411. To ensure that the Wadesmill PS was protected from any potential pollution that could be initiated from the appeal scheme, AW proposed a condition requiring; "300 m zone of unworked basal layers from the Wadesmill PS of 5 m thickness; 500 m zone of unworked basal layers from the Wadesmill PS of 3 m thickness; rest of site unworked basal layer 1 m thickness". Nearly all of Phase 4 of the appeal scheme would lie within 300 m

of the Wadesmill PS. Reliance on a distance based approach was challenged by SBQ on the grounds that flow rates and routes within the chalk aquifer should also be taken into consideration. These would depend upon the presence and extent of water-bearing fractures and karstic features in the aquifer. [34,92,93,162,237,326]

412. The effectiveness and enforceability of the condition suggested by AW would require a method for determining the thickness of the unworked basal layer. The thickness of the basal layer would depend upon the height of the underlying chalk. This would need to be known with some accuracy so as to be able to determine whether the condition had been breached or not. If the methodology was not reliable, this would call into question whether the condition complied with the legal and policy tests for planning conditions.

413. In this matter the appellants rely on the plan entitled "Topography of Chalk surface" Hafren Water (Drawing 2482/POE/03) showing the interpolated elevation of the top of the chalk from borehole data from bores located within and near to the appeal site. These contours would be used to generate a 3D GPS model that would control the depth of excavation. The undisturbed material that would remain above the chalk, using these contours to determine the position of the chalk rockhead, is shown on Isopachytes Drawings. [20,96]

414. However, for large parts of the site this interpolation is from boreholes that are widely separated, with considerable height differences reported in the elevations of the top of the chalk. The contours are derived on the assumption of a smooth gradation of this elevational difference between the boreholes. But there is no convincing evidence that this assumption is correct. The EA is not able to provide any assistance in this regard as it does not have the in-house capability and competence to carry out non-intrusive geophysical surveys to estimate the thickness of the top soil layer, relief and heterogeneity of the top of the chalk. [94,104,164,]

415. Research in other parts of southern England has shown that the top-chalk surface is rough. The photographic evidence of exposed chalk in Rickneys Quarry in the 1990s is not conclusive, but raises the possibility that peaks in the chalk rockhead might exist in the appeal site. Given uncertainty about the rockhead surface, it would not be reasonable to rely on the interpolated elevation of the top of the chalk shown on Drawing 2482/POE/03 as the basis for assessing compliance with AW's suggested condition. [95,163]

416. Furthermore, this is not a case where it would be reasonable to rely on standard leaks and spills mitigation measures. These would not prevent spilled contaminant from filtering down into the aquifer. Significant pollution could travel so rapidly through fissures that even a speedy response to a pollution incident at the surface would be ineffective. The only effective mitigation measure would be to immediately excavate the affected sand and gravel and to securely transport it to a containment area so that it could be safely removed from the site. Whether this would be practical in all potential pollution scenarios is doubtful. [101,163,236,305]

417. I have considered whether the potential contamination of the aquifer is a matter that could be dealt with by the imposition of the conditions suggested

by the parties.[170] In the absence of more details about what methodology would provide a reliable safeguard, it seems to me that the condition suggested by HCC and the appellants might unreasonably impact on the deliverability of the development. Especially so for parts of Phase 3 and Phase 4, where the available Isopachyte data indicates that the protective basal layer would be likely to be at its thinnest. SBQ's suggested condition would provide a greater safety margin. But it would be considerably more onerous, and would suffer from the same defect as the condition suggested by HCC/appellants. If SBQ's suggested Hydrogeological Impact Assessment precluded safe mineral extraction that would be an indication that planning permission should have been refused. The suggested conditions would just defer consideration of this issue to a later application for approval to discharge the condition. I consider that safeguarding the aquifer is an important matter that would need to be satisfactorily dealt with in deciding whether planning permission should be granted. [96,98,102]

418. Conditions in a similar form to that suggested by AW have been applied in other consented sand and gravel mineral sites located in SPZs, and no evidence was adduced at the Inquiry that these have proved to be inadequate safeguards. However, it is not clear what the evidential basis was for the imposition of these conditions, or whether the circumstances that applied in those cases were directly comparable to those that apply here, in terms of the local geology, the proximity of abstraction bores, and the overall risk to groundwater supplies in both the short and long term. [103,238]

419. I do not consider that it would be possible on the information currently available to devise a condition that would appropriately address this matter. Taking into account the intended pollution control measures dealing with fuel storage and refuelling plant in a contained area, I consider that the risk of contaminating groundwater would give rise to an adverse effect of moderate significance, which should be given substantial weight because of the implications for a public water supply. [17,56,99,100,136]

420. In the absence of an appropriate mechanism and planning condition to safeguard the aquifer, I find that the proposed development would pose an unacceptable risk to groundwater pollution, and so would conflict with MLP Policy 17(iv) and Policy 18(ix), and would have an unacceptable adverse impact on the natural environment for the purposes of applying paragraph 205 b) of the *Framework*.

(6) Highway safety

421. There is local concern about the effects of additional HGVs using the road network, but no objection from the highway authority. The scheme could add up to 50 HGV movements in, and 50 out, in any working day. A suggested planning condition would specify no more than 8 HGV lorry movements (4 in / 4 out) entering/leaving the access/egress onto Wadesmill Road during the peak hours.[171] Signs would be erected at the site exit requiring all HGVs to turn left onto the B158 towards the recently improved Anchor Lane roundabout on the A602. Notwithstanding its vertical and horizontal

[170] These are included as Condition 42 in the Schedule of Conditions.
[171] Suggested Condition 9.

alignment, the accident record does not indicate any significant underlying safety problem along this part of the B158. With appropriate visibility splays and a segregated right turn lane for HGVs to wait to turn into the site, I am satisfied that the scheme would provide safe and suitable access. Other objections to the scheme on safety grounds, about footpaths crossing the access or haul roads, and ensuring that the highway was kept clean of tracked out mud and gravel, are matters that could be addressed by enforceable planning conditions. [19,131-133,141-143,155,170,181,185,198,199,204,233,245,272,273,275, 276,278,284,312,314,325]

422. Additional HGVs on the B158 and using the Anchor roundabout would have some effect on other road users, especially vulnerable cyclists and pedestrians. But given the number of vehicles involved and the proposed conditions/obligations, I do not consider that any adverse effect would be of more than negligible significance. Residual cumulative impacts on the road network would not be severe, and any increased risk to highway safety would fall far short of an unacceptable impact that would, in accordance with the *Framework*, justify preventing the development on highway grounds. Local apprehension about additional HGV movements is understandable, but I do not consider that any resultant harm to highway safety should weigh significantly against the proposal. I find no conflict with MLP Policy 16.

(7) Biodiversity

423. The appeal site is not subject to any wildlife designations, but adjoins St John’s Wood local wildlife site. There are no objections from statutory authorities on ecological grounds, but this was a concern raised by some objectors. [36,246,272,273,275]

424. Local wildlife groups expressed concern about a threat to St John’s Wood from the impact of the depression on surface and sub-surface flows of water, and prevailing winds increasing dust. But there is no evidence to dispute that the trees in St John’s Wood are dependent on rainwater, rather than standing groundwater, and so a significant adverse impact from the proposed mineral extraction would be unlikely. The Woodland Trust recommends a 100 m buffer for St John’s Wood, noting that ancient woodland is particularly sensitive to dust. However, measures required by an approved dust management plan would reasonably safeguard nearby woodland from dust emissions from the appeal scheme. [33,153,236,287,323,324,327]

425. The appeal site is arable land, but used by some wildlife, including brown hare, skylarks and foraging badgers. During the 10 years of the operation some wildlife would be displaced or disrupted, but on restoration the planting and management proposed would be advantageous for biodiversity. However, there is no guarantee that these beneficial features would be retained beyond the after-care period. Local wildlife groups consider that the proposed after-care period would be inadequate to establish semi-natural habitats, and that an alternative and more appropriate mitigation strategy could provide real and sustainable gains in biodiversity. The likelihood of any long-term ecological benefits might only be sufficient to compensate for the harm to biodiversity during the extraction operation. For these reasons, I find

that the proposal would, overall, have a neutral effect on biodiversity. [173,247,248,323]

(8) Agricultural land

426. The scheme proposes restoring most of the site back to agricultural use. However, some BMV agricultural land would be permanently lost for the proposed water attenuation area. Furthermore, it could take many years for the restored agricultural land to return to its current productive capacity. The proposal would not, therefore, accord with the provisions in the *Framework* concerning the protection of soils. There would be some harm to agricultural land, which I consider would be an adverse effect of minor significance, but nonetheless should be given some slight weight in the planning balance. [23,49,220,291]

(9) Employment and the economy

427. The addition of six full-time employees to the workforce for up to 10 years would make a modest contribution to the local economy. The enterprise would have some secondary or multiplier economic effects, which again would be modest, but nonetheless beneficial. Given the nature and scale of the proposed operation, I consider that the likely effect on the economy would be a benefit of minor significance. This is a consideration which should, in accordance with the *Framework*, be combined with the need for minerals from the appeal site, and the resultant benefits of their extraction, to give a single weighting in the planning balance. [14,47]

(10) Supply of housing

428. Policy HERT4 of the EHDP allocates land to the south of the appeal site for residential development to accommodate a minimum of 150 homes, with around 50 dwellings provided to the north of Sacombe Road by 2022; and, subject to the satisfactory previous phased extraction of mineral deposits on the neighbouring site, around 100 homes to the west of the B158 Wadesmill Road between 2022 and 2027. Compliance with this policy could be achieved by planning controls on the phasing of mineral extraction and housing development over the period up to 2027. There is considerable time to devise and implement a programme that would achieve a satisfactory planning outcome. There is no convincing evidence that implementation of the appeal scheme is necessary to enable future housing development to comply with Policy HERT4. I find that dismissing this appeal would not be likely to have any material effect on the future supply of housing in East Herts. [42,59,83-86,126,185,200,204,265]

(11) Demand for and supply of sand and gravel

429. At the last annual review there was 7.5 years supply of sand and gravel on the basis of an apportionment exercise with a requirement of 1.39 Mt pa. Since then planning permission has been granted for 0.45 Mt at Furze Field. The release of additional land at the BAE Aerodrome site would significantly increase the supply. The BAE site benefits from a resolution to grant planning permission subject to finalising legal agreements. This resolution took into account the matters raised by the appellants concerning the BAE site's Green Belt location, and the fact that it falls partially outside the designated

Preferred Area. The Inquiry was advised that the only outstanding matter delaying the grant of planning permission concerns legal provision for a Country Park. No evidence was submitted to dispute this. The available evidence indicates the likelihood that the BAE site will make a substantial contribution to the landbank in the near future. [46,75,76,129,181,212,215,249,250,252]

430. The evidence does not indicate any compelling local need for sand and gravel from the appeal site. In coming to this finding I have had regard to the criteria set out in the *Guidance* for the grant of permission even if it is considered that the landbank is adequate. There is no convincing evidence of significant future increases in demand that can be forecast with reasonable certainty, or that the location of consented reserves is inappropriate. Furthermore, there is nothing to indicate that the output from consented reserves would be limited by constraints. Given my findings about the relationship between the appeal scheme and housing development of the HERT4 site, the likelihood of sterilisation of resources is not a consideration which weighs in favour of allowing the appeal.

431. Nevertheless, there is evidence that Hertfordshire's productive capacity is dwindling with a number of quarries closing, and in providing a steady and adequate supply of aggregates there would be advantage in having productive sites available in a variety of locations so as to minimise transport impact. In the circumstances that apply here, I find that the contribution that the appeal scheme would make to the supply of sand and gravel is a consideration of moderate significance in favour of the proposal. [74,165,251,253,275]

(12) Planning balance

432. If the Secretary of State finds that the proposed development is inappropriate in the Green Belt, the planning balance is whether the harm by reason of inappropriateness, and any other harm, is clearly outweighed by other considerations, so as to amount to the VSC necessary to justify the development.

433. The harm I have identified to the Green Belt should, by definition, be given substantial weight. In addition, I have found that the proposal would have an adverse effect on the character and appearance of the area, which should be given substantial weight. The harm to the amenity of the area should attract moderate weight. In the absence of an effective mechanism and planning condition to safeguard the aquifer, I consider that the risk of water pollution should be given substantial weight. Some slight weight should be given to the loss of agricultural land. Any increased risk to highway safety would be negligible, and so should not weigh in the planning balance. For the reasons set out above, the appeal scheme would have a neutral effect on biodiversity.

434. Other considerations cited by the appellants to weigh in the VSC balance include; the benefits of mineral extraction; the temporary nature of the works; the long-term landscape and ecological benefits; permanent enhancements to the PRoW network; and the benefits of extracting the minerals to allow the delivery of houses on the northern part of the HERT4 site. HCC argues that the only matter here which could conceivably constitute VSC is need. [62,225]

435. Given the landbank and measures HCC are taking to increase the supply of sand and gravel, I have found that the contribution of minerals from the appeal site would be a benefit of moderate significance. The six full time jobs and other operational aspects of the development would make a modest contribution to economy. These benefits should be awarded great weight, as required by the *Framework*.

436. The temporary nature of the works should not be given much weight as that is the nature of mineral extraction. It is a consideration in determining the quantum of any harm, but cannot also be used as a factor to weigh in favour of a proposal in assessing whether VSC exist. I have found that the proposal would result in long-term landscape harm, and that the likelihood of any long-term ecological benefits might only be sufficient to compensate for the harm to biodiversity during the extraction operation. Neither of these weighs significantly in favour of the proposal.

437. The scheme would result in permanent enhancements to the PRoW network, which is a benefit that should be given some slight weight. The delivery of houses on the northern part of the HERT4 site is not dependent upon the implementation of the appeal scheme. Contrary to the appellants' submission, this is a consideration that should attract little or no weight.

438. In this inappropriate development scenario, I consider that the other considerations, comprising the benefits of the proposed sand and gravel extraction and the contribution the scheme would make to the economy, which attract great weight, and the benefits to the PRoW network, would not outweigh the harm to the Green Belt along with the harm to the character, appearance and amenity of the area. The increased risks to the aquifer in the absence of an appropriate safeguarding mechanism and condition, along with the loss of agricultural land, would tip the balance even further against the proposal. In my judgement, the harm by reason of inappropriateness, and any other harm, is not clearly outweighed by other considerations, and the VSC necessary to justify the development do not exist. In this scenario, the proposed development would conflict with EHDP Policy GBR1, and would be contrary to national policy concerning the Green Belt. [88,268,269]

439. If the Secretary of State finds that the proposed mineral extraction is not inappropriate development in the Green Belt, then the planning balancing exercise should weigh the benefits against the harm, giving great weight to the benefits of mineral extraction, including to the economy. In this scenario, I consider that the overall harm identified to the character, appearance and amenity of the area, would outweigh the benefits of the proposed sand and gravel extraction and the contribution the scheme would make to the economy and to the PRoW network. The increased risks to the aquifer in the absence of an appropriate safeguarding mechanism and condition, along with the loss of agricultural land, would tip the balance even further against the proposal.

(13) Development Plan

440. The Secretary of State is required to decide this appeal having regard to the development plan, and to make the determination in accordance with it, unless material considerations indicate otherwise. HCC's reasons for refusal refer to the East Herts Local Plan 2007, but East Herts District Plan (EHDP) was adopted in October 2018. The development plan also includes saved policies of the Hertfordshire Minerals Local Plan Review 2007 (MLP). [37-42]

441. Significant areas of the appeal scheme would be located outside the boundaries specified in PA2. The proposal would not be an extension to Rickneys Quarry, nor would it use its existing access from the B158. Furthermore, given my findings about the effects of the proposal on the living conditions of residents and the amenity of the area, I am not satisfied that the scheme would provide appropriate buffer zones. For all these reasons, the proposed development would not accord with MLP Policy 3. [58,77,78,80,87,88,259,261,290]

442. Working outside the Preferred Area is not justified on the grounds of the current landbank, prejudice to the timely working of preferred areas, or the likely sterilisation of resources. So the appeal scheme would not gain material support from MLP Policies 4 and 5. With an overall neutral effect on biodiversity the proposal would not gain support from MLP Policy 9. The restored landform and tree planting would result in a loss of openness, which is a distinctive landscape feature of the appeal site, and so the proposal would not accord with MLP Policies 12 and 18(ii). Considered successively with past mineral extraction in the wider area, the scheme would be at odds with the underlying objectives of MLP Policy 11. On the available evidence, I am unable to find that the proposal would accord with MLP Policy 18(viii) concerning noise. In the absence of an appropriate mechanism and condition to safeguard the aquifer which feeds an important public water supply, I am unable to find that the scheme would comply with MLP Policies 17(iv) and 18(ix). However, it would gain some support from MLP Policy 18(x) concerning PRoW. [79,90,106,260,262-264,266]

443. If the Secretary of State finds that the development would be inappropriate in the Green Belt and concurs that VSC do not exist, then the proposed development would conflict with EHDP Policy GBR1.

444. Taking all the above into account, I find that the proposal would conflict with the development plan when taken as a whole.

445. HCC is in the process of reviewing the Minerals Local Plan, and a Consultation Draft (eMLP) has been the subject of public consultation. The eMLP was cited by many objectors because it recommends that Bengeo Field should not be a "preferred area" for quarrying. Some considered the proposal to be premature because the eMLP has already been approved by the HCC Environment Panel. However, objections to the plan have yet to be heard at examination. Given the stage the eMLP has reached it cannot be given much weight in determining this appeal. [43,90,167,207,277,288]

446. The appeal site lies within the area designated for the Bengeo Neighbourhood Area Plan (BNAP), but this plan is at an early stage of preparation and its draft provisions can be given little weight at this stage. [44,182]

(14) Framework and Guidance

447. In terms of compliance with the *Framework* the scheme would gain support from the great weight to be given to the benefits of mineral extraction, including to the economy. However, it would be at odds with policy about enhancing the natural and local environment and recognising the intrinsic character and beauty of the countryside, and the economic and other benefits of BMV agricultural land. On the available evidence, I am unable to find that the proposal would accord with the aim of the NPSE to avoid significant adverse impacts on quality of life. Where all necessary controls would need to be imposed by the planning system, I am unable to conclude in the absence of an appropriate mechanism and conditions to safeguard groundwater that the appeal scheme would not result in an unacceptable risk of water pollution. [45,47,49,50,51,52,106]

448. If the Secretary of State finds that the development would be inappropriate in the Green Belt and concurs that VSC do not exist, then the proposed development would conflict with national policy concerning the Green Belt. But irrespective of whether the proposal is inappropriate or 'appropriate' development in the Green Belt, I consider for the reasons set out above, that the scheme would be at odds with the policy in the *Framework* when considered as a whole.

449. Relevant provisions of the *Guidance* have been taken into account in assessing the appeal scheme. [53,54]

(15) Planning conditions and obligations

Conditions

450. Suggested conditions, in the event that planning permission was granted, were the subject of a round-table without-prejudice discussion at the Inquiry. The written list of conditions submitted by the appellants includes pre-commencement conditions. In the following paragraphs the Condition numbers are as they appear in the Schedule of Conditions attached to this report. [122-124,329,336]

451. A commencement period of three years would be appropriate here, and to effectively enforce conditions, notification of the dates of commencement of mineral extraction, and completion of site restoration, would be necessary (Conditions 1, 2 and 3). Otherwise than as set out in the decision and conditions, it would be necessary that the development was carried out in accordance with the approved plans, to ensure that it was in accordance with the scheme considered at the Inquiry (Condition 4). Given the level of detail contained in the submitted documents, subsequent approval would be required for the matters set out in Condition 5 concerning plant, structures and buildings.

452. Details for each Phase would be required to ensure that the development was carried out in an orderly manner, and restored without unnecessary delay (Conditions 6 and 7). Conditions 8-11 and 17 concerning access, number of HGVs, crossing for the haul road, and off-site highway works would be necessary in the interests of safety. There is no evidence to indicate that the true morning peak time in this location is 7.30 am to 9.30 am, and suggested

Condition 9(b) accords with the peak hours specified by the Highway Authority. A condition could not require a routeing plan where vehicles were using the public highway. There would be no need to specify a particular distance of level ground where footpaths were near to roads as such details would be matters for approval in discharging the conditions suggested by HCC and the appellants. [330,335]

453. Wheel cleaning facilities would be required to control the track-out of material onto the highway for pollution reasons (Conditions 12 and 13). Details would need to be approved of the stockpile and fuel storage areas (Conditions 14 and 15) for similar reasons. It would be necessary to limit the height of stockpiles to 5 m so as to minimise the visual impact of the development and to accord with the information in the ES.

454. There may be advantage in permissive rights of way being available for walkers, cyclists and horse riders, but it does not seem to me that this would be a reasonable requirement necessary to mitigate harm to those who currently use the area. I concur with the appellants that the condition should refer only to walkers (Condition 16). [329]

455. An archaeological scheme and recording would be necessary in the interests of local heritage (Condition 18).

456. No waste should be imported, surface and ground water drainage controlled, boreholes maintained, groundwater monitored and measures required to deal with any land contamination, so as to safeguard groundwater (Conditions 19-24). However, it would not be necessary to specify works for borehole OBH 1A as this has been repaired. SBQ's detailed suggestion for boreholes might preclude more appropriate measures. This is a matter of detail that could be better dealt with by the approval of details in discharging conditions. [330,322]

457. Landscaping for the site access and haul road, along with advance planting, would need to be approved in the interests of the appearance of the area (Conditions 25-27). Lighting and boundary treatment would need to be controlled for similar reasons (Conditions 28 and 29). Soil handling would need to accord with Defra guidance to provide for successful restoration (Condition 30).

458. The appellants' closing submissions refer to proposed ecological enhancements and maintenance for 10 years with longer-term conservation maintenance secured by way of a "landscape and nature conservation management plan" (ID111). But the reference to ecology in earlier versions of the suggested conditions (ID82.1) was omitted in subsequent versions. Ecological considerations are part of the appellants' case and so should be included in the details to be approved. This could be added to suggested Condition 31 for a landscape and ecological restoration scheme for each Phase. Details would need to be approved for a landscape and ecological restoration scheme in the interests of the appearance of the area and biodiversity (Condition 31).

459. A condition regarding completion and aftercare would be necessary to ensure compliance with Schedule 5 of the 1990 Act concerning the required standard of restoration (Condition 32).

460. The hours of working would need to be controlled in the interests of the amenity of the area (Condition 33). Some objectors considered that starting at 0700 hours and working on Saturday would cause unacceptable additional noise. However, the hours suggested by HCC/appellants are those normally accepted for working quarries. With other conditions to control adverse impact there are no good grounds for imposing more restrictive working hours. [306,316,330]

461. Dust control would be needed for health and amenity reasons (Condition 34). It would be reasonable in doing so to follow IAQM guidance. A scheme for air quality monitoring would need to be approved for health reasons (Condition 35). SBQ's air quality monitoring condition should be preferred because it would record hourly average concentration of PM_{10} which could draw attention to any short term peaks exceeding 100 $\mu g/m^3$, so providing a trigger for further investigation. This would be necessary to inform the local community about potential health risks, especially for vulnerable members of the community. Three monitoring sites would be necessary to determine, in varying weather conditions, whether the quarry was responsible for any changes in air quality. [331,332]

462. A condition concerning a community liaison group would be necessary to establish an effective complaints procedure regarding the operation of the quarry, but would not need to specify who should participate (Condition 36). [333]

463. Controls on noise emissions would be required in the interest of the amenity of nearby residents (Conditions 37,39-41). However, it would not be necessary to restrict the number of specific plant on site, or to specify their sound power levels, as this would impair operational flexibility, and in any event other noise controls would apply. If more frequent monitoring was considered necessary this could be required under Condition 41(d). [334]

464. A condition would be necessary to safeguard groundwater from pollution (Condition 42). The suggested condition by HCC and the appellants, along with the alternative suggestion by SBQ, are set out in the Schedule of Conditions. However, for the reasons given above in section (5) of this report, neither is recommended. If the Secretary of State is minded to allow the appeal and to grant planning permission then it would be necessary to go back to the parties to devise the terms of a condition that would achieve the required safeguarding of the aquifer by means of a planning condition that passed the relevant tests.

465. A condition would be necessary to give effect to the intention to restrict working within 70 m of properties at The Orchard, so that operations would not take place when the wind direction was from the north-eastern quadrant (Condition 44). [16]

466. It would not be necessary to impose any other conditions. Some minor changes to the wording of conditions suggested by the parties are necessary so as to ensure that a permitted scheme would accord with the details of the proposal that was considered at the Inquiry, and to ensure that conditions were precise and enforceable.

Obligations

467. If section 106 obligations are not material considerations, or for other reasons would not satisfy the requirements of CIL Regulation 122, they would be matters on which it would be unlawful for the Secretary of State to place any weight in granting planning permission. However, if an obligation was material and complied with CIL Regulation 122 because it was required mitigation that would not necessarily preclude it from also being considered a benefit in the overall planning balance. Whether it would do so, and what weight it should attract, would depend upon the particular circumstances.

468. Provisions in the section 106 agreement for the timing of the commencement and completion of the development would be necessary to ensure that the operation was in accord with the duration of impacts assessed at the Inquiry. The new byways would be required to mitigate the harm to the PRoW network during the operation and after restoration. Off-site highway works would be necessary for highway safety reasons during the operation, but on completion of the scheme, would need to be removed, and the accessway restored, in the interests of the long term character and appearance of the area. These obligations would be necessary to make the development acceptable in planning terms, are directly related to the proposed development, and would fairly and reasonably relate to it in scale and kind. The new byways would be permanent additions to the PRoW network and so would be beneficial. [12,337]

469. However, I have reservations about the provisions in the agreement for highway restoration, which I queried when the draft was discussed at the Inquiry. The signed version of the agreement defines "Highway Restoration", but does not thereafter use the term.[172] The intent appears to be that the removal of the highway works and restoration of the accessway would be provisions in the Highways Agreement. However, there is nothing in the obligation to require such a provision in the Highways Agreement. In addition, Clause 4.1 of Schedule 1 requires the highway works to be completed prior to the commencement of extraction. That would not make provision for any removal of the highway works and restoration of the accessway after the completion of extraction. The accessway might be dealt with in the restoration scheme for the site, but that would not deal with off-site highway works. It is not certain that the suggested conditions or the obligations would achieve the appellants' intent about removing the junction and accessway on restoration. If the Secretary of State is minded to allow the appeal then this is a matter that would have to be referred back to the parties.

470. In the section 106 agreement "Restoration of the Development" is defined as "the restoration of the Application Site in accordance with the Progressive Operations Plan annexed at Schedule 5 and the Landscape Restoration Plan and the Restoration Scheme and the Planning Permission." However, the plan at Schedule 5, Plan No.1217/PO/2, relates to the 1.25 Mt scheme, and so would not be appropriate for the 1.75 Mt scheme. Again, if the Secretary

[172] ""Highway Restoration" means the removal of the Highway Works in accordance with the Highways Agreement together with the restoration of the Accessway to the condition required by the County Council as the highway authority for Hertfordshire."

of State is minded to allow the appeal then the obligation would need to be amended.

Financial Bond

471. There is local concern about the restoration of the site. It is understandable that some of this arises from past experience with quarrying in the locality, especially how the situation has unfolded at Rickneys Quarry. However, progressive reclamation would be a practicable option for the appeal scheme, and no novel approach or technique is proposed to be used. Furthermore, there is no reliable evidence of the likelihood of either financial or technical failure. I am therefore satisfied that concerns about the funding of site restoration could be reasonably addressed here through appropriately worded planning conditions. This is not an exceptional case that would justify a financial guarantee or bond to cover restoration and aftercare costs. [140,150,161]

Overall conclusions for 1.75 Mt scheme

472. The proposed development would harm the character and appearance of the area. It would be too close to nearby residential properties, resulting in harm to living conditions and the amenity of the area. In the absence of an appropriate mechanism and planning condition to safeguard the aquifer, the appeal scheme would pose an unacceptable risk to an important public water supply. On these grounds, it would conflict with relevant development plan policies and would not accord with national policy. If the Secretary of State finds that the scheme is inappropriate development in the Green Belt and that VSC do not exist, then it would also conflict with local and national policy concerning the Green Belt. I find no other material considerations to indicate that the determination should be made other than in accordance with the development plan. For the reasons given above and having regard to all other matters raised in evidence, I conclude that the appeal should be dismissed. [87,88,124,125,213-215,268,269]

Consideration of the 1.25 Mt scheme

473. If the Secretary of State is minded to agree with my recommendation for the 1.75 Mt scheme, then consideration should also be given to the appellants' submissions about substituting the 1.25 Mt scheme, along with the representations about this by other parties and interested persons. [4,13,226,338-345]

474. In this event, the appellants requested that a condition limiting the scheme to 1.25 Mt be imposed. However, the description of the proposal, as set out in the application and appeal forms, includes a "stockpile area". A condition that precluded development of a stockpile area would, in effect, contradict part of the permission, and so would be unreasonable. Substituting the 1.25 Mt scheme in determining this appeal could not, therefore, be achieved just by the imposition of conditions. The description of the development would, as acknowledged by the appellants, also need to be amended.[173]

[173] APP10 paragraph 3.3.6.

475. Consideration should, therefore, be given to whether the appeal could be properly determined on the basis of an amended scheme, which included deletion of the reference to the "stockpile area" from the description. To do so the Secretary of State would need to find that the *Wheatcroft* principles are satisfied.[174] The *Wheatcroft* judgment referred to whether the development is so changed that to grant it would be to deprive those who should have been consulted on the changed development of the opportunity of consultation. Consideration therefore needs to be given to whether the scheme would be a substantially different scheme from that which was before HCC when it determined the application, and whether anyone would be likely to be prejudiced by dealing with the amended scheme at the appeal stage.

476. There are some significant differences between the 1.75 Mt and 1.25 Mt schemes. These are intended by the appellants to address some of the concerns about the proposal raised by HCC and objectors. However, they include alterations that could result in different outcomes, about which other parties or interested persons might wish to comment. These differences include the following:

(1) Siting of the 'load out area' further within the site on higher ground and closer to residential properties on Sacombe Road, with different bunds and road layout, and with the loading and refuelling area sited over more vulnerable geology in terms of the risk of water pollution and contamination of the underlying aquifer, albeit slightly further away from the Wadesmill Road PS.
(2) Siting of the access road and haul roads within the site, with different arrangements for screening bunds.
(3) Removal of Bund 3 and the Subsoil store from Phase 1.
(4) Restoration details, including additional woodland thicket planting and tree & hedgerow planting near the southern boundary of Phase 1, different siting and size for the proposed attenuation area, additional tree & hedgerow planting across the Phase 3 part of site, along with different contours for finished ground levels, especially in the northern part of the site.

477. I consider that these are significant differences, notwithstanding the fact that HCC found the schemes were of the same character in applying the Fees Regulations. The description of the scheme was not the same because it deleted reference to the "stockpile area". HCC's decision about fees should not be determinative for the purposes of considering whether the *Wheatcroft* principles apply here. HCC did not consider the 1.75 Mt scheme to be substantially different from the original 2.6 Mt scheme. But the revision primarily concerned the restored landform, with most other features of the 1.75 Mt proposal substantially unchanged from the 2.6 Mt scheme. [4]

478. I turn next to procedural fairness, having regard to the *Holborn Studios* judgment. A separate application for the 1.25 Mt scheme has been the subject of public consultation, and there has been considerable involvement by interested persons in the Inquiry, at which evidence was presented about the 1.25 Mt scheme. Many people took these opportunities to make representations about the 1.25 Mt scheme. But this does not rule out the

[174] *Bernard Wheatcroft Ltd v SoSE.*

possibility here of someone being prejudiced because they were deprived of such an opportunity. Many local residents commented on the confusion about the process and relevant documents. This is understandable given the chronology of events in this case. It is not possible to say that the manner in which the applications and the appeal progressed did not, for some people, result in misunderstandings about how and when to comment on the 1.25 Mt scheme, at both the application and appeal stages. [13,195,196,279,280,292]

479. Some objectors thought that dealing with the 1.25 Mt scheme as part of this appeal would neutralise and confuse any opportunity for comment or objection to any appeal against the refusal of that scheme. HCC also objects to consideration of the amended scheme because a step in the appeal process would be bypassed. There is statutory provision for two opportunities to make representations, for which there are specific public notice provisions at the application and appeal stages. The original public notice about the Inquiry, and the subsequent notice about its resumption, both correctly quoted the description of the proposed development from the application form, which included the "stockpile area", and so some readers might have reasonably assumed that the Inquiry was dealing solely with the 1.75 Mt scheme.

480. The adjournment of the Inquiry would not have remedied any procedural fairness defect regarding consideration of the 1.25 Mt scheme, as the adjournment was required to provide an opportunity for public comment on the HIA. In my judgement, the 1.25 Mt scheme is substantially different from the 1.75 Mt scheme, and for the reasons set out above, I do not believe that the likelihood of prejudice arising here is low enough to feel confident about dealing properly with the appeal on the basis of the 1.25 Mt scheme. I find that the *Wheatcroft* principles are not satisfied here, and I consider that the Secretary of State should decline the request to determine the appeal on the basis of the 1.25 Mt scheme.

481. However, in the event that the Secretary of State disagrees with this recommendation, and concurs with the appellants' view that the *Wheatcroft* principles would be met, evidence was presented to the Inquiry about both schemes, and so an addendum report about the 1.25 Mt scheme could be submitted. If the Secretary of State gives written notice that he is both minded to refuse the appeal for the 1.75 Mt scheme, and considers that it would be appropriate in the circumstances that apply here to determine the appeal on the basis of the amended scheme for the extraction of 1.25 Mt of sand and gravel, then a separate addendum report will be submitted setting out the planning merits of the 1.25 Mt scheme. This would include a recommendation as to whether the amended scheme should, or should not, be granted planning permission, along with any planning conditions considered to be necessary were the appeal to succeed on that basis.

Recommendations

482. I recommend that the appeal for the 1.75 Mt scheme should be dismissed for the reasons set out above. However, if the Secretary of State is minded to disagree with my recommendation, and to allow the appeal and to grant planning permission, then the conditions considered necessary to be imposed are set out in the Schedule of Conditions attached to this report. A revised section 106 agreement would also be necessary to ensure that an appropriate mechanism existed for highway restoration.

483. For the reasons set out above, I recommend that the Secretary of State declines the request to determine the appeal on the basis of the 1.25 Mt scheme.

John Woolcock
Inspector

APPEARANCES

FOR HERTFORDSHIRE COUNTY COUNCIL:

David Forsdick QC	Instructed by the County Solicitor
He called	
Stephen Marshall MIOA MIDiagE	Acoustic Consultant Acoustic Associates
Julie Greaves BSc(Hons) MSc	Team Leader Minerals and Waste Planning and Policy
Jennifer Clarke BA(Hons) Dip Landscape	County Landscape Officer
Felicity Hart BSc(Hons) DipTP FRTPI	Principal Planning Officer
Chay Dempster BSc(Hons) MA TP	Principal Planning Officer

FOR THE APPELLANTS:

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She called	
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Les Jephson BEng(Hons) MIOA	LF Acoustics Ltd
Jethro Redmore BEng MSc CEnv MIAQM MIEnvSc PIEMA	Redmore Environmental
James Sutton BSc Tech Member IoQ	Ingrebourne Valley Ltd
Ian Dix BSc(Hons) MSc MCIT MCIHT	Vectos
Ben Cave BA(Hons) MSc FIEMA MFPH	Ben Cave Associates Ltd
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Mark Flatman BA(Hons) Dip LA CMLI	Liz Lake Associates
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Professor Ranjeet S Sokhi PhD	Director of the Centre for Atmospheric and Climate Physics Research University of Hertfordshire acting on behalf of ReScientia Ltd

Douglas Symes BSc(Hons) ARSM CEng FGS MIMM FIQ FRGS	DK Symes Associates

FOR RULE 6(6) PARTY: STOP BENGEO QUARRY (SBQ)

Katharine Elliot of counsel	Instructed by Attwaters Jameson Hill and SBQ

She called

Professor Brassington BSc(Hons) MSc FGS MICE FCIWEM
Roger Barrowcliffe BSc(Hons) IAQM CSci CMet Director Clear Air Thinking Ltd

FOR RULE 6(6) PARTY: Dr Andrew Stevenson BSc(Hons) MSc PhD
County Councillor for Hertford All Saints
Vice Chairman Environment Planning and Transport Hertfordshire

INTERESTED PERSONS:

Andrew Smith	Local resident
Aska Pickering	Local resident and Chairperson of SBQ
Dr David Adam PhD Env Sci	Local resident and Parent Governor of Bengeo Primary School
Libby Mountford	Local resident
Julie Starkiss	Head teacher Bengeo Primary School
Suzanne Bray	Local resident
Tanya Needham	Local resident and Governor of Bengeo Primary School
Thalia Watson	Local resident
John Howson	Local resident
Robert Chandler	Local resident
Anu Palmer	Local resident
Mark Lynch	Local resident and Chairman of the Bengeo Neighbourhood Plan Steering Group
Dr Bryan Lovell OBE CGeol	Senior Research Fellow in Earth Sciences University of Cambridge
Peter Norman	Hertford Civic Society
John Wiggett	Local resident
Cllr Steve Cousins	Hertford Town and District Council
Terry Mansfield	Chapmore End Association
Dr Mike Howarth	Local resident
John Barnes	Local resident
Alan Burgess	Local resident
Kelly Martin	Local resident
Dan Griffiths	Local resident
Lee Nicholson	Local resident
Alexandra Daar	Local resident
Ben Penrose	Chairman Molewood Residents' Association
Graham Nickson	Local resident
Veronica Fraser	Health Walks Leader

Cllr Margaret Eames-Peterson FSS FRSPH MSc DLSHTM PGCE BSc	Hertfordshire County Council
Cllr Mari Stevenson	East Herts District Council
Steve Halsey	Local resident
Laura Wyer	Local resident
Simon Pickering	Local resident
Nadine Cleland	Local resident
Russell Norris	Chapmore End Association
Heston Attwell	Local resident
Amber Waight	Local resident
Cllr Bob Deering	Hertford County Council East Herts District Council and Hertford Town Council
Nigel Braggins	Local resident
Dr Laura Horsfall	Senior Epidemiologist University College London
Mark Prisk MP	Member of Parliament for Hertford and Stortford

PROOFS OF EVIDENCE and WRITTEN REPRESENTATIONS

	Appellants
APP1	Christopher Leake Proof of Evidence, Appendices A1-A6.
APP2	Les Jephson Proof of Evidence, Appendices A and B.
APP3	Jethro Redmore Proof of Evidence, Appendices 1-5.
APP4	James Sutton Proof of Evidence, Appendices 1-5.
APP5	Ian Dix Proof of Evidence, Appendices 1-3.
APP6	Ben Cave Health Impact Assessment.
APP7	Robert Sellwood Proof of Evidence, Appendices 1-9.
APP8	Mark Flatman Proof of Evidence, Appendices A-D, Rebuttal ID2.
APP9	Susan Deakin Proof of Evidence, Appendices A and B.
APP10	Douglas Symes Proof of Evidence, Appendices 1-11.
APP11	Professor Ranjeet S Sokhi Proof of Evidence September 2018.
	Hertfordshire County Council
HCC1	Stephen Marshall Proof of Evidence, Noise Assessment March 2018, Review March 2017, Rebuttal ID7.
HCC2	Julie Greaves Proof of Evidence, Appendices 1-15, Rebuttal ID8.
HCC3	Jennifer Clarke Proof of Evidence, Appendices 1-4.
HCC4	Felicity Hart Proof of Evidence, Appendices 1-3.
HCC5	Professor Jim McManus Written Representation, Appendices 1-3.
	Stop Bengeo Quarry Rule 6 Party
SBQ1	Professor Brassington Proof of Evidence, Appendices 1 and 2, Supplementary Proof April 2018.
SBQ2	Roger Barrowcliffe Proof of Evidence, Appendices A and B.
	Cllr Andrew Stevenson Rule 6 Party
AS1	Statement and Attachments

SCHEDULE OF PLANS AND DRAWINGS FOR 1.75 Mt SCHEME

Plans and drawings upon which any determination for the 1.75 Mt scheme should be made i.e. excluding drawings or figures submitted within the planning application for illustrative or information purposes, are set out in ID97 and listed as follows:

Location Plan 1217/L v4 dated 25/09/2015
Application Plan 1217/A/1 v7 dated 06/09/2017
Site Context 1217/SC/2 v2 dated 24/11/2015
Composite Operations Plan 1217/CO/1 v9 dated 19/12/2016
Progressive Operations Plan 1217/PO/1 v9 dated 19/12/2016
Stockpile Area 1217/SP/1/ v3 dated 01/02/2016
Restored Landform 1217/R/1 v10 dated 16/01/2017
Drilling Survey for Sand and Gravel 1217/DS/1 v2 dated 20/05/2013

SCHEDULE OF PLANS AND DRAWINGS FOR 1.25 Mt SCHEME

Plans and drawings upon which any determination for the 1.25 Mt scheme should be made i.e. excluding drawings or figures submitted within the planning application for illustrative or information purposes, are set out in ID97 and listed as follows:

Location Plan 1217/L v4
Application Plan 1217/A/1 v7
Site Context 1217/SC/2 v2
Drilling Survey for Sand and Gravel 1217/DS/1 v2
Operations Plan – Phase 1 1217/O/1 v4
Operations Plan – Phase 2 1217/O/2 v4
Operations Plan – Phase 3 1217/O/3 v4
Progressive Operations Plan 1217/PO/2 v4
Landscape Restoration Strategy (Liz Lake) 1571 01 H
Access Junction and Right Turn Lane (Vectos) 131124/A/04.1 Rev E

ANNEX A – RULING RE ADJOURNMENT

"I have considered the written notes and submissions this morning about the HIA. I do not consider that the appellants' Statement of Case, either SoC1 or SoC2, made it sufficiently clear what was the appellants 'full particulars of case' [175] insofar as the HIA was concerned, particularly as reference to an HIA was included in HCC's reasons for refusal. If the appellants intended to refer to an HIA it would have been better to have said so in the SoC, especially given the date SoC2 was submitted. It seems to me that the appellants are, in effect, adding to their SoC by now relying on an HIA. I will allow this, but in accordance with Inquiry Rule 15(10) shall give those appearing at the Inquiry an adequate opportunity of considering the document.

SBQ considers that proceeding without that opportunity would be prejudicial to their case. I make no ruling about this. But I cannot be certain that there are not interested persons, members of the public, who, had the HIA been cited in a SoC or made available for consultation earlier, would have wanted to give evidence about it, and so would be prejudiced by the way the matter has been dealt with so far.

My ruling is that I propose to give time for those who wish to do so to consider the HIA and to make submissions to the Inquiry about it. This will require an adjournment. I will ask the parties to consider, in a break, how long they consider will be necessary."

John Woolcock
Inspector
18 May 2018

[175] 2000 Inquiry Rules Interpretation states that 'statement of case' means, and is comprised of, a written statement which contains full particulars of the case which a person proposes to put forward at an inquiry and a list of any documents which that person intends to refer to or put in evidence.

ANNEX B Written representations about HIA submitted during adjournment

Natalie Adam (115) Fay Adams (82) John and Penny Andrew (63) Mr and Mrs BJ Archer (79) Neil and Pauline Atkins (42) Heston Attwell (139) Victoria Attwell (135) Miss KJ Ayres (78) Roger and Patricia Bardle (120) Frank and Mary Baynes (140) Jo Beatty (16) Anthony Beck (6) Clare Blackman (150) Nigel Braggins (95) Matt Bray (133) Suzanne Bray (153) Alan Cain (32) Nicola Camp (148) Andrew Cannon (116) Emma Chiew (50) Laura Church (17) Sandra Church (18) Peter Collins (54) Hannah Cope (123) Geoffrey Cordingley (152) Paul Cox (104) Rebecca Cox (12) David Cramphorn (137) Mr TE Creasey (76) Robert and Janet Cunneen (81) Denise Culverhouse and John Morgan (145) Alex Daar [East Herts Green Party] (86) Diana Davies (5) MH Davis (113) Sue Dear (70) Desiree de Silva-Power (127) Graham Dial (4) Chris Dixon (11) Thomas Dunklin (84) Nick Egginton (30) Paul Eldred (29) Elaine Elliot (106) CA and AA Etheridge (3) Mike and Brenda Excell (90) Mrs Foot (146) Mr RJ Fradley (138)	Carole Luck (22) Gillian Lynch (143) Mark Lynch (8) Ian Lyon [Chapmore End Association] (73) Alison Madge (28) Eliza Mary Mann (92) Kathy Mann PhD FRCPath (21) Mr and Mrs Martin (144) Diane and Allan Mattick (23) Lynda McKenzie (124) Catherine McMenamin (24) Nikki McMurray (154) Steve McMurray (19) Denise Mitchell (111) Peter Moore (77) Sam Mountford (2) Iris Needham (43) T Needham (41) Dr M Newman MB BS (51) Mr M Newman (52) Graham Nickson (34) RF Norris (117) Colin Nunn (64) Pamela D'Ampney Nunn (80) Wendy Oakins BHSAI (33) Anu Palmer (134) Terry and Sally Paque (56) Ben Penrose [Molewood Residents' Association] (129) Aska Pickering (102) Simon Pickering (55) James Power (126) Jane A Rainbow (89) Anne Ramsden (47) Carolyn Redfern (114) Marilyn Reynolds (59) Katharine Richardson (151) Alan Scarisbrook (121) Karen Seaborne-Lasmi (122) Alison Sheldrick (99) Robert Sheldrick (100) Marcus Silversides (105) Jo Spiers (72) Elizabeth Staley (74) Anna Stanton (27) Paul Stanton (44) Stop Bengeo Quarry (132)

Veronica Fraser (46) Edward Fuller (36) Gunilla Fuller (37) Peter Fuller (83) Nancy Gensini (147) Janet Guilbride (96) Michael Guilbride (97) Brian G Guildea (14) Paul and Lyn Groves (53) Ken and Yvonne Hall (85) Stephen Halsey (130) Gemma Harris (15) Clare and Richard Haworth (61) Mr and Mrs Heard (20) Louise Henderson-Lea (26) Brenda Heninghem (48) Jenny Herbert (58) Christine Holyfield (156) Dr Laura J Horsfall (119) Dr Mike Howarth (109) Ann Hutton (62) Frank Iddiols (93) Paula Iddiols (38) Duncan Jauncey (9) Victoria Jauncey (10) Veronica Jesson (103) Ross Jones (155) Barbara Kiln (60) Peter and Nicola King (57) Beatrice Leigh (68) Samantha and Victoria Levy (107) Paul Lloyd (118) Dr Bryan Lovell CGeol (75)	Deborah and Barry Sumby [Watermill Estate Residents' Association] (91) A J E and M Taylor (69) Robin and Celia Tesselment (45) Llinos Thomas (136) Miss CA Thompson (125) Dorothy MF Toyn (35) Amber Waight (13) Elizabeth Walden (88) Fran Wallis (142) Brian Warrington (67) Bridget Webb (65) Pete Webb (66) Thalia Weston (101) Juliet Whitehead (110) Richard Whiting (131) Linda Whiting (128) John and Carmen Wiggett (71) R M C A and B Wiles (7) Rachel Williams (149) Frances Wilson (25) Susan Wilson (87) Kathy Winsor (49) James Wiseman (31) Dr Katy Wright (39) Timothy Wright (40) Pasco and Dellen Wright (94) Laura Wyer (1) Greg Yeoman (112) Vicky Yeoman (141) Anthony Yoxall (98) Sue Yoxall (108)

SCHEDULE OF PLANNING CONDITIONS for 1.75 Mt scheme (Conditions 1-43)

If planning permission is granted for phased extraction of sand and gravel, mobile dry screening plant, stockpile area, weighbridge, wheel cleaning facilities, ancillary site offices, construction of a new access onto Wadesmill Road with phased restoration to landscaped farmland at a lower level at Land at Ware Park, Wadesmill Road, Hertford, Hertfordshire in accordance with the terms of the application No:3/0770-16, dated 4 March 2016, as amended, it is recommended that the permission be subject to the following conditions:

1) The development hereby permitted shall begin not later than three years from the date of this decision.

2) The Mineral Operator shall give not less than 21 days written notice to the Mineral Planning Authority in advance of commencement of the development and shall confirm in writing to the Mineral Planning Authority the actual date of commencement within seven days of the event occurring. The Mineral Operator shall give written notice to the Mineral Planning Authority of the date of commencement of mineral extraction within seven days of the event occurring.

3) (a) All mineral extraction shall be completed, in accordance with the approved plans, not later than 10 years from the date that mineral extraction commenced.

   (b) The Mineral Operator shall give not less than 21 days written notice to the Mineral Planning Authority prior to the completion of extraction of each Phase. The Mineral Operator shall give written notice to the Mineral Planning Authority of the actual date of completion of extraction of each Phase within seven days of the event occurring.

   (c) If operations are terminated or suspended part way through extraction of any Phase then the Operator shall inform the Mineral Planning authority in writing within 21 days of the termination/suspension occurring.

4) The development hereby permitted shall be carried out in accordance with the following approved plans and drawings.

   Location Plan 1217/L v4 dated 25/09/2015
   Application Plan 1217/A/1 v7 dated 06/09/2017
   Site Context 1217/SC/2 v2 dated 24/11/2015
   Composite Operations Plan 1217/CO/1 v9 dated 19/12/2016
   Progressive Operations Plan 1217/PO/1 v9 dated 19/12/2016
   Stockpile Area 1217/SP/1/ v3 dated 01/02/2016
   Restored Landform 1217/R/1 v10 dated 16/01/2017
   Drilling Survey for Sand and Gravel 1217/DS/1 v2 dated 20/05/2013

5) Prior to commencement of development, full details of all plant, structures and buildings to be placed on site, shall be submitted to the Mineral Planning Authority for approval. No development shall take place until the written approval of the Mineral Planning Authority has been obtained. All plant, structures and buildings shall be in accordance with the approved details and shall thereafter be retained until the last Phase has been restored unless the Mineral Planning Authority gives prior approval in writing.

6) Prior to the commencement of development in each Phase, a detailed Working Plan/Scheme shall be submitted to the Mineral Planning Authority to show:
(a) The precise extent of the extraction area.
(b) The precise location and height of screen bunds.
(c) All working including soil stripping, overburdens stripping, mineral extraction and restoration.
(d) The location of any stockpiles/storage area together with a methodology for handling soils.

No development shall take place until the details referred to above have been approved in writing by the Mineral Planning Authority. All working of the site (to include extraction and restoration) shall take place in accordance with the approved detailed Working Plan/Scheme. The detailed restoration works shall be commenced within three months of the completion date of gravel extraction in each Phase in accordance with the approved Working Plan/Scheme.

7) In the event that operations are terminated or suspended for a period in excess of 12 months, in any Phase, the excavated area and all other disturbed land shall be restored in accordance with the restoration elements of the Working Plan/Scheme approved in writing by the Mineral Planning Authority. In these circumstances, restoration shall be completed within 12 months of the date on which the Mineral Planning Authority notified the operator in writing that operations are considered to have been terminated or suspended for 12 months.

8) Prior to commencement of development, full details of the proposed access off the B158 Wadesmill Road, as shown in principle on Drawing No.131124/A/04.1E, shall be submitted to the Mineral Planning Authority for approval in writing. The access and associated road improvements shall be constructed in accordance with the approved details prior to the commencement of work on the first Phase of extraction. No other vehicular access shall be made available to the site.

9) (a) There shall be no more than 100 lorry (HGV vehicles over 7.5 tonnes) movements (50 in, 50 out) entering/leaving the access/egress onto the Wadesmill Road in any one working day. Written records of all HGVs entering and leaving the site shall be kept by the Mineral Operator and made available for inspection by the Mineral Planning Authority upon request.

(b) There shall be no more than 8 HGV lorry movements (4 in / 4 out) entering/leaving the access/egress onto Wadesmill Road during the hours of 08.00-09.00 (AM peak) and 16.00-17.00 (PM peak) in any one working day.

10) No HGVs shall turn right when exiting the site unless instructed to do so by the Police. Prior to the commencement of development details of signage requiring all HGVs to turn left onto the B158 Wadesmill Road, along with the siting of the signage close to the site exit, and a programme for its installation, shall be submitted to and approved in writing by the Mineral Planning Authority. The signage shall be erected

in accordance with the approved details and thereafter shall be retained until the last Phase has been restored.

11) Prior to the commencement of development, full details of any fencing, gates or barriers proposed to be erected at the entrance to the site in connection with the formation of the new haul road, shall be submitted to the Mineral Planning Authority for approval in writing. Any gates, fencing or barriers shall be erected in accordance with the approved details and thereafter shall be retained until the last Phase has been restored.

12) Prior to commencement of development, full details of the wheel wash, together with water supply, water storage, recycling and disposal shall be submitted to the Mineral Planning Authority for approval in writing. The wheel wash shall be implemented and operated in accordance with the approved details.

13) No vehicles shall enter the public highway from the site unless their wheels and chassis have been cleaned in the wheel wash to prevent material being deposited on the highway.

14) Prior to commencement of development, full details of the construction of the stockpile area to include cross sections, finished levels, surfacing, drainage and pollution measures shall be submitted to the Mineral Planning Authority for approval in writing. Construction shall take place in accordance with the approved details before the first use of the stockpile area, which shall thereafter be retained in accordance with the approved details. The height of stockpiles within this area shall not exceed 5 m above its finished ground level.

15) Full details of the proposed bunded fuel storage area shall be submitted to the Mineral Planning Authority for approval in writing. The bunded fuel storage area shall be constructed and used in accordance with the approved details. Plant shall only be refuelled in the bunded fuel storage area.

16) Prior to the commencement of development details of all proposed temporary permissive paths shown on Composite Operations Plan 1217/CO/1 v9 dated 19/12/2016, including the standard of construction and width of paths, shall be submitted to the Mineral Planning Authority for approval in writing. The permissive paths shall be created in accordance with the approved details and made available for public use by walkers prior to the commencement of mineral extraction, and thereafter shall be retained until the Certificate of Completion under the Section 25 Agreement has been issued and the Definitive Map routes have been dedicated.

17) Prior to commencement of development, a detailed scheme for the safe crossing by the public over the haul road of any rights of way, shall be submitted to the Mineral Planning Authority for approval in writing. The crossings shall be implemented in accordance with the approved details and made available prior to the first use of the haul road by any HGVs, and thereafter shall be retained until the last Phase has been restored.

18) (a) The development hereby permitted shall not commence until an Archaeological Written Scheme of Investigation has been submitted to

and approved in writing by the Mineral Planning Authority. The scheme shall include the following: (1) A programme and methodology of site investigation and recording. (2) A programme for post-investigation assessment. (3) Provision to be made for analysis of the site investigation and recording. (4) Provision to be made for publication and dissemination of the analysis and records of the site investigation. (5) Provision to be made for archive deposition of the analysis and records of the site investigation. (6) Nomination of a competent person or persons/organisation to undertake the works set out within the Archaeological Written Scheme of Investigation.

(b) The development hereby permitted shall be carried out in accordance with the approved programme of archaeological works set out in the Written Scheme of Investigation.

(c) The site investigation and post-investigation assessment shall be completed in accordance with the programme set out in the approved Written Scheme of Investigation, and the provision made for analysis and publication where appropriate.

19) The development hereby permitted shall not be commenced until such time as a scheme for Groundwater Monitoring has been submitted to, and approved in writing by, the Mineral Planning Authority. The scheme shall include the following: (1) A groundwater monitoring programme to cover the whole time period of mineral extraction at the site (including a maintenance plan for the groundwater boreholes) in respect of contamination and turbidity, including a timetable for monitoring and the submission of reports to the Mineral Planning Authority. (2) Provision for monitoring reports, which should include details of any necessary contingency action arising from the monitoring, to be submitted to the Mineral Planning Authority for approval in writing. Any necessary contingency measures required shall be carried out in accordance with the approved timetable as set out in the approved reports. The Groundwater Monitoring scheme shall be implemented as approved.

20) No Controlled Waste defined by *The Controlled Waste Regulations 2012* or Mining Waste defined by *The Environmental Permitting Regulations 2016* (as amended) shall be imported to the site for reuse, processing, recovery or disposal or for any other purpose.

21) If, during development, contamination not previously identified is found to be present at the site then no further development (unless otherwise approved in writing by the Mineral Planning Authority) shall be carried out until the developer has submitted a remediation strategy to the Mineral Planning Authority detailing how this unsuspected contamination shall be dealt with and obtained written approval from the Mineral Planning Authority. The remediation strategy shall be implemented as approved.

22) There shall be no drainage from the site by means of infiltration unless a detailed scheme has been submitted to and approved in writing by the Mineral Planning Authority setting out all pollution control measures and details for management and monitoring. The scheme shall be implemented in accordance with an approved timetable.

23) The development hereby permitted shall not commence until such time as a scheme for drainage and pollution control has been submitted to and approved in writing by the Mineral Planning Authority. The scheme shall include all measures for the disposal of foul and storage water, along with pollution prevention measures for the storage and handling of pollutants on the site.

24) The development hereby permitted shall not commence until such time as a scheme for managing any borehole installed for the investigation (including monitoring) of soils, or for groundwater or geotechnical purposes has been submitted to and approved in writing by the Mineral Planning Authority. The scheme shall, where necessary, be supported by detailed calculations and include a programme for future maintenance, schedule for repairs and a contingency action plan. The scheme shall be fully implemented and subsequently maintained, in accordance with the timing / phasing arrangements embodied within the scheme, or any details as may subsequently be approved, in writing, by the Mineral Planning Authority. The scheme shall provide details of how redundant boreholes are to be decommissioned and how any boreholes which need to be retained, post-development, for monitoring purposes will be secured, protected and inspected.

25) Prior to the commencement of development, full details of the new access and haul road off Wadesmill Road shall be submitted to the Mineral Planning Authority for approval in writing, to include the following: (1) Details of the location of existing vegetation to be removed. (2) Location and detailed design/specifications of new native tree and hedgerow planting along the haul road together with a timetable for planting. (3) Location and detailed design/specifications of the concrete surfacing and kerb/edge treatments. (4) Location and detailed design/specifications of proposed fencing, gates and signs. (5) Details of the haul road.

The new access and haul road shall be constructed in accordance with the approved details and shall be used as the sole access for HGVs in connection with the proposed mineral extraction. Any hedge/plant which has been planted and subsequently dies or is removed within five years of the date of first planting shall be replaced with an equivalent specimen in accordance with the approved details.

26) Prior to the commencement of the development, a tree survey and protection plan shall be submitted, in line with BS5837:2012 *Trees in relation to design, demolition and construction – recommendations*, to the Mineral Planning Authority for approval in writing. The plan shall include details regarding the layout and depth of construction exclusion zones and ecological buffers, and detailed design/specifications of bunds and any fencing, to protect the following features from the adverse effects of operational and restoration activities: (1) St John's Wood. (2) Existing vegetation and proposed advanced planting along the site boundaries, the restricted byway, and the haul road. (3) The three existing individual field trees to be retained adjacent to Sacombe Road. (4) The one existing field tree to be retained along the restricted byway.

The tree protection measures shall be implemented in accordance with the approved details, and where relevant be removed on completion of the operational works and implementation of the restoration scheme.

27) Prior to the commencement of the development, a detailed advanced planting scheme covering each Phase and any other areas of development shall be submitted to the Mineral Planning Authority for approval in writing. The scheme shall include the location and detailed design/specifications of advanced native hedgerow and tree planting along the site boundaries, the restricted byway, the haul road, and Wadesmill Road. The approved planting scheme shall be carried out in the first available planting season after completion of extraction of each Phase. Any plants which die or are removed shall be replaced within the first five years.

28) No lights or flood lights shall be erected or used on site until their location, orientation and luminosity and hours of use have been submitted to the Mineral Planning Authority for approval in writing. Any lights used on the site shall only be used in accordance with the approved details.

29) Prior to commencement of development, details of any fencing and gates required in connection with this development (other than those submitted under other Conditions of this permission) shall be submitted to the Mineral Planning Authority for approval in writing. All approved fences and gates shall be erected in accordance with the approved details, and thereafter shall be retained until the last Phase has been restored.

30) Soil handling and placement shall take place in accordance with the *Good Practice Guide for Soil Handling* produced by Defra and only when the soils are dry and friable and in dry ground conditions. The soil bunds within the site boundary shall be used for the final restoration. No soils shall be imported to the site for any purpose.

31) Within 12 months of the date of this permission a detailed landscape and ecological restoration scheme covering the working Phases shall be submitted to the Mineral Planning Authority for approval in writing. This shall include details of the location, size, species and density of new native planting, along with the following: (1) Woodland thicket planting. (2) Woodland edge rides and glades. (3) Trees. (4) Hedgerows. (5) Species rich grassland buffer strips. (6) Wildflower planting. (7) Other ecological measures including habitat maintenance for 3-10 years and longer-term conservation maintenance. (8) Arable crop areas.

The scheme shall also include details of the proposed species rich grassland and wildflower seed mix, planting specifications and protection measures for all new planting, along with a programme for the implementation of the proposed planting, and a five year programme of management of planting, maintenance and replanting of any trees or shrubs which die, become diseased or are damaged.

The haul road shall be removed and a scheme for the restoration of that land shall also be submitted to the Mineral Planning Authority for written approval within 12 months of the date of this permission and the scheme shall be implemented as approved.

The approved landscape and ecological restoration scheme shall be implemented for each working Phase in accordance with the approved phased restoration programme, and in the first available planting season on completion of mineral extraction.

32) A scheme of agricultural aftercare shall be submitted for the written approval of the Mineral Planning Authority at least 12 months prior to the anticipated completion date for each Phase identified in Condition 3. The approved scheme shall specify the steps required to achieve and maintain a good quality standard of land for agricultural use and shall include the following matters: (1) Remedial treatments. (2) Weed control. (3) Provision for site meetings on at least an annual basis with officers of the Mineral Planning Authority and any relevant consultee in order to assess the progress to date, any remedial action required, and the management of the restored areas for the following year. The approved scheme shall be carried out during the period of five years following the first cultivation of each Phase of the restoration.

33) No operational activity shall take place on the site outside of the following hours: 07:00 – 18:00 hours Mondays to Fridays; and 07:00 – 13:00 hours Saturdays. There shall be no working on Sundays or Bank Holidays.

34) A Dust Management Plan (DMP) shall be submitted prior to the commencement of development. The DMP shall: (1) Follow the recommendations in Appendix 6 of the Institute of IAQM *Guidance on the Assessment of Mineral Dust Impacts for Planning* (2016). (2) Set out and require compliance with the good practice mitigation measures set out in Tables 4 and 5 of the IAQM *Guidance* for both site design and planning and operational control. (3) Be reviewed every six months and updated accordingly in light of good practice and developing evidence. (4) Provide mitigation measures for exceedance of PM_{10} 24 hour mean average and implement these mitigation measures in the event of an exceedance. In the event of daily exceedance of limit values for PM_{10}, and that these are attributable to activity at the site, and the mitigation measures are not having the effect of removing the exceedance, site operations shall cease until acceptable conditions are restored. In the event of annual $PM_{2.5}$ limit values being exceeded, and these being attributable to activity at the site, the Mineral Operator shall be required to review mitigation measures in line with current best practice and evidence and implement them accordingly. The approved DMP shall be carried out in full until the last Phase has been restored.

35) *HCC and appellants' suggested Condition 35*

Prior to the commencement of development details of a scheme for the monitoring of air quality shall be submitted to the Mineral Planning Authority for approval in writing. The scheme shall provide that monitoring commences at least three months prior to commencement of the development to allow as much of a baseline as possible to be developed. The Mineral Operator shall be responsible for equipment maintenance and securing monitoring equipment to avoid tampering and/or wilful destruction. Monitoring shall be continuous until the last Phase has been restored and data shall be made available online. The details of how the data will be made publicly available in an accessible format (spreadsheet or similar) shall be approved in writing by the Mineral Planning Authority. The data for PM_{10} shall be provided with averaging periods and including EU PM_{10} limit values of 50 μg/m^3 in a 24 hour period. The data for $PM_{2.5}$ shall be provided with averaging periods and including EU $PM_{2.5}$ annual limit values of 25 μg/m^3. One monitor shall be appropriately located on the southern point boundary closest to sensitive receptors and the position shall be indicated on a plan approved in writing by the Mineral Planning Authority. Monitoring shall take place before commencement of development as provided above and the approved air quality monitoring scheme, including measures for publicity, shall be implemented until the last Phase has been restored.

SBQ's suggested Condition 35

(1) The proposed development shall not take place until a scheme for the design and operation of a monitoring network of instruments capable of measuring concentrations of airborne particulate matter (PM) has been submitted to and approved in writing by the Mineral Planning Authority. (2) This network shall be funded by the Mineral Operator and implemented by a third party contractor, selected and approved in writing by the Mineral Planning Authority. This third party contractor shall be responsible for the maintenance and calibration of the monitoring network and shall rectify any faults or instrument breakdowns immediately. (3) The network shall be in place and fully operational for the entire period of quarrying operations, or until from an earlier date approved in writing by the Mineral Planning Authority. (4) The network shall consist of a minimum of three sites around the quarry where public exposure might occur, at locations to be approved in writing by the Mineral Planning Authority. (5) The monitoring instruments shall be capable of measuring, as a minimum, concentrations of PM_{10} and shall record these concentrations continuously, so that a record is made of these concentrations at all times and such that the results can be expressed as 15 minute or hourly average concentrations. The instruments shall be certified according to the Environment Agency's MCERTS scheme. Continuous measurements shall also be made of wind speed and direction. (6) The monitoring network shall be designed and operated so that measurements are available in 'real time' through the use of software and telecommunications, or, as a minimum, made available with a time lag of no more than one week. (7) In the event that an hourly average concentration of PM_{10} exceeds 100 μg/m^3, the Mineral Operator shall investigate the circumstances prevailing at the time of this event, including the wind direction and the readings from all three instruments. (8) Should the frequency of events where the hourly averaged concentration of PM_{10} exceeds 100 μg/m^3 (and the wind direction is consistent with the quarry being the cause of this elevated concentration) be greater than six events in six months, then the quarrying operations shall cease until improved mitigation measures are implemented, having been submitted in writing to and approved in writing by the Mineral Planning Authority. The approved air quality

monitoring scheme, including measures for publicity, shall be implemented until the last Phase has been restored.

Inspector's note – SBQ's suggestions should be preferred

36) Prior to commencement of the development the Mineral Operator shall contact the Mineral Planning Authority to set up a Community Liaison Group which will run until the last Phase has been restored. The Community Liaison Group's purpose is to communicate matters regarding quarrying activities to the public and to establish a community complaints procedure that would be advertised widely with clear timescales within which response and resolution methods would be understood. The display of emissions on a website would be discussed at the meetings.

37) In terms of operational mechanical equipment, the screener and loading shovel shall never be operated within 250 m of any residential premises.

38) [not used]

39) All plant on site shall be maintained with particular attention given to any defect that generates any tonal or impulsive noise emissions.

40) Non-tonal reversing signals, which are background noise tracking, shall be installed on all mobile plant.

41) (a) Noise monitoring shall take place at three monthly intervals for the first 12 months of excavation operations at the following assessment locations; Sacombe Road, The Orchard / The Wick, Glenholm and Waterworks Cottage. The precise siting of monitoring equipment at these locations shall be approved in advance by the Mineral Planning Authority in writing. A minimum of two 15-minute noise measurements shall be taken at these locations during periods when the site is fully operational and the screener and loading shovel are being used, and when Rickneys Quarry is operating normally if both sites are operational. A Class 1 or 2 sound level meter and calibrator shall be used to carry out the monitoring. After the first 12 months the Mineral Planning Authority may decide to alter the frequency of testing and the Mineral Operator shall be informed in writing of the new frequency.

(b) The results of the monitoring exercise shall be compared to the following operating limits: Sacombe Road 48 dB $L_{Aeq,\ 1\ hour}$; The Orchard / The Wick 48 dB $L_{Aeq,\ 1\ hour}$; Glenholm 53 dB $L_{Aeq,\ 1\ hour}$; Waterworks Cottage 55 dB $L_{Aeq,\ 1\ hour}$. The results of the noise monitoring must be submitted to the Mineral Planning Authority within two weeks of the measurements being taken. If the above limits are exceeded, then immediate action must be taken to reduce noise levels to below the permitted limits.

(c) Additional noise monitoring shall take place during the construction of the proposed perimeter bunding when at its closest to residential properties on Sacombe Road and The Orchard / The Wick to ensure that a temporary working limit of 70 dB $L_{Aeq,\ 1\ hour}$ is not exceeded. Affected residents should be notified in writing by the Mineral Operator about the location and duration of these operations.

(d) If, following a complaint, the Mineral Planning Authority decides that further noise monitoring is required, written notice shall be given to the Mineral Operator specifying the required monitoring. The further monitoring shall be undertaken by the Mineral Operator and the results submitted in writing to the Mineral Planning Authority within four weeks of the request.

42) *HCC and appellants' suggested Condition 42*

The development hereby permitted shall not be commenced until a methodology for retaining; (1) 5 m of in-situ mineral or equivalent protection over the chalk surface within 300 m of the Wadesmill Road Pumping Station, (2) 3 m of in-situ mineral or equivalent protection over the chalk surface within 500 m of the Wadesmill Road Pumping Station, (3) 1 m of in-situ mineral or equivalent material over the chalk surface on the rest of the site, has been submitted to and approved in writing by the Mineral Planning Authority. The methodology shall specify how notification of any breach of the above requirements would be detected and notified to the Mineral Planning Authority. The site shall be worked in accordance with the approved methodology.

SBQ's suggested Condition 42

(a) The development hereby permitted shall not be commenced until such time as geophysical mapping of the Chalk has been undertaken, using both seismic refraction and resistivity tomography or other appropriate techniques approved in writing by the Mineral Planning Authority that will provide sufficient information on the fractures, fissures and karst features such as swallow holes and on the main inflow paths to the boreholes which supply the Wadesmill Road pumping station. (1) A Hydrogeological Impact Assessment (HydroIA) is to be carried out to assess the results of the geophysical mapping and to expressly consider whether or not, on the basis of those results, the geology of the site precludes safe minerals extraction, and whether, if the geology of the site can be shown not to preclude safe minerals extraction, a further scheme of mitigation measures is required to address potential contamination from operations on the site. (2) For the purposes of (a), safe minerals extraction refers to development which has no negative quantitative and/or qualitative impact on groundwater resources. (3) The HydroIA is to be submitted in writing to the Mineral Planning Authority, together with any proposed scheme of further mitigation measures, to be approved in writing by the Mineral Planning Authority. The approved scheme shall be implemented in full.

(b) Mineral extraction shall not take place below a residual layer of sand and gravel which is to be not less than 5 m above the surface of the Chalk as defined by the geophysical mapping in (a).

(c) Prior to the commencement of the development, plans shall be provided to the Mineral Planning Authority showing the contours of the surface of the Chalk underlying the sand and gravel (in metres Above Ordnance Datum (mAOD), as mapped under (a), and the contours of the upper surface of the in-situ layer of sand and gravel (in mAOD) that is to be retained in the base of the quarry excavation. The plans will show that 5 m of in-situ sand and gravel is retained in the base of the excavation. Where the in-situ layer of sand is naturally less than 5 m in thickness no quarrying shall take place although the thickness shall be increased to 5 m by placing materials derived from within the planning application site only over this part of the site.

(d) Prior to the start of restoration infilling in each Phase, a survey shall be provided to the Mineral Planning Authority confirming that the contours of the sand and gravel (in mAOD) retained at the base of the quarry excavation is the same as the pre-commencement plan for that Phase provided under (c).

(e) The development hereby permitted shall not be commenced until such time as a scheme to dispose of foul and surface water has been submitted to and approved in writing by the Mineral Planning Authority. The scheme shall be implemented in full as approved. (1) Provision shall be made for the collection, treatment and disposal of all water entering or arising on the site to ensure that there shall be no discharge of contaminated or polluted drainage to groundwaters or surface waters. This condition shall also apply to the runoff from the hard standing and bunded areas where hydrocarbon materials are stored and refuelling takes place. (2) All foul drainage shall be discharged to a sealed tank and the contents of the tank shall be removed from the site completely.

(f) There shall be no discharge of foul or contaminated drainage from the site into either groundwater or surface water, whether direct or via soakaways. This condition shall also apply to the runoff from the hard standing and bunded areas where hydrocarbon materials are stored and refuelling takes place.

(g) Fuels shall only be stored within the bunded fuel store in the location shown in principle on Drawing No.1217/SP/1. For the avoidance of doubt any facilities for the storage of oils, fuels or chemicals shall be sited on impervious bases and surrounded by impervious bund walls. The size of the bunded compound shall be at least equivalent to the capacity of the tank plus 10% or, if there is more than one container within the system, of not less than 110% of the largest container's storage capacity or 25% of their aggregate storage capacity, whichever is the greater. All filling points, vents, and sight glasses must be located within the bund. There must be no drain through the bund floor or walls.

(h) Repair, maintenance and fuelling of plant and machinery shall only take place on an impervious surface drained to a sealed interceptor and the contents of the interceptor shall be removed from the site.

(i) No Controlled Waste, as defined by *The Controlled Waste Regulations 2012*, or Extractive Waste, as defined by *The Environmental Permitting Regulations 2016 (as amended)* shall be imported to the site for reuse, processing, recover, or disposal.

(j) Prior to the start of quarrying in each phase, an HydroIA is to be carried out expressly considering whether a further scheme of mitigation measures is necessary to address operational changes arising since the grant of planning permission. The HydroIA, and any further mitigation scheme, is to be provided in writing to and approved in writing by the Mineral Planning Authority. The proposed scheme shall be implemented in full as approved.

(k) The development hereby permitted shall not be commenced until such time as a scheme for the storage and transport of potential contaminants and for the mitigation measures to be implemented in the event of any spillage of the same has been submitted to and approved in writing by the Mineral Planning Authority. The approved scheme shall be implemented in full as approved. (1) In addition to the mitigation measures identified in these conditions, the scheme is to include as a minimum the mitigation measures identified in the Hafren Water *Hydrogeological Impact Assessment in support of gravel extraction at Ware Park, Hertford, Hertfordshire* July 2014, the *Addendum to Hydrogeological Impact Assessment Ware Park, Hertford* July 2017, and the Proof of Evidence of Christopher Leake April 2018. (2) The scheme shall also include the following mitigation measure: in the event of any spillage of a potential contaminant anywhere on the site of the development hereby permitted, the affected sand and gravel shall immediately be extracted by authorised persons and removed for secure disposal off-site. This condition shall also apply to spillages that may occur during the delivery of fuel, oils and other hydrocarbons to the site or during the emptying of the storage tank or tanks of contaminated water.

(l) Should any spillage of potential pollutants in excess of 50 litres occur at the site all works at the development hereby permitted are to cease immediately and shall not resume until a scheme of mitigation and/or any remedial works required are submitted in writing to and approved in writing by the Mineral Planning Authority. The proposed scheme shall be implemented in full as approved.

(m) The development hereby permitted shall not be commenced until such time as a scheme for the following in each of the phases of the development (including an implementation timetable), has been submitted in writing to and approved in writing by the Mineral Planning Authority. The proposed scheme shall be implemented in full as approved. (1) A long-term groundwater monitoring scheme (including a maintenance plan for the groundwater boreholes) in respect of contamination and turbidity, and any potential sources of the same, including a timetable of monitoring and submission of reports to the Mineral Planning Authority. (2) The scheme shall include identification of trigger levels for monitoring sites where contingency measures would be required should those trigger levels be reached. The scheme shall also include identification of the contingency measures needed should the trigger levels be reached. (3) No development shall take place until any water monitoring devices relied upon by the approved scheme are provided in their entirety and are operational. (4) Groundwater monitoring reports as specified in the approved scheme shall be submitted no less than annually. (5) Should results of the groundwater monitoring scheme prove a negative impact on any groundwater or surface water sources, all works at the development hereby permitted are to cease immediately and should not resume until mitigation and/or any remedial works required are submitted in writing to and approved in writing by the Mineral Planning Authority and are implemented in full as approved.

(n) The Mineral Planning Authority shall be advised in writing of any changes to the operational plan of the site which have the potential to affect groundwater quality or quantity. (1) Following the proposal of such a change, an HydroIA is to be carried out, expressly considering whether a further scheme of mitigation measures is necessary to address the change. (2) The HydroIA, and any further mitigation scheme, is to be provided in writing to and approved in writing by the Mineral Planning Authority. The proposed scheme shall be implemented in full.

(o) The development hereby permitted may not commence until such time as a scheme for managing any borehole installed for the investigation (including monitoring) of soils, groundwater or geotechnical purposes has been submitted to and approved in writing by the Mineral Planning Authority. (1) The scheme shall be supported by detailed calculations and include a programme for future maintenance, schedule for repairs and a contingency action plan. (2) The scheme shall be fully implemented and subsequently maintained, in accordance with the timing/phasing arrangements embodied within the scheme, or any details as may subsequently be approved in writing by the Mineral Planning Authority. (3) The scheme shall provide details of how redundant boreholes are to be decommissioned and how any boreholes which need to be retained, post-development, for monitoring purposes will be secured, protected and inspected. The scheme shall include the provision that all redundant boreholes are to be backfilled with a bentonite-cement grout that is mixed using 1 kg of bentonite per 25 kg bag of ordinary Portland cement with the bentonite added after the cement has been mixed with water. The volume of water should be limited to 15.5 litres per bag of cement. (4) The development hereby permitted may not commence until such time as a scheme for the repair of borehole OBH 1A has been submitted to and approved in writing by the Mineral Planning Authority.

(p) If, during development, contamination not previously identified is found to be present at the site then no further development shall be carried out until the developer has submitted in writing a remediation strategy to the Mineral Planning Authority detailing how this unsuspected contamination shall be dealt with and obtained written approval from the Mineral Planning Authority. The remediation strategy shall be implemented in full as approved.

(q) Upon completion of the proposed development, a final report demonstrating that any unacceptable impacts to the aquifer have been mitigated, and documenting the decision to cease monitoring, shall be submitted in writing to and approved in writing by the Mineral Planning Authority.

Inspector's note – Neither of the above conditions is recommended. If the Secretary of State is minded to allow the appeal and to grant planning permission then it would be necessary to go back to the parties to devise the terms of a planning condition that would achieve the required safeguarding of the aquifer by means of planning conditions that passed the relevant tests.

43) A restricted working zone shall be created within 70 m of properties at The Orchard within which operations shall not take place when the wind direction is from the north-eastern quadrant.

DOCUMENTS SUBMITTED AT THE INQUIRY (ID)

ID1	Joint noise statement by Les Jephson and Stephen Marshall
ID2	Rebuttal by Mark Flatman
ID3	Opening statement on behalf of the appellants
ID4	Opening comments for Hertfordshire County Council
ID5	Opening submissions on behalf of Stop Bengeo Quarry
ID6	Opening summary by Cllr Stevenson
ID7	Rebuttal by Stephen Marshall
ID8	Rebuttal by Julie Greaves
ID9	Letter dated 30 April 2018 from Mark Prisk FRICS MP
ID10	Note on EHDC involvement regarding the appeal site submitted by Cllr Stevenson
ID11	Agreed Statement of Common Ground between HCC and DK Symes: Position on Existing and Future Supply of Sand and Gravel dated 24 April 2018 [requested by Inspector]
ID12	Email dated 26 April 2018 from Les Jephson to Stephen Marshall concerning monitoring Volvo EC380 excavator Volvo L350 loading shovel and CAT 730C ADT
ID13.1	Email dated 20 March 2018 from HCC to Hanson concerning Rickneys Quarry
ID13.2	Emails between HCC and Hanson dated 20 March 2018 and 23 August 2018 concerning Rickneys Quarry
ID14	Stanstead and Luton Airports Weather data 17,18,19 and 21 October 2013
ID15	Extracts from BS4142 [requested by Inspector]
ID16.1	Minutes Development Control Committee 29 May 2007 re Rickneys Quarry extension
ID16.2	Decision Notice 23 December 2009 re Rickneys Quarry extension
ID16.3	Minutes Development Control Committee 27 February 2014 re Rickneys Quarry extension
ID17	Minutes Development Control Committee 22 March 2017 re appeal scheme
ID18	Minutes Development Control Committee 25 January 2017 re former Hatfield aerodrome (BAE site)
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ID40	Statement by Dr Mike Howarth
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ID77	Note re consideration of amended scheme by appellants
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91.3	Hertfordshire County Council dated 24 July 2018
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ID93	Written representations about HIA submitted during adjournment (in blue folder with list of those who submitted comments at Annex B of this report)
ID94	Statement of Common Ground by HCC and appellants dated 3 October 2018
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ID95.2	Plan and schedule of distances to properties/features for 1.25 Mt scheme by HCC and appellants [requested by Inspector]
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ID97	Updated suggested planning conditions indicating matters agreed and those remaining in dispute between HCC and appellants – including revisions submitted on 5 and 8 November 2018
ID98.1	Comments on updated conditions on behalf of SBQ with 12 November 2018 update
ID98.2	Suggested water management conditions by SBQ with 12 November 2018 update
ID99	Extract from East Herts District Plan adopted 23 October 2018 Policy HERT4
ID100	Decision Notice Furze Field dated 19 October 2018
ID101	Hertfordshire Minerals Local Plan – Comparative Evaluation of Sites Final Site Summary AFS 11
ID102	Correspondence between Hanson UK and Ingrebourne Valley Limited dated 14 July 2015 13 July 2016 15 August 2017 and 29 August 2017
ID103	Letter to HCC from Affinity Water dated 2 November 2017
ID104	Hertfordshire's Local Transport Plan May 2018
ID105	Note by Cllr Stevenson – Summary of health impact 24 October 2018
ID106	Extract draft BNAP Natural Environment and Green Spaces
ID107	Bengeo Neighbourhood Area Plan chronology
ID108	Closing submissions on behalf of SBQ
ID109	Closing submissions by Cllr Stevenson
ID110	Closing speech on behalf of HCC
ID111	Closing submissions on behalf of the appellants
ID112.1	Email from Cllr Stevenson regarding AM peak time condition for HGV movements dated 6 November 2018
ID112.2	Response by appellants dated 9 November 2018
ID113	HCC comments dated 15 November 2018 on SBQ updated note about conditions
ID114	Section 106 deed of agreement dated 15 November 2018

CORE DOCUMENTS

CD1	CD1 – Doc 1 Proposed Strategy (Dec 2012)
CD2	CD2 – Doc 1 Planning Application 1 – 2.6 Million tonnes (Mar 2016) CD2 – Doc 2 Volume 1 CD2 – Doc 3 Volume 2 CD2 – Doc 4 NTS
CD3	Further Information 1 (Dec 2016)
CD4	Further Information 1a (Jan 2017)
CD5	Committee Report (Revised) (Mar 2017)
CD6	Refusal Notice (Mar 2017)
CD7	CD7 – Doc 1 Statement of Case 1 – Appellant CD7 – Doc 2 Statement of Case 2 – Appellant
CD8	Statement of Case – Herts CC
CD9 CD9a	Rule 6 – Bengeo Statement of Case (excluding Academic Papers) Rule 6 – Bengeo Statement of Case Academic Papers (on cd only)
CD10	Rule 6 – Stevenson Statement of Case
CD11	Professor Rick Brassington – PoE and Supplementary etc.
CD12 CD12a	Mark Prisk MP – Correspondence Rt Hon Sir Oliver Heald QC MP - Correspondence
CD13	EA Correspondence – Doc 1, Doc 2, Doc 3, Doc 4, Doc 5, Doc 6
CD14	Herts CC Director of Public Health letter (Mar 2017)
CD15	CD15 – Doc 1 Planning Application 2 – 1.25 Million tonnes (Sept 2017) Volume 1 CD15 – Doc 2a Volume 2 - (First ring binder) 1. Landscape and Visual 2. Ecology 3. Hydrogeology 4. Flood Risk CD15 – Doc 2b Volume 2 – (Second ring binder) 5. Transport 6. Archaeology 7. Noise 8. Air Quality CD15 – Doc 3 NTS
CD16	Further Information 2 and Updated NTS Addendum 1 (Feb 2018) CD16 – Doc 1 Further Information 2 CD16 – Doc 2 Updated NTS Addendum 1
CD17	Consultee Replies (1.25 Mt scheme)

CD18 CD18a	Committee Report - (April 2018) Committee Report Plan
CD19	CD19 – Doc 1 Decision - Refusal Notice April 2018 [1.25 Mt scheme] CD19 – Doc 2 Addendum Report to DCC April 2018
CD20	Minerals Local Plan Review 2002 – 2016 – Adopted March 2007
CD21	Herts CC Cabinet Panel – Item 7 Sites to be identified in the Draft MLP (Sept 2017)
CD22	Minerals Local Plan Consultation draft - December 2017
CD23	~~East Herts Local Plan Second Review - Adopted April 2007~~ *No longer a Core Document*
CD24	East Herts District Plan – Pre-Submission Consultation (Nov 2016) (Extract of Chapters 4 & 7)
CD25	East Herts District Plan Main Mods Consultation Feb 15 – March 29 2018
CD26	Guidance for Landscape and Visual Impact Assessment Third Edition
CD27	East of England Landscape Framework
CD28	Extract of the MLPCS003 Site Selection Report - Ware Park (Nov 2017)
CD29	Extracts of the 111: Northern Thames Basin Landscape Character Assessments
CD30	East Herts District LCA
CD31	Inspectors Report for Herts CC MLP Review 2005 *(*Extract of Inspectors Report for Preferred Area 2)
CD32	Noise Metres Calibration Certificates and LAB 23
CD33	BS5228 Code of Practice for noise & vibration control on construction & open sites
CD34	Control of Dust & Emissions During Construction & Demolition - SPG Mayor of London
CD35.1	Guidance on the Assessment of Mineral Dust Impacts for Planning - IAQM
CD35.2	Land-Use Planning & Development Control: Planning for Air Quality - IAQM
CD36	The Environment Agency’s Approach to Groundwater Protection
CD37	~~Landscape Partnership Report Suitability of Landscape Character Areas for Mineral Extraction 2001~~ *No longer a Core Document*
CD38	East Herts Landscape Character Assessment – SPD Adopted Sept 2007
CD39	Pre Inquiry Note dated 20.4.18
CD40	Response to Request for Further Information - from PINS dated 03 April 2018
CD41	Plan showing residential development in locality
CD42	Agricultural Land Classification May 1997

JUDGMENTS

Bernard Wheatcroft Ltd v SoSE (1982) 43 P.&C.R. 233
Blewett v Derbyshire CC [2003] EWHC 2775 (Admin)
DLA Delivery Ltd and Baroness Cumberlege of Newick [2018] EWCA Cv 1305
Europa Oil and Gas Ltd v SSCLG [2013] EWHC 2643 (Admin)
Europa Oil and Gas Ltd v SSCLG [2014] EWCA Civ 825
Gladman Developments Ltd v SoS CLG [2017] EWHC 2768 (Admin)
Holborn Studios Ltd and LB Hackney [2017] EWHC 2823 (Admin)
J v North Warwickshire BC [2001] EWCA CIV 315
Linda Davies v SoSCLG [2008] EWHC 2223 (Admin)
Mount Cook Ltd v Westminster CC [2003] EWCA Civ 1346
R (On the application of Jones) v Mansfield DC [2003] EWCA Civ 1408
Samuel Smith Old Brewery and North Yorkshire CC [2018] EWCA Civ 489
Shadwell Estates Ltd and Breckland District Council [2013] EWHC 12 (Admin)

APPEAL DECISION

Land adjacent to Bramleymoor Lane Appeal Ref:APP/U1050/W/17/3190838 dated 16 August 2018

RIGHT TO CHALLENGE THE DECISION IN THE HIGH COURT

These notes are provided for guidance only and apply only to challenges under the legislation specified. If you require further advice on making any High Court challenge, or making an application for Judicial Review, you should consult a solicitor or other advisor or contact the Crown Office at the Royal Courts of Justice, Queens Bench Division, Strand, London, WC2 2LL (0207 947 6000).

The attached decision is final unless it is successfully challenged in the Courts. The Secretary of State cannot amend or interpret the decision. It may be redetermined by the Secretary of State only if the decision is quashed by the Courts. However, if it is redetermined, it does not necessarily follow that the original decision will be reversed.

SECTION 1: PLANNING APPEALS AND CALLED-IN PLANNING APPLICATIONS

The decision may be challenged by making an application for permission to the High Court under section 288 of the Town and Country Planning Act 1990 (the TCP Act).

Challenges under Section 288 of the TCP Act
With the permission of the High Court under section 288 of the TCP Act, decisions on called-in applications under section 77 of the TCP Act (planning), appeals under section 78 (planning) may be challenged. Any person aggrieved by the decision may question the validity of the decision on the grounds that it is not within the powers of the Act or that any of the relevant requirements have not been complied with in relation to the decision. An application for leave under this section must be made within six weeks from the day after the date of the decision.

SECTION 2: ENFORCEMENT APPEALS

Challenges under Section 289 of the TCP Act
Decisions on recovered enforcement appeals under all grounds can be challenged under section 289 of the TCP Act. To challenge the enforcement decision, permission must first be obtained from the Court. If the Court does not consider that there is an arguable case, it may refuse permission. Application for leave to make a challenge must be received by the Administrative Court within 28 days of the decision, unless the Court extends this period.

SECTION 3: AWARDS OF COSTS

A challenge to the decision on an application for an award of costs which is connected with a decision under section 77 or 78 of the TCP Act can be made under section 288 of the TCP Act if permission of the High Court is granted.

SECTION 4: INSPECTION OF DOCUMENTS

Where an inquiry or hearing has been held any person who is entitled to be notified of the decision has a statutory right to view the documents, photographs and plans listed in the appendix to the Inspector's report of the inquiry or hearing within 6 weeks of the day after the date of the decision. If you are such a person and you wish to view the documents you should get in touch with the office at the address from which the decision was issued, as shown on the letterhead on the decision letter, quoting the reference number and stating the day and time you wish to visit. At least 3 days notice should be given, if possible.

Study: The costs of not implementing EU environmental law

Final Report

Written by COWI A/S
& Eunomia Research & Consulting Ltd
March 2019

EUROPEAN COMMISSION

Directorate-General for Environment
Directorate E
Unit E.2 Environmental Implementation

Contact: Louis Meuleman

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Study: The costs of not implementing EU environmental law

Final Report

LEGAL NOTICE

More information on the European Union is available on the Internet (http://www.europa.eu).

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Table of Contents

Abstract

The effectiveness of EU environmental law depends on its implementation at Member State, regional and local levels. Implementation gaps are costly to society and materialise in various forms, such as reduced amenity values of surface waters with poor ecologic quality, and increased illness due to air and noise pollution. The purpose of this study is to estimate the costs and foregone benefits for the EU from not achieving the environmental targets specified in the EU environmental legislation for seven policy areas: air and noise, nature and biodiversity, water, waste, chemicals, industrial emissions and major accident hazards, and horizontal instruments. This is done via deriving the environmental targets provided for by EU Directives and Regulations – with a focus on the targets to be achieved by 2018 – and comparing these targets with the respective environmental conditions. The impacts of any differences, i.e. implementation gaps, are the assessed and quantified in monetary terms.

Executive summary

The effectiveness of EU environmental law depends on its implementation at Member State, regional and local levels. Complaints concerning non-compliance with EU environmental law and a high number of infringement cases indicate that there is room for improvement with respect to implementation. Implementation gaps are costly to society and materialise in various forms, such as reduced amenity values of surface waters with poor ecologic quality, increased illness due to air and noise pollution, lack of environmental risk prevention due to insufficient liability requirements for economic operators, or unrealised market opportunities resulting from low levels of waste recycling.

This study estimates – as shown in the table below – the costs and foregone benefits for the EU to be **around EUR 55 bn per year** (in 2018) from not achieving the environmental targets specified in the EU environmental legislation for seven policy areas: air and noise, nature and biodiversity, water, waste, chemicals, industrial emissions and major accident hazards, and horizontal instruments. A similar estimate of EUR 50 bn per year was determined for 2011 in a previous study conducted by COWI (2011).

Acknowledging that this implementation gap cost estimate is connected with much uncertainty, this study has estimated cost ranges – i.e. estimates of reasonable certainty – of **EUR 29.7 - 79.6 bn per year**.

Cost of not implementing EU environmental law, EUR bn per year, 2018

Policy area	Range estimate	Central estimate
Air	8.7 - 40.4	24.6
Nature and biodiversity	10.5 - 15.7	13.1
Water	4.3 - 14.3	9.3
Waste	3.2 - 4.8	4.0
Chemicals	0 – 0	0
Industrial emissions and major accident hazards	3.0 - 4.4	3.7
Horizontal instruments	-	-
Total	**29.7-79.6**	**54.7**

Source: COWI/Eunomia.

The estimate takes outset in the environmental targets to be achieved by 2018, compared to the best estimate of the current situation. Where relevant, the study transparently outlines where and how the use of older data causes uncertainty to the estimate. A benefit of focusing on providing an estimate for 2018 is that 2018 is covered by the second round of the Environmental Implementation Review (EIR) reports (to be published in spring 2019). Hence, this study was able to benefit from the draft EIR findings and vice-versa to provide input to the EIR findings.

The policy areas differ, however, in the way the respective Directives and Regulations intervene to improve the environment, hereunder with respect to the concreteness of the environmental targets they aim to achieve. In itself, this implies that the implementation gaps estimated for the diverse policy areas differ with respect to their concreteness and quality.

The table below shows that the EU environmental legislation for example on air provides for specific environmental targets. The implementation gap for air can be estimated by comparing air pollution monitoring information gathered by Member States with the targets, i.e. the number of people who are exposed to air pollution above the concentration values. Hence, for the estimation of implementation gap costs the focus lies on the health costs to the EU urban population exposed above the environmental limits. As such, the estimation is based on the data of the number of people living in urban areas where air pollution too often exceeds concentration values, on assumptions about how much the air pollution exceeds the concentration values, and on assumptions (modelling) about how this impacts health conditions.

Comparison of environmental targets across policy areas

Policy area	Type	Measurability
Air and noise	*Air*: specific limits for air pollution concentration values and for overall national emission ceilings *Noise*: WHO guidelines may be used as 'policy targets'	*Air*: High – concrete, quantitative target values are specified *Noise*: High – but new WHO guidelines provide target values not yet included in many monitoring activities
Nature and biodiversity	Target to halt the loss of biodiversity and ecosystem services, and to ensure that species and habitats recover sufficiently to enable them to flourish over the long term	Low – as the assessment of whether this target has been achieved or not is limited by the fact that there is no clear baseline against which to estimate how the status of flora and fauna might have developed in the absence of EU action
Water	Different target types within different pieces of EU water legislation – e.g. targets for ecological status, bathing water quality, nitrate concentration, and requirements to waste water discharges	High – each target type is measurable in quantitative terms
Waste	Different target types within different pieces of EU waste legislation – e.g. targets for collection, reuse, recovery, recycling, and landfill	High – each target type is measurable in quantitative terms
Chemicals	No specific targets – but requirements to controlling in connection with using and placing chemicals on the market	Low – no quantitative target values
Industrial emissions and major accident hazards	Specific source emission targets – where most are set to contribute to the above air pollution targets, apart from the targets for heavy metals and organic substances	High – concrete, quantitative target values are specified
Horizontal instruments	No targets but requirements to take actions to avoid environmental damage	Low - no specific targets

Source: COWI/Eunomia.

Although the above table indicates that there are noise targets, this study does not include the costs of not achieving these in the implementation gaps cost for air and noise shown in the first table. The reason is that the EU legislation on noise does not provide for specific noise limits. Hence, the noise limits measured against in this study are the WHO (1999) recommended noise exposure limits. Assuming that these recommendations represent EU 'policy targets' indicates a significant health cost estimate of EUR 30.7 bn per year for those living in locations where there is too much noise – e.g. close to major roads.

For nature and biodiversity, measurability of the environmental targets is particularly low. The reasons for this are the broad definition of the target and the fact that the assessment of whether the target has been achieved or not is limited by the fact that there is no clear baseline against which to estimate how the status of flora and fauna might have developed in the absence of EU action. In other words, it is difficult to assess how much higher the level of biodiversity and ecosystem services would have been if all provisions of the Habitats and Birds Directives had been fully implemented. This said, the study includes a very rough implementation gap estimate in the first table. It is based on the estimates by ten Brink et al. (2008) that the Natura 2000 network provides EUR 200-300 bn per year in benefits, and that around 5% could be seen as the annual rate of loss, i.e. the costs of deterioration of ecosystems from not fully implementing the EU legislation.

For the water policy area, there are different target types within different pieces of the EU legislation. There are, for example, targets for ecological status, bathing water quality, nitrate concentration, and requirements to waste water discharges. Measurability is generally high as each environmental target type is of quantitative nature. Consequently, any implementation gaps can be calculated as the distance to target – e.g. the distance from having the target of 'good' ecological status of surface waters. The implementation gap costs are then estimated as the foregone benefits from water not being clean or of a 'good' ecological status, and as the economic value of damages to water resources e.g. from nitrogen discharges.

For the waste policy area, there are similarly different target types within different pieces of the EU legislation – e.g. targets for collection, reuse, recovery, recycling, and landfill. Measurability is also high as each environmental target type is of quantitative nature, and so are any implementation gaps. Such gaps lead, for example, to health and environmental costs associated with illegal landfills and illegal waste export activities. There may also be foregone benefits from non-realised circular economy market developments. Furthermore, there may be spillover effects from potentially increased use of more polluting power sources where non-recycled waste is landfilled rather than undergoing energy recovery.

Measurability of the environmental targets for chemicals is low. The reason is here that the requirements of the respective EU legislations do not concern specific targets but merely focus on actions to be taken to avoid environmental damage. The lack of quantitative targets obviously limits the possibility to measure implementation gaps. However, the study finds that the Directives REACH and CLP have been fully implemented in the Member States, concluding that there are no implementation gaps, which implies that there are no implementation gap costs either.

For industrial emissions and major accident hazards, the measurability of environmental targets is also high as the EU legislation provides for specific source emission targets. The achievement of most of these source emission targets will, however, already be accounted for by the analysis of implementation gaps for the air policy area. Hence, the focus is on achieving the additional targets for heavy metals and organic substances. Hence, the implementation gap cost estimates here only relate to the non-achievement of these additional targets.

Finally, the cross-cutting nature and the lack of quantifiable environmental targets for the horizontal instruments does not allow the estimation of an implementation gap cost. Nonetheless, this study discusses the role of these instruments in improving decision-making, legislative development and implementation, and hence in achieving the environmental targets set within the specific policy areas.

Résumé analytique

L'efficacité du droit environnemental de l'UE dépend de sa mise en œuvre par les États membres, aux niveaux régional et local. Les plaintes posées pour non-conformité au droit environnemental de l'UE, ainsi qu'un nombre élevé de cas de procédures d'infraction indiquent que des progrès sont encore à envisager vis-à-vis de la mise en œuvre du droit. Des lacunes dans la mise en œuvre s'avèrent coûteuses pour la société et se matérialisent sous diverses formes, comme la diminution de la valeur d'agrément des eaux de surface avec une mauvaise qualité écologique, l'accroissement de maladies ayant pour cause la pollution de l'air et sonore, l'absence de prévention du risque environnemental en raison des exigences en matière de responsabilité insuffisantes pesant sur les opérateurs économiques, ou même encore les débouchées commerciales non réalisées à cause d'un faible niveau de recyclage des déchets.

La présente étude estime (comme il est illustré dans le tableau ci-dessous) à **environ 55 milliards d'euros par an** (en 2018) les coûts et les bénéfices perdus pour l'UE du fait de la non-réalisation des objectifs environnementaux prévus au sein de la législation de l'UE dans les sept domaines politiques suivants: l'air et le bruit, la nature et la biodiversité, l'eau, les déchets, les substances chimiques, les émissions industrielles et les risques d'accidents majeurs, et enfin, les instruments horizontaux. Une estimation similaire de 50 milliards d'euros par an avait été déterminée pour 2011 dans le cadre d'une étude précédente menée par COWI (2011).

En reconnaissance que cette estimation de coûts liés à des lacunes dans la mise en œuvre est accompagnée d'une incertitude considérable, la présente étude a estimé que les coûts oscillaient (avec une certitude raisonnable) entre **29,7 et 79,6 milliards d'euros par an.**

Le coût lié aux lacunes dans la mise en œuvre du droit environnemental de l'UE, en milliards d'euros par an, en 2018

Domaine politique	Fourchette estimée	Estimation centrale
Air	8,7 - 40,4	24,6
Nature et biodiversité	10,5 - 15,7	13,1
Eau	4,3 - 14,3	9,3
Déchets	3,2 - 4,8	4,0
Substances chimiques	0 – 0	0
Émissions industrielles et risques d'accidents majeurs	3,0 - 4,4	3,7
Instruments horizontaux	-	-
Total	**29,7-79,6**	**54,7**

Source: COWI/Eunomia.

L'estimation se fonde sur les objectifs environnementaux à atteindre en 2018, par rapport à la meilleure estimation de la situation actuelle. Lorsque cela s'avère pertinent, l'étude souligne de façon transparente où et comment l'utilisation de données plus anciennes donne lieu à des incertitudes dans l'estimation. Un avantage du fait de se concentrer sur la fourniture d'une estimation pour 2018 est le fait que l'année 2018 est abordée par le second tour des rapports de l'examen de la mise en œuvre de la politique environnementale de l'UE (à paraître au printemps 2019). Ainsi, la présente étude a pu bénéficier des résultats préliminaires de ces rapports et vice-versa, puisqu'elle contribue à leurs conclusions.

Les domaines politiques diffèrent, néanmoins, quant à la façon dont les directives et les règlements respectifs interviennent pour améliorer l'environnement, ci-dessous, pour ce qui est du caractère concret des objectifs environnementaux à atteindre. Ceci implique, en soi, que les lacunes dans la mise en œuvre estimées pour les différents domaines politiques diffèrent quant à leur faisabilité et leur qualité.

Le tableau ci-dessous montre que, par exemple, la législation environnementale de l'UE concernant l'air prévoit des objectifs environnementaux spécifiques. Les lacunes dans la mise en œuvre concernant l'air peuvent être estimées en comparant les informations relatives au contrôle de la pollution atmosphérique rassemblées par les États membres aux objectifs, à savoir, le nombre de personnes exposées à la pollution de l'air au-dessus des valeurs de concentration. Dans ces conditions, pour l'estimation des coûts liés aux lacunes dans la mise en œuvre, l'accent est mis sur les coûts sanitaires pour la population urbaine de l'UE exposée au-delà des limites environnementales. En tant que telle, l'estimation se fonde sur les données afférentes au nombre de personnes habitant dans des zones urbaines dans lesquelles la pollution atmosphérique dépasse, trop souvent, les valeurs de concentration, ainsi que sur des hypothèses concernant le degré avec lequel la pollution de l'air dépasse les valeurs de concentration et des suppositions (modélisations) quant à la façon dont cette situation affecte l'état de santé.

Comparaison des objectifs environnementaux dans les différents domaines politiques

Domaine politique	Type	Mesurabilité
Air et bruit	*Air*: des limites spécifiques pour les valeurs de concentration de la pollution atmosphérique et les plafonds d'émission nationaux d'ensemble *Bruit*: les directives de l'OMS peuvent être utilisées en tant «qu'objectifs politique»	*Air*: Élevée – des valeurs cibles concrètes et quantitatives sont précisées *Bruit*: Élevée – mais les nouvelles directives de l'OMS prévoient des valeurs cibles qui n'ont pas encore été incluses dans de nombreuses activités de contrôle
Nature et biodiversité	Objectif visant à freiner la perte de biodiversité et de services écosystémiques, ainsi qu'à assurer que les espèces et les habitats récupèrent suffisamment pour permettre leur épanouissement sur le long terme	Faible – dans la mesure où l'appréciation du fait de savoir si cet objectif a été ou non atteint est limitée par le fait qu'il n'existe pas de référentiel clair par rapport auquel on peut estimer la façon dont la flore et la faune auraient pu se développer en l'absence de toute action de la part de l'UE
Eau	Différents objectifs dans différents textes législatifs concernant l'eau de l'UE – par exemple, des objectifs concernant l'état écologique, la qualité de l'eau de baignade et les exigences concernant le déversement des eaux usées	Élevée – chaque type d'objectif est mesurable en termes quantitatifs
Déchets	Différents types d'objectifs au sein des différents textes législatifs de l'UE concernant les déchets – par exemple, objectifs en matière de collecte, de réutilisation, de récupération, de recyclage et d'enfouissement	Élevée – chaque type d'objectif est mesurable en termes quantitatifs
Substances chimiques	Pas d'objectifs spécifiques – mais des exigences de contrôle en matière d'utilisation et de mise sur le marché de substances chimiques	Faible – pas de valeurs cibles quantitatives
Émissions industrielles et risques d'accidents majeurs	Des objectifs en matière d'émissions pour des sources spécifiques – la plupart étant fixés pour contribuer aux objectifs en matière de pollution atmosphérique ci-dessus, à part ceux afférents aux métaux lourds et aux substances organiques	Élevée – des valeurs cibles concrètes et quantitatives sont précisées
Instruments horizontaux	Pas d'objectifs, mais des exigences d'intervention afin d'éviter les dommages à l'environnement	Faible - pas d'objectifs spécifiques

Source: COWI/Eunomia.

Bien que le tableau ci-dessus suggère l'existence d'objectifs en matière de bruit, la présente étude n'inclut pas les coûts afférents à l'absence de leur satisfaction dans les coûts liés aux lacunes dans la mise en œuvre concernant l'air et le bruit illustrés dans le premier tableau. Il en est ainsi car la législation de l'UE concernant le bruit ne prévoit pas de limites particulières en la matière. Par conséquent, les limites du bruit prises en considération dans le cadre de cette étude sont les limites d'exposition aux nuisances sonores recommandées par l'OMS (1999). Partant du principe que ces recommandations représentent les «objectifs politiques» de l'UE, l'on aboutit à une estimation de coûts annuels de 30,7 milliards d'euros pour les personnes qui vivent dans des lieux très exposés au bruit (par exemple, à proximité de grandes routes).

Pour ce qui est de la nature et de la biodiversité, la mesurabilité des objectifs environnementaux s'avère particulièrement faible. Les raisons pour cela sont la définition étendue de l'objectif et le fait que l'appréciation du fait de savoir si ce dernier a été ou non atteint est limitée par l'absence d'un référentiel clair par rapport auquel on pourrait estimer la façon dont la flore et la faune aurait pu se développer à défaut de toute action de la part de l'UE. Autrement dit, il s'avère difficile d'apprécier à quel degré le niveau de biodiversité et des services écosystémiques aurait été plus élevé si les dispositions des directives Habitats et Oiseaux avaient été pleinement mises en œuvre. Ceci étant dit, dans le premier tableau, la présente étude comporte une estimation très approximative des lacunes dans la mise en œuvre qu'il existe. Celle-ci se fonde sur les estimations de ten Brink et al. (CE, 2008) selon lesquelles le réseau Natura 2000 fournit un bénéfice annuel d'entre 200 et 300 milliards d'euros, et environ 5% de ce bénéfice pourrait être considéré comme le taux de perte annuel, à savoir, le coût de la détérioration des écosystèmes du fait de l'absence de mise en œuvre de la législation de l'UE.

Pour ce qui est du domaine politique afférent à l'eau, il existe différents types d'objectifs dans les différents textes législatifs de l'UE. Nous trouvons, par exemple, des objectifs concernant le statut écologique, la qualité des eaux de baignade, la concentration en nitrates et les exigences en matière de déversement des eaux usées. La mesurabilité s'avère généralement élevée, dans la mesure où chacun de ces types d'objectifs environnementaux est de nature quantitative. Aussi, toutes les éventuelles lacunes dans la mise en œuvre peuvent être calculées en tenant compte de la distance par rapport à l'objectif – par exemple, la distance pour atteindre l'objectif constitué par un état écologique «bon» des eaux de surface. Les coûts liés aux lacunes dans la mise en œuvre sont alors estimés comme étant les bénéfices perdus du fait que l'eau ne soit pas propre ou qu'elle n'ait pas un état écologique «bon», ainsi qu'en tant que valeur économique des dommages causés aux ressources hydriques (par exemple, à cause des rejets d'azote).

Dans le domaine politique afférent aux déchets, il existe différents types d'objectifs similaires au sein des différents textes législatifs de l'UE – par exemple, des objectifs en matière de collecte, de réutilisation, de récupération, de recyclage et d'enfouissement. La mesurabilité s'avère également élevée dans ce domaine, chacun des types d'objectifs environnementaux revêtant une nature quantitative, de même que toute éventuelle lacune dans la mise en œuvre. De telles lacunes entraînent, par exemple, des coûts pour la santé et l'environnement, associés aux décharges sauvages et aux activités d'exportation illicites des déchets. Il existe aussi de nombreux bénéfices perdus du fait de l'absence de réalisation du développement des marchés de l'économie circulaire. En outre, il pourrait y avoir de nombreux effets indirects découlant de l'utilisation potentiellement accrue de ressources énergétiques plus polluantes là où les déchets non recyclés sont mis à la décharge au lieu de faire l'objet d'une valorisation énergétique.

La mesurabilité des objectifs environnementaux s'avère faible dans le domaine des substances chimiques. La raison pour ceci est que les exigences des textes législatifs respectifs de l'UE ne concernent pas d'objectifs particuliers, se concentrant simplement sur les mesures à adopter pour éviter des dommages envers l'environnement. L'absence d'objectifs quantitatifs restreint, évidemment, la possibilité de mesurer les lacunes dans la mise en œuvre. Néanmoins, la présente étude constate que la directive REACH et le règlement CLP ont été pleinement mis en œuvre dans les États membres, concluant qu'il n'existe pas de lacunes dans la mise en œuvre, ce qui implique également une absence de coûts y afférents.

Pour ce qui est des émissions industrielles et des risques d'accidents majeurs, la mesurabilité des objectifs environnementaux s'avère aussi élevée, la législation de l'UE prévoyant des objectifs d'émissions spécifiques en la matière. L'accomplissement de la plupart des objectifs fixés pour les sources d'émissions seront néanmoins déjà comptabilisés dans l'analyse des lacunes dans la mise en œuvre relative au domaine politique afférent à l'air. Ainsi, l'accent sera mis sur la réalisation des objectifs additionnels concernant les métaux lourds et les substances organiques. De ce fait, les coûts liés aux lacunes dans la mise en œuvre n'ont trait, ici, qu'à l'absence de satisfaction de ces objectifs additionnels.

Enfin, la nature transversale et le manque d'objectifs environnementaux quantifiables pour ce qui est des instruments horizontaux ne permet pas d'estimer les frais liés aux lacunes dans la mise en œuvre y afférents. Néanmoins, la présente étude évoque le rôle de ces instruments pour l'amélioration de la prise de décision, le développement et la mise en œuvre de la législation, et ainsi pour l'accomplissement des objectifs environnementaux fixés pour chacun des domaines politiques particuliers.

1. Introduction

The effectiveness of EU environmental law depends on its implementation at Member State, regional and local levels. Complaints concerning non-compliance with EU environmental law and a high number of infringement cases[1] indicate that there is room for improvement to implementation. Implementation gaps are costly to society.

In this study, we estimate the costs and foregone benefits to be around EUR 55 bn per year (in 2018) for the EU from not achieving the environmental targets specified in the EU legislation. A similar estimate of EUR 50 bn per year for 2011 was provided by the COWI (2011) study.

The estimate is based on estimates for the following seven policy areas: air and noise, nature and biodiversity, water, waste, chemicals, industrial emissions and major accident hazards, and horizontal instruments. The policy areas differ, however, in the way the respective Directives and Regulations intervene to improve the environment, hereunder with respect to the concreteness of the environmental targets they aim to achieve. This also implies that the implementation gaps we estimate for the different policy areas differ with respect to their concreteness and quality.

Furthermore, to get to the estimate, we have taken outset in the environmental targets to be achieved by 2018[2] and compare these targets to our 2018 estimates of the actual situation. We have where relevant tried to make it clear where and how the use of older data cause uncertainty to the estimate. A benefit of focusing on a providing an estimate for 2018 estimate is that 2018 is covered by the second round of the Environmental Implementation Review (EIR) reports (to be published in spring 2019). Hence, we have been able to benefit from the draft EIR findings and this study can provide input to the final EIR findings. This said, where an EU environmental law or EU policy specifies future targets, we report on these and try to estimate the likelihood of them being achieved – i.e. estimating possible future implementation gaps.

The estimation methodology applies the principles of the Better Regulation Guidelines (BRG)[3] for obtaining a transparent quality evidence base that is widely accepted among stakeholders, and so suitable for policy-making. Furthermore, as illustrated in Figure 1-1, we estimate the implementation gap costs stepwise.

First, we estimate the implementation gap as the difference between the environmental status and the respective environmental target – given that the target has not been reached. We then estimate the impacts of an implementation gap on the health of the population and the environment. Finally, we apply socioeconomic unit cost measures to the impact estimates to obtain implementation gap cost estimates in EUR. This said, the sources we use in the estimation process for some of the policy areas do not allow a full distinction between impacts and costs. In these cases, some of the estimation steps are combined. In any case, in this report we present the three last steps under the heading: 'implementation gap cost' for all policy areas.

[1] Source: European Commission Infringement Decision Database, http://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/infringement_decisions/index.cfm?lang_code=EN&typeOfSearch=true&active_only=0&noncom=0&r_dossier=&decision_date_from=&decision_date_to=&DG=ENVI&title=&submit=Search

[2] We acknowledge that for some policy areas there are future environmental targets – i.e. targets to be achieved later than 2018. When this is the case, we look into the likelihood of future implementation gaps.

[3] https://ec.europa.eu/info/sites/info/files/better-regulation-guidelines.pdf

Figure 1-1 From implementation gap to cost

In Chapters 2 to 8, we present these estimation steps policy area by policy area. For each policy area, we first provide a brief in description of how the policy area contributes to the EU vision and the key objectives of the 7th Environment Action Programme (EAP).[4] The focus is here on the interventions triggered by the key Directives and Regulations. We then present the environmental targets specified by the key Directives and Regulations, followed by our estimate of the implementation gap – which is defined as the difference between the environmental target and the respective environmental state (given that the target has not been achieved). Finally, we estimate the implementation gap cost by assessing the impact on human health and the environment from not having achieved the environmental target and we monetise this impact. In Chapter 9, we finally present the total implementation gap cost estimate and we explain how the different policy areas contribute to this estimate.

The report has two annexes. In Annex 1, we list the data sources identified and made use of for the implementation gap cost estimate. In Annex 2, we list all the environmental Directives and Regulations that were reviewed when identifying the key ones.

2. Air and noise

2.1 EU environmental policy and law

The 7th EAP has as one of its three key objectives to safeguard the Union's citizens from environment-related pressures and risks to health and wellbeing. Both air pollution and high noise levels are central causes of adverse health effects such as cardiovascular problems. This applies in particular to the urban population and those living close to major roads. Air pollution is also a cause of respiratory diseases and cancer with the most problematic pollutants being fine particles, nitrogen dioxides and ground-level ozone, and noise can affect the quality of life and lead to significant levels of stress and sleep disturbance. Furthermore, air pollution has a negative impact on the quality of water and soil and it damages ecosystems, and noise has an impact on wildlife.

Air

The EU already started to tackle air pollution in 1970s and air quality in Europe has improved much since. As shown in Annex 2, the EU has adopted three different legal mechanisms to reduce air pollution: defining air quality standards for ambient concentrations of air pollutants, setting national limits on total pollutant emissions, and designing source-specific legislation. A part of the latter legal mechanism is covered by the sixth policy area: Industrial emissions and major accident hazards (see Chapter 7).

[4] http://ec.europa.eu/environment/action-programme/

Here we focus, as shown in Table 2-1, on the Ambient Air Quality (AAQ) Directive 2008/50/EC which sets air quality standards in the form of limit/target values for the exposure to air pollutants and which provides for Member States to monitor and assess air quality in their territory in a harmonised and comparable manner. Furthermore, we cover the National Emission Ceilings (NEC) Directive 2016/2284/EU which specifies national emission reduction commitments for Member States and the EU for five important air pollutants with the aim of reducing the health and environmental impacts. Hence, the two Directives complement each other with the former focusing on reducing air pollution in hotspots such as urban areas and in areas close to heavily trafficked roads, while the latter covers overall emission levels in the Member.

Noise

Regarding noise pollution, Table 2-1 shows that we focus on the Environmental Noise Directive (END) 2002/49/EC which requires Member States to assess noise levels by producing environmental noise maps and, based on the noise mapping, prepare action plans with measures to address noise issues and their effects for those areas where the indicators, laid by the Directive, have been exceeded. The END does, however, not specify limit or target values, but as described in the next section we assume that the EU policy targets are the noise exposure limits recommended by the WHO. Finally, in addition to the END, the EU has adopted various legislation addressing noise at source such as road traffic noise, aircraft noise, railway noise and noise from equipment for use outdoors.

Table 2-1 Key EU environmental law – air and noise

Directives and Regulations	Brief characteristic
Ambient Air Quality (AAQ) Directive 2008/50/EC	Sets air quality standards in the form of limit/target values for the exposure to air pollutants and provides for Member States to monitor and assess air quality, to ensure that the information on air quality is made public, and to maintain good air quality and improve it where it is not good.
National Emission Ceilings (NEC) Directive 2016/2284/EU	Specifies national emission reduction commitments for Member States and the EU for five important air pollutants with the aim of reducing the health and environmental impacts attributed to transboundary pollution.
Environmental Noise Directive (END) 2002/49/EC	Requires Member States to assess noise levels by producing environmental noise maps and, based on the noise mapping, informing about exposures to noise, and preparing action plans with measures to address noise issues.

Sources: Annex 2 and COWI/Eunomia.

2.2 Environmental target

Air

The two air Directives: AAQ and NEC specify as introduced above concrete environmental targets. The different focuses of the two Directives, however, imply that the environmental targets differ in type. The AAQ Directive sets limit and target values concentrations of air pollutants in zones and agglomerations not to be exceeded (above permitted levels). The NEC Directive focuses on overall emissions in the Member States and thus it sets targets for overall emission levels.

Table 2-2 Concentration values for the protection of human health[(1)] – AAQ Directive

Emission type	Averaging period	Concentration	Permitted exceedances each year	Date by which limit value is to be met
Fine particles ($PM_{2.5}$)	1 year	25 µg/m³	n/a	1 January 2015
Sulphur dioxide (SO_2)	1 hour 24 hours	350 µg/m³ 125 µg/m³	24 3	1 January 2005 1 January 2005
Nitrogen dioxide (NO_2)	1 hour 1 year	200 µg/m³ 40 µg/m³	18 n/a	1 January 2010 1 January 2010 [(2)]
PM_{10}	24 hours 1 year	50 µg/m³ 40 µg/m³	35 n/a	1 January 2005 [(3)] 1 January 2005 [(3)]
Lead (Pb)	1 year	0.5 µg/m³	n/a	1 January 2005 [(4)]
Carbon monoxide (CO)	Maximum daily 8 hour mean [(5)]	10 mg/m³	n/a	1 January 2005
Benzene	1 year	5 µg/m³	n/a	1 January 2010 [(3)]
Ozone (O_3)	Maximum daily 8 hour mean [(5)]	120 µg/m³	25 days averaged over 3 years	1 January 2010
Arsenic (As)	1 year	6 ng/m³	n/a	31 December 2012
Cadmium (Cd)	1 year	5 ng/m³	n/a	31 December 2012
Nickel (Ni)	1 year	20 ng/m³	n/a	31 December 2012
Polycyclic Aromatic Hydrocarbons (PAH)	1 year	1 ng/m³ [(4)]	n/a	31 December 2012

Source: Directive 2008/50/EC: Annex VII, Annex XI and Annex XIV.

Notes:
(1) Critical levels for the protection of vegetation are provided in Annex XIII.
(2) The Member State could apply for an extension of up to five years (i.e. maximum up to 2015) in a specific zone.
(3) The Member State was able to apply for an extension until three years after the date of entry into force of the new Directive (i.e. May 2011) in a specific zone.
(4) Already in force since 1 January 2005. Limit value to be met only by 1. January 2010 in the immediate vicinity of the specific industrial sources situated on sites contaminated by decades of industrial activities.
(5) Measured by examining eight hour running averages.
(6) Limit value expressed as concentration of Benzo(a)pyrene.

Table 2-3 presents the national emissions ceilings of the 'old' NEC Directive 2001/81/EC which will be in force until 2019, thus applying to the focus year of this study: 2018. Like the AAQ Directive, it covers sulphur dioxide, while it covers oxides of nitrogen in general. Furthermore, as shown in Table 2-4, reduction commitments for fine particles: $PM_{2.5}$ will be in place from 2020. Compared with the AAQ Directive, the NEC Directive also covers Non-Methane Volatile Organic Compounds (NMVOC) and ammonia (NH_3).

NMVOCs are a collection of organic compounds that differ widely in their chemical composition but display a similar behaviour in the atmosphere. They stem from a large number of sources including combustion activities, solvent use and production processes. They contribute to the formation of ground-level ozone, and other air pollutants that are hazardous to human health, and that also may lead to crop damage.

Table 2-3 National emission ceilings 2018, kilotonnes per year

Member State	SO_2	NO_x	NMVOC	NH_3
Austria	39	103	159	66
Belgium	99	176	139	74
Bulgaria	836	247	175	108
Croatia	39	87	90	30
Cyprus	39	23	14	9
Czech Republic	265	286	220	80
Denmark	55	127	85	69
Estonia	100	60	49	29
Finland	110	170	130	31
France	375	810	1050	780
Germany	520	1051	995	550
Greece	523	344	261	73
Hungary	500	198	137	90
Ireland	42	65	55	116
Italy	475	990	1159	419
Latvia	101	61	136	44
Lithuania	145	110	92	84
Luxembourg	4	11	9	7
Malta	9	8	12	3
Netherlands	50	260	185	128
Poland	1397	879	800	468
Portugal	160	250	180	90
Romania	918	437	523	210
Slovakia	110	130	140	39
Slovenia	27	45	40	20
Spain	746	874	662	353
Sweden	67	148	241	57
United Kingdom	585	1167	1200	297

Source: Directive 2001/81/EC.

The agriculture sector is responsible for over 90% of ammonia emissions in the EU. Exposure to high concentrations of ammonia in air causes immediate burning of the eyes, nose, throat and respiratory tract and can result in blindness, lung damage or death. Furthermore, ammonia contributes to acid deposition and eutrophication, which in turn, can lead to potential changes occurring in soil and water quality. It is highly toxic to fish and other aquatic life.

Table 2-3 also shows that the national emission ceilings for 2018 differ between Member States. This is not only due to differences in the sizes of the economies but are also based on computer models searching for the lowest cost solution to attain a given health and environmental goal. In other words, the variation between national targets is due to the model taking into account different parameters, hereunder that because of the transboundary nature the impacts often occur elsewhere from emissions.

As already mentioned, the 'new' NEC Directive (EU) 2016/2284 specifies, as shown in Table 2-4, reduction commitments for 2020 and beyond. For EU-28 as a whole, these reduction commitments lead to stricter commitments than those in force until 2020. This is particularly the case for SO_2-emissions while there also are large reduction commitments for NO_x.

Table 2-4 NEC Directive: national emission ceiling and reduction commitments (EU-28 level)

Emission type	2010 emission ceiling - 1000 tonnes	Reduction commitment – compared to 2005		Corresponding absolute reduction compared to 2005 - 1000 tonnes	
	- 2019	2020-2029	2030-	2020-2029	2030-
SO_2	8367	59%	79%	3132	1604
NO_x	9090	42%	63%	6782	4327
NMVOC	8938	28%	40%	6402	5335
NH_3	4324	6%	19%	3827	3298
$PM_{2.5}$	---	22%	49%	1324	865

Sources: Directive 2001/81, Directive 2016/2284/EU and https://www.eea.europa.eu/data-and-maps/dashboards/necd-directive-data-viewer-1

Noise

For noise pollution, there are no specific EU limit or target values set by the END. However, we acknowledge that the END requirements are made in pursuance of limiting the exposure of the EU population to noise pollution, and so we assume that EU policy targets are the noise exposure limits recommended by the WHO. This said, when we calculate the total implementation gap costs we limit ourselves to legislative environmental targets – i.e. exclude the costs of not complying with the WHO recommendations.

The WHO (1999) recommendations are widely referred to by the studies we have made use of in this study when estimating adverse impacts on population health from noise pollution. These recommendations have, however, been revised for the European region since 1999 (WHO, 2009 and 2018). Based on scientific evidence, the WHO (2009) published guidelines for night-time noise outdoor of 40 dB with an interim target of 55 dB for European countries not able to achieve the target in the short term. Furthermore, recommendations for even stricter noise exposure limits have as shown in Table 2-5 been published very recently (WHO, 2018).

The categorisation of the noise exposure limits and the measurement units have also changed slightly from 1999 to 2018. The 1999 WHO recommendations distinguished between 14 different specific environments – three of which are shown in the below table, while the 2018 recommendations focus on noise sources instead. However, we acknowledge – maybe best indicated by the reduction in the outdoor living area limit of 55 dB to the 53 dB for road traffic which is the main cause of noise in outdoor living areas – that the 2018 recommendations involve lower/stricter noise exposure limits than the 1999 recommendations did. In itself this obviously implies that more people are estimated to be exposed to noise pollution when using the 2018 limit values than when using the 1999 values. Such implications for the implementation gap estimation are further discussed in Section 2.3.

When developing the 2018 recommendations, the WHO also assessed the quality of the evidence used. This information is valuable for our study as we try to determine how much of the uncertainty inherent in the implementation gap estimates[5] can be attributed to the different steps of the estimation process. In this context, it must be underlined that WHO concludes that the central road traffic noise recommendations are based on strong evidence of adverse health impacts from noise levels above the limit values.

Table 2-5 1999, 2009, and 2018 WHO recommendations for noise exposure limits for the European Region

Specific environment / noise source	Day-evening-night noise 1999: dB L_{Aeq} 2018: dB L_{den}	Night-time noise dB L_{night}
1999 WHO recommendations		
Outdoor living area	(1)55 (2)50	na
Bedrooms	(3)45 (4)30	na
Music and other sounds through headphones/ earphones	85	na
2009 WHO recommendations		
Night-time noise outside	na	(5)40
2018 WHO recommendations		
Road traffic	53	45
Railway	54	44
Aircraft	45	40
Wind turbine	45	na
Leisure	70	na

Sources: WHO (1999, 2009, and 2018)
Notes: dB: decibel
L_{Aeq}: A-weighted equivalent continuous sound pressure level
L_{den}: Day-evening-night-weighted sound pressure level
L_{night}: Equivalent continuous sound pressure level when the reference time interval is the night
(1) Serious annoyance
(2) Moderate annoyance
(3) Outside bedrooms
(4) Inside bedrooms
(5) Interim target of 55 dB for European countries not able to achieve the target in the short term

2.3 Implementation gap

Air

As described above, the two key Directives: the AAQ Directive and the NEC Directive specify different types of environmental targets, implying that any implementation gaps also will differ in type.

At the time of the 2011 study, it was concluded that monitoring data of a sufficient quality to assess whether the AAQ Directive concentration values were exceeded were

[5] Note that the implementation gap costs for noise are not included in the total implementation gap cost estimate as the environmental targets are not directly specified by EU law.

not available in 2011. Hence, this analysis was not carried out. For this study, we have benefitted from the EEA data on the EU urban population that is exposed above the limit/target values and from the analysis of this data that is carried out in the context of the ongoing COWI, Eunomia, and Milieu support study to the fitness check by DG ENV of the Ambient Air Quality Directives.

Table 2-6 shows that data are only available for four of the pollutants covered by the AAQ Directive (see Table 2-2): $PM_{2.5}$, PM_{10}, O_3 and NO_2. Therefore, we do not assess the implementation gap cost of exceedances of other pollutants – such as lead (Pb), carbon monoxide (CO), benzene and arsenic (As). For all four emission types for which data exists, there are exceedances (implementation gaps) in 2016 (the last year of data). However, the general trend is for fewer and fewer exceedances – although the development is somewhat fluctuating for O_3, where some of the fluctuation may e.g. be caused by varying weather conditions. Hence, compared to 2011 – for which data have become available after the completion of the 2011 study – the percentage of the EU urban population exposed above AAQ Directive concentration values has more than halved for $PM_{2.5}$ and PM_{10}, and decreased by a quarter for O_3 and by a third for NO_2.

Table 2-6 Percentage of EU urban population exposed above AAQ Directive concentration values (1) – 2000-2016

	$PM_{2.5}$ (2)	PM_{10} (3)	O_3 (4)	NO_2 (5)
2000		32.4	17.9	25.9
2001		30.1	30.5	22.3
2002		31.5	20.7	23.1
2003		41.8	54.9	31.0
2004		28.2	19.4	20.6
2005		34.0	22.7	21.4
2006	16.7	37.8	45.5	18.2
2007	11.6	30.4	21.8	20.7
2008	12.6	23.9	15.3	12.3
2009	8.8	24.4	16.1	14.3
2010	10.8	25.2	17.4	11.7
2011	13.6	29.6	16.1	11.8
2012	11.5	21.9	15.5	8.8
2013	8.5	20.5	16.2	9.0
2014	8.0	16.4	7.3	7.4
2015	7.4	18.6	29.5	8.4
2016	5.5	13.2	12.4	7.3

Source: COWI/Eunomia (2019) and https://www.eea.europa.eu/data-and-maps/indicators/exceedance-of-air-quality-limit-3/assessment-4.

Notes: (1) Shading indicates exceedances prior to the compliance date with the concentration values.
(2) Annual mean $PM_{2.5}$ concentrations above 25 µg/m^3.
(3) Percentage of population exposed to daily PM_{10} concentrations exceeding 50 µg/m^3 for more than 35 days a year.
(4) Percentage of population exposed to maximum daily 8-hour mean O_3 concentrations exceeding 120 µg/m^3 for more than 25 days a year.
(5) Annual mean NO_2 concentrations above 40 µg/m^3.

The exceedances – and so the implementation gap costs – differ as shown in Table 2-7 much between Member States. In particular, the Member States that lasted joined the EU appear to have difficulties complying with the environmental targets. For O_3 and to some extent for NO_2, older Member States also experience difficulties.

Table 2-7 Percentage of EU urban population exposed above AAQ Directive concentration values– by Member State, 2015

	$PM_{2.5}$(1)	PM_{10}(2)	O_3(3)	NO_2(4)
Austria	0	0	98	5
Belgium	0	0	0	3
Bulgaria	55	78	0	0.5
Croatia	3	81	94	3
Cyprus	0	6	0	0
Czechia	7	19	89	1
Denmark	0	0	0	2
Estonia	0	0	0	0
Finland	0	0	0	1
France	0	1	17	4
Germany	0	0.5	37	5
Greece	0	4	97	3
Hungary	0	27	100	2
Ireland	0	0	0	0
Italy	26	60	80	35
Latvia	0	4	0	4
Lithuania	0	2	0	0
Luxembourg	0	0	0	9
Malta	0	100	0	0
Netherlands	0	0	0	2
Poland	46	81	38	1
Portugal	0	1	0	2
Romania	2	54	12	1
Slovakia	9	6	60	5
Slovenia	0	100	100	0
Spain	0	5	34	16
Sweden	0	0	0	0.5
United Kingdom	0	0	0	11
EU urban	**7**	**19**	**30**	**9**

Source: COWI/Eunomia (2019) and https://www.eea.europa.eu/data-and-maps/indicators/exceedance-of-air-quality-limit-3/assessment-4.

Notes: (1) Annual mean $PM_{2.5}$ concentrations above 25 μg/m^3.
(2) Percentage of population exposed to daily PM_{10} concentrations exceeding 50 μg/m^3 for more than 35 days a year.
(3) Percentage of population exposed to maximum daily 8-hour mean O_3 concentrations exceeding 120 μg/m^3 for more than 25 days a year.
(4) Annual mean NO_2 concentrations above 40 μg/m^3.

To calculate an estimate, shown in Table 2-8, for EU urban population exposed above AAQ Directive concentration values, we combine the data from the above table with information on urban population from UN (2018).

Table 2-8 Calculated EU urban population exposed above AAQ Directive concentration values – by Member State, 2015

Member States	Urban population (1)	PM_{10}	O_3	NO_2
Austria	5008930	-	4908751	250447
Belgium	11048237	-	-	331447
Bulgaria	5310568	4142243	-	26553
Croatia	2378726	1926768	2236002	71362
Cyprus	777234	46634	-	-
Czech Republic	7791316	1480350	6934271	77913
Denmark	4979108	-	-	99582
Estonia	899890	-	-	-
Finland	4672016	-	-	46720
France	51343241	513432	8728351	2053730
Germany	63078413	315392	23339013	3153921
Greece	8755057	350202	8492405	262652
Hungary	6897667	1862370	6897667	137953
Ireland	2939375	-	-	-
Italy	41393818	24836291	33115054	14487836
Latvia	1354612	54184	-	54184
Lithuania	1971134	39423	-	-
Luxembourg	511081	-	-	45997
Malta	403728	403728	-	-
Netherlands	15273879	-	-	305478
Poland	23065377	18682955	8764843	230654
Portugal	6617197	66172	-	132344
Romania	10711013	5783947	1285322	107110
Slovakia	2931170	175870	1758702	146559
Slovenia	1115846	1115846	1115846	-
Spain	36933458	1846673	12557376	5909353
Sweden	8450611	-	-	42253
United Kingdom	54035311	-	-	5943884
EU urban	**380648013**	**71181178**	**114194404**	**34258321**

Source: COWI/Eunomia (2019) and https://www.eea.europa.eu/data-and-maps/indicators/exceedance-of-air-quality-limit-3/assessment-4.

Notes: (1) The 2015 urban population data is extracted from UN (2018).

Although, we focus on the AAQ Directive when estimating implementation gap costs in the next section, we do in this section also estimate the implementation gaps with respect to the NEC Directive. With the environment targets specified in the NEC Directive, as shown in Table 2-4, being measurable in tonnes of emissions they can be directly compared with the actual tonnes of air pollutants being emitted. Table 2-9 shows that total emission levels for EU-28 have reduced significantly since 2011 – apart from NH_3 which has remained fairly constant and even increased in recent years.

Table 2-9 Emissions by type, EU-28, and change compared to 2011

Emission type	2011	2012	2013	2014	2015	2016
Kilotonnes						
SO_2	4078	3673	3214	2941	2774	2329
NO_x	9144	8814	8420	8100	7932	7660
NMVOC	7436	7276	7090	6820	6818	6793
NH_3	3842	3806	3799	3828	3887	3906
$PM_{2.5}$	1463	1481	1449	1347	1356	1343
Change compared to 2011						
SO_2		-10%	-21%	-28%	-32%	-43%
NO_x		-4%	-8%	-11%	-13%	-16%
NMVOC		-2%	-5%	-8%	-8%	-9%
NH_3		-1%	-1%	0%	1%	2%
$PM_{2.5}$		1%	-1%	-8%	-7%	-8%

Source: https://www.eea.europa.eu/data-and-maps/dashboards/necd-directive-data-viewer-1

Note: The table is based on the latest air pollutant emissions inventory data reported to DG Environment and EEA up until 2016.

Recalling that the national emission ceilings presented in Table 2-3 differ between Member States and that these differences are not only due to differences in the sizes of the economies, it is not that informative to calculate an overall EU-28 implementation gap. Anyhow, as shown in Table 2-10, only few Member States had in 2016 difficulties with complying with the NEC Directive environmental targets – i.e. six Member States experienced implementation gaps for one or several pollutants especially with regards to NH_3. Hence, most Member States had in 2016 emission levels below the targets (negative numbers in the table overleaf).

Table 2-10 Implementation gaps by Member State in 2016, kilotonnes

Member State	SO_2	NO_x	NMVOC	NH_3
Austria	-25		-22	1
Belgium	-57	-50	-26	-6
Bulgaria	-731	-122	-91	-58
Croatia	-55	-35	-20	5
Cyprus	-23	-8	-5	-3
Czech Republic	-150	-121	-7	-7
Denmark	-45	-12	-18	-2
Estonia	-70	-29	-27	-17
Finland	-70	-39	-42	-1
France	-235	-119	-442	-150
Germany	-164	-82	-147	52
Greece	-451	-84	-57	-16
Hungary	-477	-81	4	-3
Ireland	-28	26	-8	1
Italy	-359	-229	-255	-37
Latvia	-98	-26	-96	-28
Lithuania	-130	-56	-40	-50
Luxembourg	-3	-2	0	-1
Malta	-7	-3	-9	-2
Netherlands	-22	-10	-42	0
Poland	-815	-153	-191	-201
Portugal	-126	-103	-32	-40
Romania	-810	-226	-265	-43
Slovakia	-83	-63	-76	-9
Slovenia	-22	-8	-9	-2
Spain	-528	-82	-68	139
Sweden	-48	-17	-82	-4
United Kingdom	-406	-274	-381	-8

Sources: Directive 2001/81, Directive 2016/2284/EU and https://www.eea.europa.eu/data-and-maps/dashboards/necd-directive-data-viewer-1

Notes: Negative implementation gaps indicate how much lower actual emissions are compared with the national emission ceilings.
Ireland and Hungary submitted adjustment applications submitted in 2018, which, if approved by the EC, will bring emissions below their respective ceilings.

The new NEC Directive reduction commitments, shown in Table 2-4 for EU-28 as a whole, will as emphasised in the NEC Directive reporting status 2018 by EEA (2018b) require additional efforts to reduce air pollution. Table 2-11 shows the Member States' indications of the progress made in meeting the 2020/2030 reduction commitments. Hence, 20 Member States, on the basis of their projected emissions, do not consider themselves on track towards meeting their 2020 reduction commitments for one or several of the pollutants based on policies and measures currently in place. Likewise, 27 Member States will have to take more steps for one or several emissions to meet their 2030 commitments. In other words, we might expect increased implementation gaps in 2020, but also expect that actions are taken in the Member States to deal with this situation – keeping any future implementation gaps low.

Table 2-11 Progress in meeting 2020/2030 NEC Directive reduction commitments

Member State	SO_2		NO_x		NMVOC		NH_3		$PM_{2.5}$	
	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
Austria	+	+			+	-	-	-	+	-
Belgium	+	+	+	-	+	+	+	+	+	+
Bulgaria	+	+	+	+	-	-	+	+	-	-
Croatia	+	+	+	+	+	+	+	+	+	+
Cyprus	+	+	-	-	+	+	+	+	+	+
Czech Republic	+	-	+	-	+	+	+	-	+	+
Denmark	+	-	+	+	+	+	-	-	+	-
Estonia	+	-	+	+	+	+	-	-	Not available	
Finland	+	+	+	+	+	+	+	+	-	-
France	+	-	+	+	+	-	-	-	+	-
Germany	+	-	+	-	+	+	-	-	+	+
Greece	+	-	+	-	-	-	-	-	-	-
Hungary	-	-	-	-	-	-	+	+	Not available	
Ireland	+	-	+	-	+	+	-	-	+	+
Italy	+	+	+	+	+	-	+	-	+	-
Latvia	+	-	-	-	+	+	-	-	+	+
Lithuania	-	-	-	-	-	-	+	+	-	-
Luxembourg	+	+	-	-	+	-	-	-	-	-
Malta	+	+	+	-	+	-	-	-	+	+
Netherlands	+	+	+	+	+	-	+	+	+	+
Poland	+	-	+	-	-	+	+	-	+	-
Portugal	+	-	+	+	+	-	+	+	+	-
Romania	+	-	+	-	+	-	+	+	+	-
Slovakia	+	-	+	-	+	-	+	-	-	-
Slovenia	+	-	-	+	+	-	+	-	-	-
Spain	+	-	+	-	+	-	-	-	+	-
Sweden	+	+	+	-	+	+	-	-	+	+
United Kingdom	+	-	+	-	+	-	-	-	-	-

Source: https://www.eea.europa.eu/publications/nec-directive-reporting-status-2018
Note: '+' indicates that the reduction commitment has been, or is anticipated to be, achieved. '-' indicates that the reduction commitment has not been, or is not anticipated to be, attained. The table is based on the 'with measures' (WM) projections calculated by the Member States on the basis of adopted policies and measures currently in place.

Noise

For noise, the 2017 EIR found that more than 30% of the noise maps and 60% of action plans were missing in the current reporting cycle. The draft 2019 EIR reports suggest the same tendency in relation to missing noise maps and action plans – and so indicates that this element of an implementation gap remains.

Furthermore, Table 2-12 shows that more than 75 million EU citizens are exposed to excessive noise from road traffic inside urban areas. In developing this estimate, we assume that the WHO (1999) recommended noise exposure limits considered by EU as 'policy targets'. This assumption is fully in line with 7th EAP[6] that defines 'high noise levels' as noise exposure levels above 55 dB L_{den} and 50 dB L_{night}. Furthermore, the 7th EAP sets the objective that by 2020 noise pollution in the EU will have significantly decreased and thereby moved closer to WHO recommendation. This objective will obviously be more difficult to achieve if the latest, stricter WHO (2018) recommendations (see Table 2-5) for both day-evening-night noise levels and night-time noise levels are adopted by the EU as updated environmental targets. It should, however, be highlighted that information is still to be gathered, e.g. by the EEA, about the extent of exposure to noise above these lower levels. Furthermore, since the new WHO recommendations build on new evidence of more severe adverse impacts of noise than the old evidence, the estimates of the implementation gap impacts for e.g. an average person will also be higher.

Table 2-12 Implementation gaps by noise source, number of people (EU-28) exposed to day-evening-night noise levels (L_{den}) and night-time noise levels (L_{night}), 2017

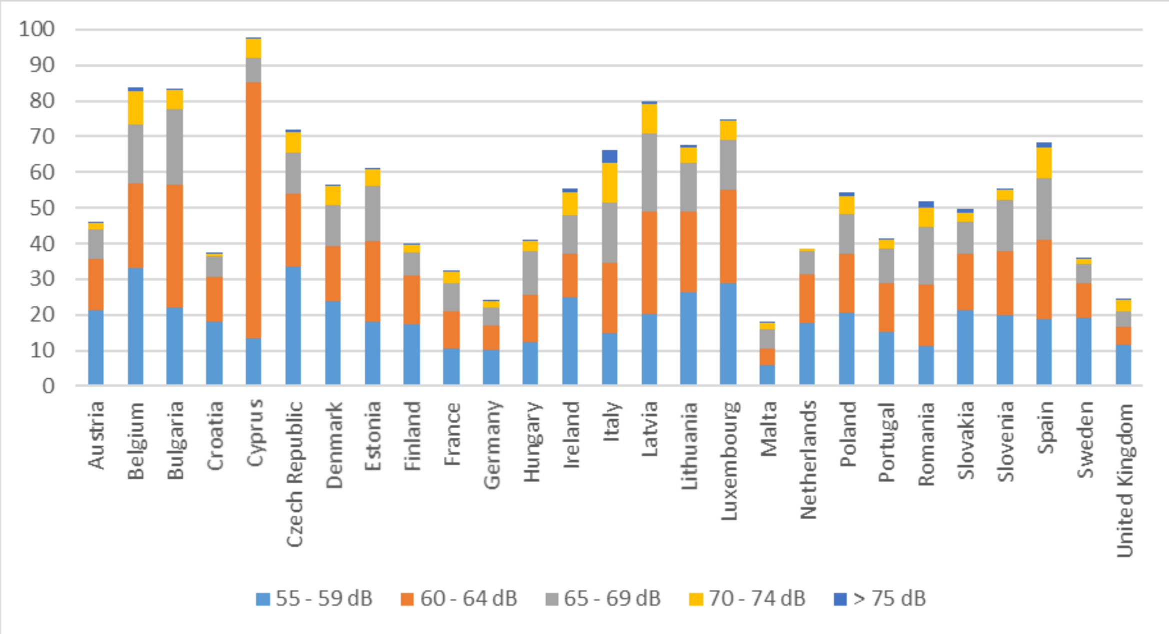
Noise source	Day-evening-night noise ≥ 55 dB	Night-time noise ≥ 50 dB	*Urban/ non-urban areas*
Roads	75451500	53532900	Inside urban area
Railways	9656700	6552200	Inside urban area
Airports	2848100	797800	Inside urban area
Industry	827700	382500	Inside urban area
Major roads	29371800	19982700	Outside urban area
Major railways	9145100	7621700	Outside urban area
Major airports	2334800	752500	Outside urban area

Source: EEA (2018e)
Note: The data refer to the most recent country submissions and redeliveries of the 2017 round of noise reporting, which were received by the EEA until 12/09/2018.

Regarding road noise in urban areas, Figure 2-1 shows that there are significant Member States differences in the share of the population that are exposed. Such differences obviously reflect differences in the road infrastructure and the location of housing close to this as well as the amount of traffic. Furthermore, as also pointed out by the 2011 study, a varying degree of implementation and noise reduction may be caused by the non-binding requirements of the END in relation to specific target values. In this context, there are missing noise maps in the current reporting cycle potentially distorting the accuracy of the estimated variation between Member States in relation to road noise pollution.

[6] http://ec.europa.eu/environment/action-programme/

Figure 2-1 Share of population in urban areas exposed to road noise (L_{den}), 2017



Source: EEA (2018e)
Note: Data from Greece was not available.

2.4 Implementation gap cost

Air

The focus on the implementation gap measured as the EU urban population that are exposed to air pollution above the AAQ Directive[7] concentration values is maintained when estimating the implementation gap costs.

For this estimation we have also benefitted from the analysis carried out within the support study to the fitness check by DG ENV of the AAQ Directives. The support study made use of the ALPHA-RiskPoll (ARP) model[8] to quantify the social impacts of a unit change in pollutant concentration (1µg/m^3 $PM_{2.5}$ and NO_2, and 200 ppb.hours ozone SOMO35[9]). As pointed out in the support study, the ARP model has been developed and used in several other analyses for the Commission, the EEA and in the Member States. The resulting valuation data shown in Table 2-13 were first reported by Holland (2014) and since updated until 2017. The table shows that the costs of damage to the health differ between Member States. This reflects differences in health as well as economic statuses.

[7] In the previous section we also provided an estimate of the NEC Directive implementation gap. A rough and conservative estimate of the costs of this gap is, using the recent unit cost figures provided by the German Environment Agency (2019), EUR 3 to 6 bn per year. These are mainly health costs and we consider them to (partly) overlap with the AAQ Directive implementation cost estimates.
[8] See Holland et al (2015) for a description of the modelling framework.
[9] SOMO35 is the sum of Ozone Means Over 35 ppb is the indicator for health impact assessment recommended by WHO. It is defined as the yearly sum of the daily maximum of 8-hour running average over 35 ppb.

Table 2-13 Damage costs for different pollutants with mortality valued using Value of a Statistical Life (VSL) in Member States, 2017

Member State	$PM_{2.5}$	NO_2	O_3
	EUR per person per µg/m^3		EUR per person per 100 ppb.days
Austria	135.0	74.8	0.45
Belgium	137.9	76.6	0.44
Bulgaria	239.8	139.3	0.55
Croatia	198.9	114.3	0.48
Cyprus	109.2	58.7	0.41
Czech Republic	162.9	91.7	0.46
Denmark	139.4	77.6	0.44
Estonia	180.7	103.0	0.48
Finland	140.5	78.4	0.46
France	121.1	66.3	0.43
Germany	163.1	91.9	0.47
Greece	158.6	89.4	0.45
Hungary	199.7	114.7	0.49
Ireland	103.3	55.4	0.41
Italy	143.7	80.2	0.45
Latvia	228.5	132.7	0.51
Lithuania	221.3	128.2	0.51
Luxembourg	96.5	50.9	0.42
Malta	122.4	67.0	0.43
Netherlands	127.1	69.9	0.43
Poland	161.9	91.2	0.46
Portugal	156.3	88.1	0.45
Romania	203.8	117.1	0.50
Slovakia	159.0	89.4	0.46
Slovenia	143.3	79.7	0.44
Spain	125.2	68.7	0.43
Sweden	124.3	68.3	0.43
UK	128.1	70.8	0.43

Source: COWI, Eunomia, and Milieu (2019 forthcoming).

The second step in the estimation of the implementation gap costs at EU level is to calculate a unit cost measurement that recognises the variation between Member States. This calculation, shown in Table 2-14, is also based on the results of the support study. To get to these unit cost figures for PM_{10}, NO_2 and O_3, the data in Table 2-13 are weighted by the population exposed above concentration values combined with assumptions about how large the exceedances are.

For PM_{10} and NO_2, both low and high unit cost estimates are provided. Furthermore, the table shows that cost estimates are quite stable over time.

Table 2-14 Unit cost measurement (EU-average) for PM_{10}, NO_2 and O_3 weighted by the fraction of the total population subject to exceedance by Member State

	PM_{10}		NO_2		O_3
	EUR per person. 1μg/m^3		EUR per person. 1μg/m^3		EUR per person per 200ppb hours SOMO35
	Low	**High**	**Low**	**High**	
2008	36.3	107	23.3	85.7	0.83
2009	36.4	108	23.3	86.4	0.84
2010	36.9	110	23.6	88.1	0.86
2011	37.6	111	24.0	87.3	0.88
2012	38.1	111	24.3	85.9	0.90
2013	38.3	110	24.4	83.4	0.90
2014	38.1	108	24.2	80.0	0.90
2015	37.7	105	23.9	76.1	0.89
2016	37.6	105	23.8	76.1	0.89
2017	38.0	107	24.0	77.2	0.91

Source: COWI, Eunomia, and Milieu (2019 forthcoming).

The third step is then to apply these cost estimates to the estimated number of people in EU urban areas that are exposed above AAQ Directive concentration values (see Table 2-8). While these data help us to quantify the number of people affected by implementation gaps, they do not tell the extent of exceedance. The implementation gap cost will be higher the more the concentration values are exceeded. To address this, we use estimates of the frequency distribution of the EU population exposed to pollutants from the EEA's (2018a) Air Quality in Europe report.[10] As support study, we do not have data on frequency distribution for each year and therefore, we assume that average exceedances in the group exposed above AAQ Directive concentration values is the same for all years. Due to the decline in the overall exceedances, as shown in Table 2-6, this assumption will cause an underestimation of the implementation gap cost for earlier years.

By combining unit cost measurement with total EU urban population exposed above AAQ Directive concentration values and the frequency distribution data from EEA (2018a), the estimates of the implementation gap costs are given in Table 2-15. It shows that costs have almost halved in the period for which we have estimates. Note in this context, that the most recent estimate is for 2016. We use this estimate for 2018, which when adjusting for inflation[11] gives us a cost range of **EUR 8.7-40.4 bn per year – with the central estimate being EUR 24.6 bn**.

[10] From Figure 9.2 of the EEA report, it is estimated that average exposure associated with exceedance is equal to 2μg/m^3 PM_{10} and 7 μg/m^3 NO_2. No similar figures are available for ozone, but an indicative range of 3 to 5 μg/m^3 O_3 has been adopted here.
[11] Using Eurostat Harmonised index of consumer prices (HICP).

Table 2-15 Implementation gap costs of air pollution in EU-28 for $PM_{2.5}/PM_{10}$, NO_2 and O_3 (EUR million)

	$PM_{2.5}/PM_{10}$ (1)		NO_2 (2)		O_3 (3)		Total	
Average exceedance, µg/m³	3	3	7	7	3	5		
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
2008	8012	46838	-	-	-	-	-	-
2009	5613	47426	-	-	-	-	-	-
2010	6986	48540	85	142	7517	27782	14588	76464
2011	8971	58585	81	135	7718	27784	16770	86504
2012	7702	42964	79	132	5834	20412	13615	63508
2013	5716	38577	83	139	5981	20291	11780	59007
2014	5352	30147	37	62	4883	16020	10272	46229
2015	4897	34721	150	250	5474	17315	10521	52286
2016	3631	23814	63	105	4739	15048	8433	38967

Source: COWI/Eunomia (2019 forthcoming)

Notes:
(1) $PM_{2.5}/PM_{10}$: low uses VOLY for mortality valuation and area exceeded for annual mean $PM_{2.5}/PM_{10}$ limit; high uses VSL for mortality valuation and area exceeded for daily mean $PM_{2.5}/PM_{10}$ limit.
(2) NO_2: low uses VOLY for mortality valuation; high uses VSL for mortality valuation
(3) Note that COWI/Eunomia also report high and low estimates for O_3.

Noise

As described above, for noise pollution there are no specific legal EU limit or target values set by the END. For the sake of this analysis, we instead refer to the WHO recommendations. This said, when we calculate the total implementation gap costs we limit ourselves to legislative environmental targets – i.e. exclude the likely costs of not complying with the WHO recommendations. In other words, the estimation provided here is to demonstrate that noise pollution is costly to society. Our 'policy' implementation gap estimate shows that a significant number of people across the EU still were exposed to 'high noise levels' in 2017. To estimate the impact of this we make use of the noise country fact sheets from the EEA (2018d). Here, each country profile shows the impact on health in terms of annoyance, sleep disturbance, cardiovascular effects and mortality caused by noise pollution above the noise exposure limits. Based on the disability weights described in WHO (2018), disability-adjusted life years (DALYs) attributed to noise exposure are estimated for the Member States.

However, 2018 noise country fact sheets for nine Member States (Cyprus, France, Greece, Hungary, Italy, Luxembourg, Malta, Slovakia and Slovenia) were not publicly available from the EEA at the time of completing this report. For these Member States a 'gap-filling' method is applied, where we calculate the number of people (EU-28) not covered by the country fact sheets and include them based on the implementation gap cost of the countries for which country fact sheets are available. This of course introduces additional uncertainty into our estimate.

Furthermore, to estimate the unit cost per DALY, we calculated expected annual income per capita in each Member State based on Eurostat data to quantify the value of lost working years caused by noise pollution. By using this unit cost measurement, we get an estimate of the health cost of not implementing the noise exposure limits.

Table 2-16 Implementation gap cost of noise pollution in EU-28, 2017

Member State	Disability adjusted life years (DALYs) per year	Expected annual income (EUR) per capita	Implementation gap cost (EUR)
Austria	34337	59709	2050231367
Belgium	21519	57895	1245846809
Bulgaria	17598	8443	148574635
Croatia	3799	18698	71035222
Cyprus	-	28704	-
Czech Republic	20458	19764	404325775
Denmark	8561	66768	571596568
Estonia	2503	20908	52332474
Finland	4183	52647	220222401
France	-	55980	-
Germany	114226	55958	6391869931
Greece	-	26042	-
Hungary	-	16198	-
Ireland	5925	50096	296818800
Italy	-	44133	-
Latvia	5982	14515	86829926
Lithuania	7019	13992	98209848
Luxembourg	-	66665	-
Malta	-	27062	-
Netherlands	19252	61144	1177136587
Poland	46634	15839	738635926
Portugal	12034	23688	285061392
Romania	2240	11655	26107200
Slovakia	-	18926	-
Slovenia	-	28968	-
Spain	14062	36443	512458654
Sweden	13707	64076	878288361
UK	123874	48650	6026482487
Total (EU-28) without gap-filling			21282064361
Total (EU-28) with gap-filling			30754628390

Source: Noise country fact sheets (EEA 2018d), EC (2014b) and COWI calculations.
Note: The table illustrates the total number of DALYs lost due to noise pollution from both road, rail, air and industry in the Member States.

Table 2-16 above shows the estimated implementation gap cost of noise pollution in 2017. It shows that by taking outset in the WHO (1999) recommended noise exposure limits our estimate of the **central 'policy target' implementation gap cost estimate of EUR 30.7 bn per year** (2017 estimate) shows high costs from noise pollution. It must though be stressed that the estimation is subject to high uncertainty due to limited data on health costs for all Member States. We thus acknowledge that this estimate is connected with much uncertainty and so it may be more suitable to provide a range estimate. Hence, our best estimate is that the **cost of excessive noise pollution in the EU is in the range[12] of EUR 24.6-36.8 bn per year**.

2.5 Lessons learnt and recommendations

Air

A main challenge when estimating the implementation gap costs for the air policy area is that we have two Directives – the AAQ Directive and the NEC Directive – that both provide well-specified environmental targets, and thus provide for actions to achieve these targets. Hence, while this allows for the estimation of two types of implementation gaps, it is not straightforward to assess the extent to which the impacts of the two estimated implementation gaps overlap. We have, hereunder by acknowledging that health impacts are the most important ones, based the cost estimates on the implementation gap estimates for the AAQ Directive – i.e. the urban population that are exposed above the air pollution concentration values. In any case, the two implementation gap cost estimates for the AAQ Directive and the NEC Directive differ in magnitude and seem not fully comparable.

Hence, our recommendation is that a possible update of this study in the future should better deal with how the two Directives complement – as well as overlap – each other in the fight against air pollution. This should also be seen in the light of the stricter NEC Directive reduction commitments in the coming years.

Noise

The total implementation gap cost estimate – which does not include the costs of not achieving the WHO recommendations – would be significantly higher if this was the case. Hence, it would be beneficial to a future analysis of implementation gap costs if the EU decides on legislate noise exposure limits – being the WHO recommendations or other more/less strict limits.

Another challenge is that the WHO very recently has recommended stricter noise exposure limits than before. This implies in itself a lack of noise monitoring data that refer to the new limits. Therefore, any cost estimate updates using the WHO 'policy targets' in the near future will be even more complicated than in this study.

3. Nature and biodiversity

3.1 EU environmental policy and law

The EU environmental policy[13] recognises the importance of nature and biodiversity for food production, air, water, energy and raw materials. Furthermore, healthy ecosystems provide social benefits such as recreational services and they can contribute to adapting to climate change. At the same time, the EU recognises that the ecosystems are under pressure from urban sprawl, intensive agriculture, pollution, invasive species and climate change.

The Habitats and Birds Directives form the backbone of the EU nature and biodiversity policy and the legal basis for the EU nature protection network that has the aim to halt the loss of biodiversity and ecosystem services. As briefly described in Table 3-1, both

[12] +/- 20% of the central estimate.
[13] See http://ec.europa.eu/environment/nature/index_en.htm for a comprehensive presentation.

Directives provide prohibitions and permits that help to avoid adverse developments for a wide range of rare, threatened or endemic animal, bird and plant species. In this context, the legislation provides for the Natura 2000 ecological network of protected area that stretches across all Member States and that currently[14] covers over 18% of the EU's land area and 6% of its sea territories. The Natura 2000 network also encourages cooperation and makes sure that protection measures can be tailored to suit specific regional needs.

In addition to these two key pieces of EU nature and biodiversity legislation, as shown in Annex 2, conservation and protection also takes place via Regulation (EU) No 1143/2014 that aims to prevent and manage the introduction and spread of invasive alien species. There is also legislation that focuses on biodiversity services – i.e. on the sustainable use of natural resources via prohibiting the use of leghold traps, in relation to keeping wild animals in zoos, and regarding access to genetic resources. Furthermore, there is legislation that focuses on trade in nature products, that also concerns a sustainable use of natural resources such as seals and timber.

Finally, other EU actions guided by the EU biodiversity strategy (EC, 2011) contributes to halting the loss of biodiversity and ecosystem services (see also Table 3-3 below).

Table 3-1 Key EU environmental law – nature and biodiversity

Directives and Regulations	Brief characteristic
Habitats Directive 92/43/EEC	With outset in the aim to halt the loss of biodiversity and ecosystem services, it focuses on the conservation of a wide range of rare, threatened or endemic animal and plant species. It does so by providing for prohibitions and permits. Furthermore, it establishes the EU-wide Nature 2000 ecological network of protected areas, safeguarded against potentially damaging developments.
Birds Directive 2009/147/EC	With outset in the assessment[15] that at least 32% of the more than 500 wild bird species in the EU are currently not in a good conservation status, it aims to protect all 500 species. Similar to the Habitats Directive, it does so by providing for prohibitions. Furthermore, it establishes a network of Special Protection Areas (SPAs) including all the most suitable territories for these species. All SPAs are included in the Natura 2000 ecological network.

Sources: Annex 2 and COWI/Eunomia.

3.2 Environmental target

As just described, the overall objective of the Habitats and Birds Directives is to halt the loss of biodiversity and ecosystem services. Actually, it is not just about halting further decline or loss but to ensure that species and habitats recover sufficiently to enable them to flourish over the long term. A central source of information for analysing the status and trends of the protected species and habitat types is the official reporting by Member States in fulfilment of the requirements of Article 17 of the Habitats Directive and Article 12 of the Birds Directive. The most comprehensive and recent assessment, 'the State of Nature in the EU', covers the period 2007-2012 and was published in May 2015 (EEA, 2015).

However, as also emphasised by the 2016 fitness check of the Habitats and Birds Directives (EC, 2016b), the assessment of whether this overall objective has been achieved or not is limited by the fact that there is no clear baseline against which to estimate how the status of flora and fauna might have developed in the absence of EU

[14] See footnote 13.
[15] http://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm

action. Hence, we acknowledge that the implementation of the Directives has taken place at a time of accelerating rates of urbanization, changing demographic and diet patterns, technological changes, deepened market integration, and climate change, all of which place unprecedented demands on land.

This said, the fitness check points to that the overall objective has not yet been met and that it is not possible to predict when it will be fully achieved. However, the fitness check provides evidence of changes that logically can be attributed to the interventions of the Directives. Hence, it concludes that developments would have been significantly worse in the absence of the targeted interventions.

As part of this study, we also looked into the possibility of analysing the achievement of the specific objectives of the Directives, presented in Table 3-2, to inform about the achievement of the overall objective. However, when trying to do this we acknowledge that these specific objectives do not have very specific[16] formulations and in consequence they do not provide measurable targets. Hence, it is not straightforward to assess whether there is an implementation gap or not.

Table 3-2 Specific objectives and provisions of the Habitats and Birds Directives – and indicators for assessment of specific objective achievement

Specific objectives	Main Directive provisions	Indicators
A. Ensure that the most valuable sites are managed and protected and form a coherent whole	Habitats Directive: Articles 3, 4(1), 4(4) and 6 Birds Directive: Articles 4(1) and 4(2)	A1. Establishment of Natura 2000 Sites of Community Importance (SCI) and Special Protection Areas (SPA) A2. Designation of Special Areas of Conservation (SACs) A3. Establishment of the necessary conservation measures for each Natura 2000 sits and implement them A4. Avoidance of deterioration of habitats and of disturbance of species A5. Appropriate assessments of plans/projects to avoid negative impact on sites
B. Manage/restore habitats/landscape features beyond Natura 2000	Habitats Directive: Articles 3(3) and 10 Birds Directive: Articles 3(2) and 4(4)	B1. Management of landscape features outside Natura 2000 B2. Management/restoration of habitats outside Natura 2000
C. Ensure protection and sustainable use of species	Habitats Directive: Article 12 Birds Directive: Articles 5 and 7	C1. Establishment of systems of species protection C2. Regulation of hunting and trade C3. Control of species introduction
D. Ensure adequate knowledge, data availability and awareness	Habitats Directive: Article 17 Birds Directive: Article 12	D1. Monitoring and reporting of species and habitats D2. Undertaking of research on species and habitats D3. Awareness raising on species and habitats

Sources: Habitats and Birds Directives and EC (2016b) fitness check.

[16] See e.g. Better Regulation Tool #16 for guidelines to S.M.A.R.T objective formulations – with S = Specific, https://ec.europa.eu/info/sites/info/files/file_import/better-regulation-toolbox-16_en_0.pdf

Table 3-3 EU biodiversity strategy targets

Target	Measurement
Target 1: Fully implement the Birds and Habitats Directives	To halt the deterioration in the status of all species and habitats covered by EU nature legislation and achieve a significant and measurable improvement in their status so that, by 2020, compared to current assessments: (i) 100% more habitat assessments and 50% more species assessments under the Habitats Directive show an improved conservation status; and (ii) 50% more species assessments under the Birds Directive show a secure or improved status.
Target 2: Maintain and restore ecosystems and their services	By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems.
Target 3: Increase in the contribution of agriculture and forestry to maintaining and enhancing biodiversity	3A) Agriculture: By 2020, maximise areas under agriculture across grasslands, arable land and permanent crops that are covered by biodiversity-related measures under the CAP so as to ensure the conservation of biodiversity and to bring about a measurable improvement(*) in the conservation status of species and habitats that depend on or are affected by agriculture and in the provision of ecosystem services as compared to the EU2010 Baseline, thus contributing to enhance sustainable management. 3B) Forests: By 2020, Forest Management Plans or equivalent instruments, in line with Sustainable Forest Management (SFM), are in place for all forests that are publicly owned and for forest holdings above a certain size** (to be defined by the Member States or regions and communicated in their Rural Development Programmes) that receive funding under the EU Rural Development Policy so as to bring about a measurable improvement(*) in the conservation status of species and habitats that depend on or are affected by forestry and in the provision of related ecosystem services as compared to the EU 2010 Baseline. (*) For both targets, improvement is to be measured against the quantified enhancement targets for the conservation status of species and habitats of EU interest in Target 1 and the restoration of degraded ecosystems under target 2. (**) For smaller forest holdings, Member States may provide additional incentives to encourage the adoption of Management Plans or equivalent instruments that are in line with SFM.
Target 4: Ensure the sustainable use of fisheries resources	Achieve Maximum Sustainable Yield (MSY) by 2015. Achieve a population age and size distribution indicative of a healthy stock, through fisheries management with no significant adverse impacts on other stocks, species and ecosystems, in support of achieving Good Environmental Status by 2020, as required under the Marine Strategy Framework Directive.
Target 5: Combat invasive alien species	By 2020, Invasive Alien Species (IAS) and their pathways are identified and prioritised, priority species are controlled or eradicated, and pathways are managed to prevent the introduction and establishment of new IAS.
Target 6: Help avert global biodiversity loss	By 2020, the EU has stepped up its contribution to averting global biodiversity loss.

Source: EC (2011).

Finally, as mentioned in Section 3.1, in line with the Habitats and Birds Directives the EU biodiversity strategy (EC, 2011) has as its headline target to halt the loss of biodiversity and the degradation of ecosystem services in the EU (by 2020), and restore them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss. Actually, it provides, as shown in Table 3-3, its own operational targets – where the first target is similar to the one we focus on when assessing the implementation gap in Section 3.3. Hence, we do not go into detail with assessing the achievements of Targets 2 to 6 in the next section – although we briefly describe the findings of the EC (2015) mid-term review of the EU biodiversity strategy.

3.3 Implementation gap

The lack of a measurable environmental target for nature and biodiversity implies that it is not feasible to measure an implementation gap. This was also the case when carrying out the 2011 study.

Similarly, as shown in Table 3-4, the mid-term review of the EU biodiversity strategy does not provide concrete measurements of how far the EU is from achieving the six targets, but merely provides statements of whether any progress made towards achieving the targets is considered sufficient or not.

Table 3-4 Achievement of EU biodiversity strategy – Mid-term review

Target	Achievement
Target 1: Fully implement the Birds and Habitats Directives	Progress has been made as the number of species and habitats covered by the Directives in secure/favourable or improved conservation status has increased slightly since the 2010 baseline. However, many habitats and species that were already in unfavourable status remain so, and some are deteriorating further. Member States have progressed at different rates in developing and implementing action plans for species and Natura 2000 site management plans.
Target 2: Maintain and restore ecosystems and their services	Insufficient progress has been made by 2015 as actions have not yet halted the trend of degradation of ecosystems and services. Hence, national and regional frameworks to promote restoration and green infrastructure need to be developed and implemented.
Target 3: Increase in the contribution of agriculture and forestry to maintaining and enhancing biodiversity	No significant progress has been made. The continuing decline in the status of species and habitats of EU importance associated with agriculture indicates that greater efforts need to be made to conserve and enhance biodiversity in these areas. EU forest area has increased as compared with the EU 2010 biodiversity baseline. However, the conservation status of forest habitats and species covered by EU nature legislation shows no significant signs of improvement.
Target 4: Ensure the sustainable use of fisheries resources	Progress towards the target but at an insufficient rate. Although significant progress has been made in setting the policy framework for sustainable fisheries. However, policy implementation has been uneven across the EU and major challenges remain to ensure that the objectives are achieved to schedule: just over 50% of MSY-assessed (Maximum Sustainable Yield) stocks were fished sustainably in 2013.
Target 5: Combat invasive alien species	Implementation of Regulation (EU) No 1143/2014 is currently on track. However, invasive alien species are a fast-growing threat to biodiversity.
Target 6: Help avert global biodiversity loss	Insufficient progress with respect to the impacts of EU consumption patterns on global biodiversity. However, the EU remains by far the largest financial donor.

Source: EC (2015a).

3.4 Implementation gap cost

The lack of a good implementation gap measurements obviously implies as a consequence a lack of a good implementation gap cost measure. This was also the case at the time of the 2011 study.

However, we have chosen – similarly to the 2011 study – to make a very rough estimate of the costs of not having fully implemented the Habitats and Birds Directives. Actually, we have not identified more recent studies than ten Brink et al

(2008) which was also used by the 2011 study. Hence, our implementation gap cost estimate takes in its estimate that the Natura 2000 network provides EUR 200-300 bn per year in benefits, and that around 5% could be seen as the annual rate of loss, i.e. the costs of deterioration of ecosystem. In other words, we make the crude assumption that an achievement of the overall Habitats and Birds Directives would avoid this loss of biodiversity – i.e. the implementation gap costs would be EUR 10-15 bn per year (in 2008 prices) – i.e. 5% of EUR 200-300 bn. In 2018 prices, the estimate would amount to **EUR 10.5-15.7 bn per year, and so a central estimate of EUR 13.1 bn per year**.

The size and uncertainty of our implementation gap cost estimate (guestimate) can also be put into perspective by comparing it with the recent estimates provided as part of the EC (2016b) fitness check. It provides the benefit estimate for Natura 2000 that a 1% reduction of the ecosystem services flowing from the Directives would lead to losses of EUR 2-3 bn per year. Hence, if the 2016 level of non-implementation implies a reduction of 5-8% in ecosystem services the two costs estimates are similar.

3.5 Lessons learnt and recommendations

There are several lessons to be learnt from our attempt to estimate implementation gap costs for the nature and biodiversity policy area. Firstly, assessing the achievement of the environmental target to halt the loss of biodiversity and ecosystem services is limited by the fact that there is no clear baseline against which to estimate how the status of flora and fauna might have developed in the absence of EU action. Hence, from this perspective any implementation gap cost estimate will be connected with much uncertainty. Secondly, the more specific objectives of the Habitats and Birds Directives do not have measurable targets. Hence, it is not straightforward to assess whether there is an implementation gap or not from this perspective. Thirdly, there is in general a lack of reliable quantitative estimates of the costs of biodiversity loses.

Our recommendation is that efforts are made to encourage that stakeholders accept that any estimates are uncertain. However, at the same time we recommend that further work is done to quantify the value of nature and biodiversity. The alternative of leaving the policy area out of the total implementation gap cost estimate is not appealing as it would distort the picture and come to omit one important element of environmental policy.

4. Water

4.1 EU environmental policy and law

The landscape of EU water policy has only changed slightly since the preceding 2011 study on the cost of non-implementation. There is no new legislation, but existing legislation has been subject to changes. The Drinking Water Directive (DWD) was amended in 2015, which resulted in a change in the monitoring and sampling frequency as well as in a change in the assessment methods (Directive 2015/1787/EC). These changes have however no implication on the environmental gap. As of today, the DWD has reached a level of nearly full compliance in all Member States and the gap is therefore close to non-existent (EC, 2016d); consequently, the gap is not assessed in this study. Furthermore, the Marine Strategy Framework Directive (MSFD) had its first deadline on the reporting of the environmental gap in 2012 (Directive 2008/56/EC). As elaborated in Annex 2 of this study, the 2012 reporting resulted in highly inconsistent assessments. The existing gap is therefore unclear. Consequently, this study does not include an assessment of the gap on the MSFD as the knowledge base is currently too weak.

4.2 Environmental target

The European water policy is extensive and addresses various types of waters (e.g. coastal water and groundwater) and different attributes of water (e.g. chemical quality and organic pollution). Most of the directives feed into the Water Framework Directive (WFD), which acts an umbrella directive to many of the European water Directives. Further, a significant part of the gap under the WFD can be traced back to gaps in other specific water directives. Assessing the gap under the WFD can thus be argued to capture gaps of related specific directives. This excludes the Drinking Water Directive (DWD) and the Marine Strategy Framework Directive (MSFD) as they do not impact the environmental objectives of the WFD. Annex 2 to this report provides a more detailed assessment on the relationship between the WFD and the individual directives.

The 2011 study on the cost of non-implementation took this approach and provided a cost estimate of the gap of EU water legislation expressed in terms of the gap on the ecological status under the WFD as a representation of the value of good water quality. This study calculates the same value, which can be compared to the 2011 study, but further adds the implementation gap costs that cannot be attributed to the WFD. This study hence provides an update of the estimate provided in the 2011 study, but also provides additional investigations of the implementation gap cost for each of the specific directives. The resulting totals are a value comparable with the 2011 study and a total value of all directives that accounts for double counting.

The assessed directives are the Bathing Water Directive (BWD), Environmental Quality Standards Directive (EQSD), Floods Directive (FD), Groundwater Directive (GWD), Nitrates Directive (ND), Urban Wastewater Treatment Directive (UWWTD), and WFD.

Water Framework Directive – Ecological Status

The WFD sets environmental targets on the ecological status of surface waterbodies (SWB), on the chemical status of SWBs and groundwater bodies (GWB), and on the quantitative status of GWBs (Directive 2000/60/EC). This study assesses the environmental gap of the chemical status as part of the EQSD and GWD. The quantitative status of GWBs is only partly assessed quantitatively. This is because the impact of the status on the environment is difficult to determine, as the impacts are specific to the geography and to the specific aquifer. There is a need to assess the gap on the ecological status on its own to obtain a comprehensive picture of the cost of the gap for water policy, as the ecological status of SWBs is partially determined by action under other directives (e.g. the UWWTD, which is a 'basic measure' under the WFD).

In terms of the ecological status of SWBs, Article 4 of the WFD sets environmental objectives on the ecological status that need to be fulfilled by 2021. All surface waters need to achieve a 'good' ecological status. The point of departure to measure the status is the extent to which anthropogenic activities lead to a deviation of the undisturbed state of SWBs (referred to as a reference state). Depending on the degree of the deviation from the reference state, the status can be 'high', 'good', 'moderate', 'poor', or 'bad'. The Directive defines each status category in normative terms for a range of parameters, i.e. so-called biological quality elements, that need to be used to describe the ecological status. The number of biological quality elements required vary by water category and represent the status of benthic fauna, fish fauna, flora, and phytoplankton. The categorisation of the status builds on an 'one-out all-out' approach in which the lowest categorisation of the individual quality elements determines the overall ecological status. The table below shows an example of the description of the biological quality elements that apply to rivers.

The WFD enables an extension of the compliance deadline (Article 4.4). It also has a provision to assign a reduced environmental target provided that it is infeasible or disproportionately expensive to achieve a 'good' status (Article 4.5). Based on such an exemption, a waterbody can be considered as compliant although it does not correspond to a 'good' status. This option is not considered owing to limitedly available data.[17] This has the implication that there is a risk of overestimating the implementation gap.

Table 4-1 Normative description of the environmental target on the ecological status of rivers under Directive 2000/60/EC establishing a framework for the Community action in the field of water policy (Water Framework Directive)

Element	Description of 'good'
Phytoplankton	There are slight changes in the composition and abundance of planktonic taxa compared to the type-specific communities. Such changes do not indicate any accelerated growth of algae resulting in undesirable disturbances to the balance of organisms present in the water body or to the physio-chemical quality of the water or sediment. A slight increase in the frequency and intensity of the type-specific planktonic blooms may occur.
Macrophytes and phytobenthos	There are slight changes in the composition and abundance of macrophytic and phytobenthic taxa compared to the type-specific communities. Such changes do not indicate any accelerated growth of phytobenthos or higher forms of plant life resulting in undesirable disturbances to the balance of organisms present in the water body or to the physio-chemical quality of the water or sediment. The phytobenthic community is not adversely affected by bacterial tufts and coats present due to anthropogenic activity.
Benthic invertebrate fauna	There are slight changes in the composition and abundance of invertebrate taxa from the type-specific communities. The ratio of disturbance-sensitive taxa to insensitive taxa shows slight alteration from type-specific levels. The level of diversity of invertebrate taxa shows slight signs of alteration from type-specific levels.
Fish fauna	There are slight changes in species composition and abundance from the type-specific communities attributable to anthropogenic impacts on physicochemical and hydromorphological quality elements. The age structures of the fish communities show signs of disturbance attributable to anthropogenic impacts on physico-chemical or hydromorphological quality elements, and, in a few instances, are indicative of a failure in the reproduction or development of a particular species, to the extent that some age classes may be missing.

Source: Directive 2000/60/EC establishing a framework for the Community action in the field of water policy (WFD)

The resulting waterbodies (number and size) that are subject to the environmental target of 'good' ecological status is shown in the table below by each surface water category. In contrast to the case of the EQSD below, there is no environmental target for territorial waters. On the EU-28 level, there are about 110,000 SWBs with an environmental target on the ecological status. Of those, about 97% of the waterbodies are freshwater.

[17] The EEA's WISE database provides the specific waterbodies with an exemption/reduced environmental objective. There are however some challenges regarding the interpretation of the data in the database, which will be clarified for the next report version.

Table 4-2 Environmental target of the Water Framework Directive on ecological status

	River		Lake		Transitional		Coastal	
Member State	Number	Length (km)	Number	Area (km²)	Number	Area (km²)	Number	Area (km²)
Austria	8065	32278	62	522	-	-	-	-
Belgium	527	9346	18	40	6	43	2	130
Bulgaria	873	44082	37	116	28	140	17	1464
Croatia	1484	19074	37	166	25	150	26	13747
Cyprus	174	1809	8	20	-	-	22	869
Czech Republic	1044	18142	77	275	-	-	-	-
Denmark	7776	18898	856	477	-	-	119	20325
Estonia	645	11624	89	1978	-	-	16	14518
Finland	1913	35753	4617	28826	-	-	276	32507
France	10706	243312	435	1973	94	2956	179	27864
Germany	8998	137160	730	2415	5	835	75	22929
Greece	not available							
Hungary	963	19313	115	1017	-	-	-	-
Ireland	not available							
Italy	7493	81050	347	1658	172	1273	561	17012
Latvia	203	8331	259	807	3	935	5	1349
Lithuania	not available							
Luxembourg	110	1214	-	-	-	-	-	-
Malta	3	3	2	0	5	0	9	399
Netherlands	246	4927	451	3055	5	717	9	4095
Poland	4586	111510	1044	2297	9	1937	10	666
Portugal	1899	26299	23	9	52	835	66	17129
Romania	2891	75486	130	1009	2	383	4	252
Slovakia	1510	17843	-	-	-	-	-	-
Slovenia	137	4743	12	32	-	-	5	91
Spain	4390	83455	326	1169	186	985	220	17725
Sweden	15092	80282	7422	32025	-	-	653	33685
United Kingdom	7506	86539	1068	1894	190	3465	561	63419
EU-27	**81728**	**1085934**	**17097**	**79886**	**592**	**11189**	**2274**	**226756**
EU-28	**89234**	**1172473**	**18165**	**81780**	**782**	**14654**	**2835**	**290175**

Note: '-' denotes that the target is not applicable; No data is reported on Greece, Ireland, and Lithuania – neither for the 1st RBMP nor the 2nd RBMP.
Source: EEA (2018d), WISE Water Framework Directive (data viewer)

Water Framework Directive – Quantitative Status

In terms of the quantitative status of GWBs, Article 4 of the WFD sets an environmental objective on the quantitative status that needs to be fulfilled by 2021. All GWBs must have a 'good' quantitative status. As with the ecological status, the Directive defines 'good' in normative terms, which are presented in the table below.

The possibility for an extension of the compliance deadline (Article 4.4) and a reduced environmental target (Article 4.5) applies here as well. Again, this option is however not considered in this study due to limited available data, which entails a risk of overestimating the gap.

Table 4-3 Normative description of the environmental target on the quantitative status of groundwater bodies under Directive 2000/60/EC establishing a framework for the Community action in the field of water policy (Water Framework Directive)

Description of 'good'
The level of groundwater in the groundwater body is such that the available groundwater resource is not exceeded by the long-term annual average rate of abstraction.
Accordingly, the level of groundwater is not subject to anthropogenic alterations such as would result in: - failure to achieve the environmental objectives specified under Article 4 for associated surface waters, - any significant diminution in the status of such waters, - any significant damage to terrestrial ecosystems which depend directly on the groundwater body,
and alterations to flow direction resulting from level changes may occur temporarily, or continuously in a spatially limited area, but such reversals do not cause saltwater or other intrusion, and do not indicate a sustained and clearly identified anthropogenically induced trend in flow direction likely to result in such intrusions.

Source: Directive 2000/60/EC establishing a framework for the Community action in the field of water policy (WFD)

The table below presents the number and the area of GWBs that are subject to an environmental target for the quantitative status. There are nearly 13,500 GWBs on the EU-28 level with a total geographical extent of 1.2 million km².

Table 4-4 Environmental target of the Water Framework Directive on quantitative status

Member State	Number	Area (km²)
Austria	138	27419
Belgium	80	19640
Bulgaria	169	28400
Croatia	33	8089
Cyprus	21	998
Czech Republic	174	45601
Denmark	402	34639
Estonia	39	2758
Finland	3773	9930
France	645	140733
Germany	1177	274104
Greece	not available	
Hungary	185	51462
Ireland	not available	
Italy	1052	134692
Latvia	22	2539
Lithuania	not available	
Luxembourg	6	2895
Malta	15	357
Netherlands	23	4779
Poland	178	30861
Portugal	151	19246
Romania	143	25636
Slovakia	102	27589
Slovenia	21	7024
Spain	761	163245
Sweden	3311	30658
United Kingdom	790	126112
EU-27	**12621**	**1093294**
EU-28	**13411**	**1219406**

Note: '-' denotes that the target is not applicable; No data is reported on Greece, Ireland, and Lithuania – neither for the 1st RBMP nor the 2nd RBMP.
Source: EEA (2018d), WISE Water Framework Directive (data viewer)

Environmental Quality Standards Directive

The EQSD sets thresholds for chemical substances in surface waters to achieve a 'good' chemical status in all SWBs by 2021 (Directive 2008/105/EC). The EQSD essentially defines specific targets for chemical substances in SWBs which translate into threshold values for the chemical status under the WFD.

The EQSD defines targets for 33 chemical substances. These targets are defined for inland surface waters (i.e. lakes and rivers) and other surface waters (i.e. transitional coastal waters). The targets are further defined as an annual average and a maximum allowable concentration. The types of substances listed includes chlorinated hydrocarbons such as pesticides (e.g. DDT), polycyclic aromatic hydrocarbons (e.g. Benzopyrene), herbicides, and heavy metals (e.g. lead and mercury).

The threshold levels of each substance define the minimum quality standards that a SWB must fulfil. The Directive applies, as under WFD, an 'all-in, all-out' approach, in which the exceedance of one substance leads to a 'poor' chemical status. The implementation reporting on the environmental status occurs under the WISE reporting framework under the WFD (EEA, 2018d). The reporting does not provide the measured levels of each substance but provides the overall environmental gap of each substance on a Member State level.

The table below presents the number of SWBs that are subject to an environmental target under the EQSD, including the total length and area of waterbodies. On the EU-28 level, there are about 110,000 waterbodies with an environmental target. These are composed of all SWBs, and therefore consists of rivers, lakes, transitional waters, coastal waters, and territorial waters. Note that there is no reported data available on Greece, Ireland and Lithuania.

Table 4-5 Environmental target of the Environmental Quality Standards Directive, as measured by the number, length, and area of SWBs that need to achieve a 'good' chemical status by 2021

Member State	Number	Length (km)	Area (km²)
Austria	8127	32278	522
Belgium	554	9346	1517
Bulgaria	955	44082	1720
Croatia	1572	19074	14063
Cyprus	204	1809	889
Czech Republic	1121	18142	275
Denmark	8765	18898	44195
Estonia	752	11624	27120
Finland	6806	35753	61333
France	11414	243312	32793
Germany	9808	137160	26179
Greece		not available	
Hungary	1078	19313	1017
Ireland		not available	
Italy	8581	81050	145495
Latvia	470	8331	3091
Lithuania		not available	
Luxembourg	110	1214	-
Malta	19	3	399
Netherlands	711	4927	7866
Poland	5649	111510	4901
Portugal	2040	26299	17974
Romania	3028	75486	6086
Slovakia	1510	17843	-
Slovenia	155	4743	435
Spain	5162	83455	24426
Sweden	23186	80282	113831
United Kingdom	9328	86539	68806
EU-27	**101777**	**1085934**	**536127**
EU-28	**111105**	**1172473**	**604933**

Note: '-' denotes that the target is not applicable; No data is reported on Greece, Ireland, and Lithuania – neither for the 1st RBMP nor the 2nd RBMP.

Source: EEA (2018d), WISE Water Framework Directive (data viewer)

Groundwater Directive

The GWD sets chemical standards to GWBs in a way similar to the EQSD above (Directive 2006/118/EC). As such, the Directive has the environmental target to achieve a 'good' chemical status of all GWBs by 2021.

Similar to the EQSD, the GWD defines targets for a range of chemical substances. The constellation of substances is however individual to each GWB. All GWBs must comply with a threshold of nitrates and pesticides and a minimum set of chemical substances. Further, Article 3 of the Directive requires the inclusion of any substance that puts

GWBs at risk of not delivering a 'good' chemical status. Furthermore, only nitrates and pesticide have a prescribed threshold level, whereas the threshold of the remaining substances must be set in accordance with a 'good' chemical status. 'Good' is in turn defined individually for each GWB, based on the impact and interrelationship of the specific substances vis-à-vis the environment. The corresponding threshold values must therefore be established by the Member States at the appropriate scale (i.e. national level, river basin, or water body) using procedures in accordance with Annex II of the Directive. The table below presents the substances that must be included for all GWBs.

Table 4-6 Substances that must be included for all groundwater bodies as part of the environmental target under Directive 2006/118/EC on the protection of groundwater against pollution and deterioration (Groundwater Directive), as listed in Annex I and II.

Substance	Substance (continued)
Annex I – Threshold values established by the European Union, with thresholds in brackets	
Nitrates (50 mg/l)	Pesticides (0.5 µg/l)
Annex II – Threshold values that must be established by Member States	
Ammonium	Nitrites
Arsenic	Phosphorus/Phosphates
Cadmium	Salinity
Chloride	Sulphate
Lead	Trichloroethylene
Mercury	Tetrachloroethylene

Source: Directive 2006/118/EC

As for the EQSD, the threshold levels of each substance define the minimum quality standards that a GWB must comply with. Again, the 'one-out all-out' principle applies. The implementation reporting on the environmental status occurs under the WISE reporting framework under the WFD (EEA, 2018d). The table below presents the number of GWBs that are subject to an environmental target, which amounts to a total of about 13,500 waterbodies on the EU level.

Table 4-7 Environmental target of the Groundwater Directive, as measured by the number and area of groundwater bodies that need to achieve a 'good' chemical status by 2021

Member State	Number	Area (km²)
Austria	138	96032
Belgium	80	66434
Bulgaria	169	158602
Croatia	33	55802
Cyprus	21	5984
Czech Republic	174	88080
Denmark	402	69701
Estonia	39	113028
Finland	3773	9969
France	645	1235075
Germany	1177	368382
Greece	not available	
Hungary	185	279641
Ireland	not available	
Italy	1052	269190
Latvia	22	76211
Lithuania	not available	
Luxembourg	6	2896
Malta	15	357
Netherlands	23	39974
Poland	178	311978
Portugal	151	93727
Romania	143	267804
Slovakia	102	77410
Slovenia	21	20294
Spain	761	361531
Sweden	3311	40438
United Kingdom	790	229912
EU-27	**12621**	**4108540**
EU-28	**13411**	**4338451**

Note: No data is reported on Greece, Ireland, and Lithuania – neither for the 1st RBMP nor the 2nd RBMP.
Source: EEA (2018d), WISE Water Framework Directive (data viewer)

Floods Directive

The FD has the purpose of "establishing a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community" (Article 1, Directive 2007/60/EC). To achieve this purpose, the Directive has two primary provisions: The preparation of flood hazard maps and flood risk maps (Article 6) and the establishment of Flood Risk Management Plans (Article 7). The Directive follows a principle of prevention, protection, and preparedness. The FD establishes therefore no specific environmental target as such, but instead seeks to minimise the possibly adverse consequences floods may have on humans and/or the environment. The incorrect or incomplete implementation of the main provisions may lead to insufficient flood protection and consequently result in damages from floods that could otherwise have been avoided. Insufficient flood protection can thus be traced back to insufficient implementation. Hence, it is relevant to assess potential implementation gaps. For the purposes of this study, the environmental target of the FD is therefore defined as a complete preparation of flood hazard maps and flood risk maps (Article 6) and the establishment of Flood Risk Management Plans (Article 7).

Nitrates Directive

The ND requires Member States to identify waters that could be subject to nitrate pollution (Article 3.1) and to implement an action programme for such waters to address nitrate pollution (Article 5). Waters subject to nitrate pollution are defined by the following environmental targets: i) surface freshwaters exceeding the maximum nitrates concentration of the DWD, which is currently set at 50 mg/l (Directive 91/676/EEC; Directive 98/83/EC); ii) groundwaters exceeding a maximum nitrates concentration of 50 mg/l; and iii) freshwaters or marine waters with a eutrophic state.

The Directive has a reporting obligation on the three thresholds above. More specifically, Member States have established a monitoring network in relevant waters to measure the environmental status on the three indicators mentioned above. The environmental target is thus that the measurements of monitoring stations may not exceed the above thresholds. The reporting on the eutrophication state is not consistent across Member States: Some do report, but in a deviating format, and some do not report any data. An indicator on eutrophication is therefore not included in this study.

The table below shows the number of monitoring stations in groundwaters and freshwaters respectively - across Member States - that should not exceed a nitrate concentration of 50 mg/l.

Table 4-8 Environmental target of the Nitrates Directive, as measured by the number of monitoring stations in 2012-2015 that should not exceed a nitrate concentration of 50 mg/l

Member State	Groundwater (number of stations)	Freshwater (number of stations)
Austria	1965	108
Belgium	2937	835
Bulgaria	406	318
Croatia	126	64
Cyprus	230	13
Czech Republic	621	1917
Denmark	1201	177
Estonia	385	324
Finland	187	167
France	2598	3390
Germany	697	241
Greece	1078	479
Hungary	1756	530
Ireland	5035	3154
Italy	205	254
Latvia	199	222
Lithuania	65	320
Luxembourg	20	16
Malta	41	5
Netherlands	1318	850
Poland	1563	2526
Portugal	580	154
Romania	1256	1224
Slovakia	1717	512
Slovenia	198	136
Spain	4132	3903
Sweden	436	2792
United Kingdom	3139	8411
EU-27	**30952**	**24631**
EU-28	**34091**	**33042**

Source: EC (2018a), SWD (2018) 246 final, Table 1 & 2

Bathing Water Directive

The environmental quality of bathing waters is regulated by Directive 2006/7/EC concerning the management of bathing water quality. The BWD sets a classification standard of bathing water quality as measured by the presence of faecal organisms in freshwater and coastal- and transitional waters. Bathing waters can be categorised into 'excellent', 'good', 'sufficient' and 'poor' quality (article 5).

Resulting from these classifications, the directive sets the environmental target that all bathing waters must at least have a 'sufficient' water quality by the end of the bathing season of 2015. The BWD sets a second - but less precise - environmental target that Member States shall take 'realistic' and 'proportionate' measures to increase the number of bathing water with a 'good' or 'excellent' status. With respect to the latter target, no specifically defined target was identified that is relevant to this study. Bathing waters can further be compliant with a 'poor' status – however only on a temporary basis and this does therefore not comprise a compliance with the Directive's environmental target.

The bathing water quality is measured by the presence of intestinal enterococci and Escherichia coli (E. coli). The quality standard is different for freshwaters and coastal- and transitional waters. The table below shows the threshold values for compliance that derive from the classification standard. It should be noted that the classification uses different percentiles to evaluate the quality. Whereas as the 'sufficient' status uses a 90-percentile evaluation, 'good' and 'excellent' use a 95-percentile evaluation. This means that the threshold value in the Directive, i.e. the concentration level, is higher for 'good' than for 'sufficient'. The reporting of the environmental quality is in terms of the four quality standards of the Directive, rather than the concentration levels of each bathing water. This environmental target is therefore assessed by quality levels, rather than the levels of coliforms.

Table 4-9 Threshold that determines compliance with the environmental target of Directive 2006/7/EC concerning the management of bathing water quality (Bathing Water Directive)

Member State	Freshwater	Coastal- and transitional waters	Evaluation	Measurement frequency (sufficient; poor)	Deadline
Intestinal enterococci (cfu/100 ml)	330	185	90-percentile	(3 yrs ; 2 yrs)	End of bathing season 2015
Escherichia coli (cfu/100 ml)	900	500	90-percentile	(3 yrs ; 2 yrs)	End of bathing season 2015

Note: CFU – colony-forming-unit
Source: Directive 2006/7/EC

The environmental target applies to every bathing water that is identified. The number of bathing waters is not fixed and is therefore subject to slight changes over time. Whereas there were 21,344 bathing waters in the EU in 2016, there were 21,509 bathing waters in 2017 (EEA, 2018e). The table below shows the number of bathing waters that need to be compliant with the BWD.

Table 4-10 Environmental target of the Bathing Water Directive, as measured by the number of bathing waters in 2017

Member State	Freshwater	Coastal- and transitional waters	Total
Austria	263	-	263
Belgium	71	42	113
Bulgaria	4	91	95
Croatia	27	949	976
Cyprus	-	113	113
Czech Republic	154	-	154
Denmark	114	915	1029
Estonia	27	27	54
Finland	222	77	299
France	1314	2065	3379
Germany	1921	366	2287
Greece	3	1595	1598
Hungary	257		257
Ireland	9	133	142
Italy	667	4864	5531
Latvia	23	33	56
Lithuania	98	16	114
Luxembourg	12	-	12
Malta	-	87	87
Netherlands	626	93	719
Poland	108	97	205
Portugal	123	480	603
Romania	1	49	50
Slovakia	32	-	32
Slovenia	26	21	47
Spain	259	1960	2219
Sweden	197	244	441
United Kingdom	16	618	634
EU-27	**6558**	**14317**	**20875**
EU-28	**6574**	**14935**	**21509**

Note: '-' denotes that the target is not applicable
Source: EEA (2018e), European Bathing Water Quality in 2017, Annex 2, 3, 4

Urban Wastewater Treatment Directive

The UWWTD sets environmental targets on the discharges of wastewater into the environment (Directive 91/271/EEC). Article 3 requires that specific agglomerations must be provided with collecting systems. Articles 4 and 5 set minimum standards of the organic quality of discharged wastewater, measured by biological oxygen demand (BOD), chemical oxygen demand (COD), and suspended solids (Articles 4 and 5). For areas that are subject to Article 5 due to eutrophication, additional reduction requirements for nitrogen and phosphorus are in place. The table below presents the maximum concentration in the discharge and the minimum percentage reduction of pollution parameters.

Table 4-11 Environmental requirements for discharges from urban waste water treatment plants under Directive 91/271/EEC concerning urban waste-water treatment (Urban Wastewater Treatment Directive)

Articles	Parameters	Concentration	Min. percentage reduction	Reference method of measurement
4 & 5	Biochemical oxygen demand (BOD5 at 20 °C) without nitrification	25 mg/l O2	70-90 40 under Article 4 (2)	Homogenized, unfiltered, undecanted sample. Determination of dissolved oxygen before and after five-day incubation at 20 ° C ± 1 ° C, in complete darkness. Addition of a nitrification inhibitor
4 & 5	Chemical oxygen demand (COD)	125 mg/l O2	75	Homogenized, unfiltered, undecanted sample Potassium dichromate
4 & 5	Total suspended solids	35 mg/l 35 under Article 4 (2) (more than 1 0 000 p.e.) 60 under Article 4 (2) (2 000-10 000 p.e.)	90 90 under Article 4 (2) (more than 1 0 000 p.e.) 70 under Article 4 (2) (2 000-10 000 p.e.)	— Filtering of a representative sample through a 0,45 μm filter membrane. Drying at 105 °C and weighing — Centrifuging of a representative sample (for at least five mins with mean acceleration of 2 800 to 3 200 g), drying at 105 °C and weighing
5	Total phosphorus	2 mg/1 P (10 000 - 100 000 p.e.) 1 mg/1 P (more than 100 000 p.e.)	80	Molecular absorption spectrophotometry
5	Total nitrogen	15 mg/1 N (10 000 - 100 000 p.e.) 10 mg/1 N (more than 100 000 p.e.)	70-80	Molecular absorption spectrophotometry

Source: Directive 91/271/EEC

The target for Member States is expressed as the person equivalent (p.e.) subject to each of the three articles mentioned above. Each Member State has thus an environmental target for articles 3, 4, and 5. As the p.e. load depends on multiple factors, such as population, the p.e. targets are subject to change over time. The environmental target foresees a 100% compliance with the target load. The table below presents thus the latest environmental targets under the UWWTD.

The application and compliance deadline of these three requirements depends primarily on the agglomeration size, as measured in p.e. For most agglomerations in the EU, the compliance deadline has already passed in the mid 2000’s. At the time of the latest publicly available compliance reporting, which reports the status as of 2015 and was published in 2017, some EU13 Member States were still in a transitional period for specific agglomerations.[18] Only a part of the load was thus subject to compliance in the cases of Hungary, Latvia, Poland, Slovenia, and Slovakia (end of transition in 2015), as well as Romania (end of last transition in 2018). The load that

[18] http://ec.europa.eu/environment/water/water-urbanwaste/legislation/pdf/transitional_periods_eu10_eu2.pdf; http://ec.europa.eu/environment/water/water-urbanwaste/legislation/pdf/Transitional%20periods%20Croatia.pdf

is subject to compliance in 2019 can thus be expected to be higher for those countries.

As of 2019, only Croatia has an outstanding compliance deadline at the end of 2023. Romania further had an outstanding compliance deadline that concluded at the end of 2018. In 2015, it was however only Croatia that was in a transitional period for all of its agglomerations. Hence, Croatia was not subject to any environmental target during the most recent status reporting.

The table below presents the best estimate of the environmental target for 2019. The total load subject to Article 3 compliance (i.e. connection to a collection system) in the EU in 2015 amounted to about 590 million p.e. For the target on Article 4 (i.e. secondary treatment), about 560 million p.e. were subject to compliance. At last, a target is in place for a more stringent treatment of 365 million p.e.

Table 4-12 Environmental target of the Urban Wastewater Treatment Directive at the end of 2014, as measured by the p.e. load subject to Articles 3, 4, and 5 of the Directive

Member State	Article 3 (p.e.)	Article 4 (p.e.)	Article 5 (p.e.)
Austria	20408871	20270894	18520071
Belgium	9209400	9188937	8117211
Bulgaria	8085615	6780496	6250420
Croatia		not applicable	
Cyprus	955000	738128	193418
Czech Republic	7701010	7173910	5471877
Denmark	11612545	11332384	10369776
Estonia	1654546	1580586	1466171
Finland	5373100	5323900	4748650
France	71820261	71405542	43612984
Germany	109232961	107081697	97240859
Greece	11790586	10342267	6566970
Hungary	9413601	8567625	210989
Ireland	77422701	71267654	32660186
Italy	5255765	4992977	3468245
Latvia	1318018	1273728	1273728
Lithuania	2652090	2527461	2398107
Luxembourg	606215	601924	449835
Malta	513001	513001	51450
Netherlands	18225775	18196367	17753688
Poland	38536550	34944327	31605359
Portugal	12035660	11042560	2593300
Romania	14438094	7735199	7341991
Slovakia	4489979	3816697	3292980
Slovenia	882485	805521	132052
Spain	61860028	60055487	22271002
Sweden	12523628	12225508	11236474
United Kingdom	70882026	70362966	26732839
EU-27	**518017485**	**489784777**	**339297793**
EU-28	**588899511**	**560147743**	**366030632**

Source: EC (2017), Ninth Report on the implementation status and the programmes for implementation (as required by Article 17) of Council Directive 91/271/EEC concerning urban waste water treatment, Annex V: National Chapters

4.3 Implementation gap

As in the case of the environmental target, the implementation gap on EU water policy is presented separately for each directive.

Water Framework Directive – Ecological Status

The assessment of the implementation gap on the ecological status is informed by the second generation of the RBMPs. The status assessment occurs in a six-year cycle, with the next being due in 2021, and the status thus reflects the situation in 2016, which is the best estimate for 2019. The EEA's recent European water assessment uses for example these data as well (EEA, 2018f). As in the case on the environmental target, the implementation gap is not available for Greece, Ireland, and Lithuania, owing to unreported data for the RBMPs. The table below provides the observed implementation gap, measured by the share of SWBs with a failing ecological status. As many as two-thirds of the number of waterbodies is below a 'good status' and 63% when measured by area/length.

Table 4-13 Implementation gap for the ecological status under the Water Framework Directive as of 2016, defined as ecological status below 'good'

Member State	All types of waterbodies			
	Number of waters	% of number of waters	Area/Length	% of area/length
Austria	4342	53	19547	60
Belgium	408	74	6584	69
Bulgaria	515	54	28756	63
Croatia	910	58	14093	43
Cyprus	85	42	745	28
Czech Republic	906	81	15426	84
Denmark	6281	72	33923	85
Estonia	299	40	21282	76
Finland	1821	27	41104	42
France	6372	56	163527	59
Germany	9010	92	153474	94
Greece	not available			
Hungary	989	92	18150	89
Italy	4990	58	61532	61
Ireland	not available			
Latvia	371	79	9590	84
Lithuania	not available			
Luxembourg	107	97	1191	98
Malta	12	63	33	8
Netherlands	709	100	12782	100
Poland	3884	69	81396	70
Portugal	967	47	19649	44
Romania	1025	34	31415	41
Slovakia	662	44	9788	55
Slovenia	64	42	2064	42
Spain	2293	45	47034	46
Sweden	14631	63	108074	74
United Kingdom	6183	66	77290	50
EU-27	**61653**	**61**	**901159**	**64**
EU-28	**67836**	**66**	**978449**	**63**

Note: '-' denotes that the target is not applicable; No data is reported on Greece, Ireland, and Lithuania – neither for the 1st RBMP nor the 2nd RBMP.
Source: EEA (2018d), WISE Water Framework Directive (data viewer)

Water Framework Directive – Quantitative Status

As for the ecological gap, the gap on the quantitative status is informed by the by the second generation of the RBMPs. Similarly, the status assumes that the situation in 2019 is as it was in 2016, which is the most recent year for which data are available. The table below provides the observed implementation gap, measured by the number, area, and share of GWBs with a failing quantitative status. Compared to the ecological status gap above, the gap is much smaller, with 8% of the number of groundwaters and 13% of the area of groundwaters failing to deliver on the target. There are six Member States with no gap at all.

Table 4-14 Implementation gap for the ecological status under the Water Framework Directive as of 2016, defined as ecological status below 'good'

Member State	Number of waters	% of groundwaters	Area (km²)	% of area
Austria	0	0	0	0
Belgium	8	10	1.163	6
Bulgaria	8	5	735	3
Croatia	1	3	302	4
Cyprus	16	76	826	83
Czech Republic	54	31	8.135	18
Denmark	3	1	469	1
Estonia	1	3	>0	>0
Finland	64	2	441	4
France	66	10	13.014	9
Germany	51	4	9.291	3
Greece	not available			
Hungary	37	20	7.108	14
Ireland	not available			
Italy	410	39	41.322	31
Latvia	0	0	0	0
Lithuania	not available			
Luxembourg	0	0	0	0
Malta	2	13	284	80
Netherlands	0	0	0	0
Poland	13	7	4.531	15
Portugal	4	3	1.428	7
Romania	0	0	0	0
Slovakia	30	29	12.084	44
Slovenia	0	0	0	0
Spain	211	28	34.016	21
Sweden	9	>0	2.250	7
United Kingdom	124	16	26.344	21
EU-27	**988**	**8**	**137.399**	**13**
EU-28	**1.112**	**8**	**163.743**	**13**

Note: '>0' denotes that there is a gap that is greater than zero
Source: EEA (2018d), WISE Water Framework Directive (data viewer), https://www.eea.europa.eu/data-and-maps/dashboards/wise-wfd

Environmental Quality Standards Directive

The last reported chemical status of SWBs was with the provision of the second generation of the RBMPs. The existing implementation gap refers therefore to the status in 2016 and is the best available estimate for 2019, as is the case for the WFD above.

The table below presents the existing implementation gap by the number and share of surface waters, the total river length, and surface area of lakes, coastal waters, transitional waters, and territorial waters. The table shows that about 50,000 SWBs or 46% of the relevant SWBs are not compliant with the target. When measured by length and area, it is about one-third of SWBs that are not compliant. There is no Member State with an implementation gap of zero. Particularly Austria, Germany, Luxembourg, Slovenia, and Sweden are non-compliant on all of their waterbodies. In contrast, 13 MS have a gap below 10% when measured by the number of waterbodies. At last, there is no Member State that is fully compliant.

Table 4-15 Implementation gap under the Environmental Quality Standards Directive as of 2016, defined as 'poor' chemical status

Member State	Surface waterbodies – below 'good' chemical status.			
	Number of waters	% of waters	% of length	% of area
Austria	8127	100	100	100
Belgium	541	98	100	99
Bulgaria	25	3	4	15
Croatia	129	8	9	6
Cyprus	7	3	3	>0
Czech Republic	349	31	35	22
Denmark	62	1	1	10
Estonia	15	2	>0	41
Finland	3440	51	30	16
France	1814	16	16	11
Germany	9808	100	100	100
Greece	not available			
Hungary	84	8	14	13
Italy	733	9	9	3
Ireland	not available			
Latvia	22	5	5	78
Lithuania	not available			
Luxembourg	110	100	100	-
Malta	9	47	0	100
Netherlands	368	52	52	88
Poland	1489	26	32	17
Portugal	27	1	2	21
Romania	69	2	4	0
Slovakia	37	2	3	-
Slovenia	153	99	100	100
Spain	329	6	7	3
Sweden	23185	100	100	100
United Kingdom	187	2	3	2
EU-27	**50932**	**50**	**35**	**36**
EU-28	**51119**	**46**	**33**	**32**

Note: '-' denotes that the target is not applicable; No data is reported on Greece, Ireland, and Lithuania – neither for the 1st RBMP nor the 2nd RBMP.
Source: EEA (2018d), WISE Water Framework Directive (data viewer)

Groundwater Directive

As is the case with the EQSD above, the most recent status assessment is from 2016, when the second RBMPs were submitted. The resulting implementation gap is provided in the table below. The table presents the gap by the number and share of surface waters, as well as the share of the total area. About 2,500 GWBs are not compliant with the target on the EU-28 level, which corresponds to about one-fifth of all GWBs and one-quarter of the total area. There are six Member States with a gap below 10% (of the number of GWBs), and Lithuania is the only Member State with no implementation gap.

Table 4-16 Implementation gap under the Groundwater Directive as of 2016, defined as 'poor' chemical status

Member State	Groundwater bodies – below 'good' chemical status		
	Number of waters	% of waters	% of area
Austria	4	3	2
Belgium	47	59	63
Bulgaria	58	34	45
Croatia	3	9	2
Cyprus	7	33	12
Czech Republic	127	73	63
Denmark	224	56	22
Estonia	8	21	5
Finland	247	7	12
France	199	31	25
Germany	427	36	38
Greece	not available		
Hungary	38	21	17
Ireland	not available		
Italy	446	42	42
Latvia	0	0	0
Lithuania	not available		
Luxembourg	3	50	79
Malta	12	80	97
Netherlands	3	13	4
Poland	14	8	8
Portugal	15	10	3
Romania	15	10	13
Slovakia	38	37	40
Slovenia	3	14	6
Spain	254	33	30
Sweden	76	2	6
United Kingdom	242	31	49
EU-27	**2268**	**18**	**25**
EU-28	**2510**	**19**	**26**

Note: Groundwater bodies with 'unknown' status are classified as non-compliant
Source: EEA (2018d), WISE Water Framework Directive (data viewer); own calculations

Floods Directive

All Member States had to submit final flood hazard and risk maps by the end 2013 (Article 6, Directive 2007/60/EC). As of 2015, all Member States succeeded in submitting such maps.

The FD has two implementation targets, as mentioned above, consisting of the preparation of flood hazard and risk maps (Article 6), as well as the establishment of Flood Risk Management Plans (Article 7).

All Member States submitted final flood hazard and risk maps by 2015. As of March 2019, all Member States submitted Flood Risk Management Plans, with the exception that Spain did not submit a Flood Risk Management Plan for the Canary Islands. Due to the insignificant land area of the Canary Islands compared to Spain's mainland, the implementation gap is thus nearly zero. For the purposes of this study, the implementation gap under the Floods Directive is therefore assumed to be zero.

Nitrates Directive

The most recent implementation reporting was published in 2018 and reports the average environmental state for 2012-2015. These, most recent estimates are thus best estimates for 2019 (EC, 2018a).

The table below shows the share of the number of monitoring stations across Member States with a nitrate concentration above 50 mg/l. The table is categorised into groundwaters and freshwaters. It should be noted that the implementation report calculates the share on EU-28 level as the unweighted average of the share in the individual Member States. This distorts the picture as it attributes the same weight for each Member State. However, as the number of monitoring stations differ among Member States, an accurate reflection provides the weighted average. The table below presents therefore the observed implementation gap on the EU level using both approaches.

Table 4-17 Implementation gap of the Nitrates Directive, as measured by the share of the number of monitoring stations where the four-year average nitrate concentration exceeded 50 mg/l in 2012-2015

Member State	Groundwater (number of stations)	Freshwater (number of stations)
Austria	8	0
Belgium	16	5
Bulgaria	19	>0
Croatia	17	0
Cyprus	12	2
Czech Republic	28	0
Denmark	17	1
Estonia	4	0
Finland	16	0
France	22	1
Germany	1	0
Greece	12	1
Hungary	1	2
Ireland	7	2
Italy	0	0
Latvia	11	>0
Lithuania	2	0
Luxembourg	15	0
Malta	2	0
Netherlands	71	60
Poland	12	1
Portugal	6	1
Romania	18	0
Slovakia	16	1
Slovenia	1	0
Spain	12	0
Sweden	13	1
United Kingdom	13	5
EU-27	**14**	**3**
EU-28	**14**	**3**
EU-28*	13	2

Note: * This is the reported share in the implementation reporting which uses the unweighted average and therewith provides an inaccurate picture; '>0' denotes a value greater than zero
Source: EC (2018a), SWD(2018) 246 final, Table 1 & 2

Bathing Water Directive

The implementation gap under the BWD is calculated as the number/share of bathing waters that have a 'poor' or 'unknown' status. The latter has thus been counted as non-compliance. The best estimate for 2019 is the reported data for 2017. In total, 4% of Europe's Bathing waters are not compliant with the BWD, of which the share is higher for inland waters (5.9%) and lower for coastal- and transitional waters (3.1%) (see table below). Member States that are notably behind in the implementation are

Estonia, Poland, Hungary, Slovakia, and Sweden. Belgium, Luxembourg, Malta, Romania, and Slovenia are on the other hand fully compliant.

Table 4-18 Implementation gap under the Bathing Water Directive as of 2017, defined as 'poor' bathing waters

Member State	Inland waters – non-compliant		Coastal and transitional waters – non-compliant		All waters – non-compliant	
	Number of waters	% of waters	Number of waters	% of waters	Number of waters	% of waters
Austria	1	0.4	-	-	1	0.4
Belgium	0	0.0	0	0.0	0	0.0
Bulgaria	0	0.0	2	2.2	2	2.1
Croatia	19	70.4	29	3.1	48	4.9
Cyprus	0	n/a	2	1.8	2	1.8
Czech Republic	11	7.1	-	-	11	7.1
Denmark	1	0.9	21	2.3	22	2.1
Estonia	4	14.8	4	14.8	8	14.8
Finland	8	3.6	9	11.7	17	5.7
France	126	9.6	51	2.5	177	5.2
Germany	36	1.9	10	2.7	46	2.0
Greece	1	33.3	52	3.3	53	3.3
Hungary	34	13.2	-	-	34	13.2
Ireland	0	0.0	10	7.5	10	7.0
Italy	21	3.1	150	3.1	171	3.1
Latvia	2	8.7	1	3.0	3	5.4
Lithuania	4	4.1	0	0.0	4	3.5
Luxembourg	0	0.0	-	-	0	0.0
Malta	0	n/a	0	0.0	0	0.0
Netherlands	33	5.3	3	3.2	36	5.0
Poland	7	6.5	21	21.6	28	13.7
Portugal	9	7.3	11	2.3	20	3.3
Romania	0	0.0	0	0.0	0	0.0
Slovakia	4	12.5	-	-	4	12.5
Slovenia	0	0.0	0	0.0	0	0.0
Spain	54	20.8	31	1.6	85	3.8
Sweden	12	6.1	33	13.5	45	10.2
United Kingdom	0	0.0	25	4.0	25	3.9
EU-27	**387**	**5.9**	**440**	**3.1**	**827**	**4.0**
EU-28	**387**	**5.9**	**465**	**3.1**	**852**	**4.0**

Note: '-' denotes that the target is not applicable; Bathing waters with 'unknown' status are classified as non-compliant
Source: EEA (2018e), European Bathing Water Quality in 2017, Annex 2, 3, 4; own calculations

Urban Wastewater Treatment Directive

The most recent reporting on the implementation of the UWWTD is the 9th implementation reporting, which provides the implementation of the Directive as of the beginning of 2015 (EC, 2017b). The implementation report provides the compliance of each Member State with Articles 3, 4, and 5. Accordingly, the implementation gap is expressed as the share of the actually treated load out of the target load. The table below provides the implementation gap for each Member State, expressed in load (p.e.) and share (%).

As explained above, Croatia was not subject to compliance at the time of reporting, as its accession to the EU was only in 2013. Some of the EU-13 Member States were similarly subject to a transitional period for some of their agglomerations at the time of reporting. These exemptions are accounted for in the assessment of the implementation gap.

As can be seen from the table below, there are several Member States that are compliant with the UWWTD on at least one of the three environmental targets. However, there are only Austria and the Netherlands, which are fully compliant. The existing gap is further small for several Member States. On the EU-28 level, the remaining gap is thus about 5% for Article 3 (i.e. connection to a collection system), 10% for Article 4 (i.e. secondary treatment), and 16% for Article 5 (i.e. more stringent treatment).

Table 4-19 Implementation gap under the Urban Wastewater Treatment Directive as of 2014, defined as in compliance with Articles 3, 4, and 5 of the Directive

Member State	Article 3		Article 4		Article 5	
	p.e.	%	p.e.	%	p.e.	%
Austria	0	0	0	0	0	0
Belgium	206500	2	292603	3	718805	9
Bulgaria	6001105	74	5395332	80	5833460	93
Croatia	not applicable					
Cyprus	308500	32	106618	14	28418	15
Czech Republic	0	0	682912	10	2042174	37
Denmark	0	0	25300	0	476383	5
Estonia	53089	3	152393	10	136170	9
Finland	0	0	254600	5	424800	9
France	0	0	8200167	11	2410690	6
Germany	0	0	242143	0	200012	0
Greece	0	0	121066	1	25500	0
Hungary	0	0	413197	5	16470	8
Italy	4780053	6	20018979	28	11407534	35
Ireland	0	0	2311727	46	2788225	80
Latvia	0	0	0	0	54531	4
Lithuania	0	0	0	0	38800	2
Luxembourg	0	0	2480	0	246138	55
Malta	0	0	513001	100	51450	100
Netherlands	0	0	0	0	0	0
Poland	3212002	8	3444860	10	10293679	33
Portugal	21000	0	2555550	23	880600	34
Romania	14054162	97	7438847	96	7274756	99
Slovakia	0	0	78873	2	1408813	43
Slovenia	343142	39	666982	83	65852	50
Spain	1906504	3	9521397	16	7390184	33
Sweden	0	0	119439	1	651002	6
United Kingdom	0	0	991465	1	1911573	7
EU-27	**30886057**	**6**	**62558466**	**13**	**54864446**	**16**
EU-28	**30886057**	**5**	**63549931**	**11**	**56776019**	**16**

Source: EC (2017), Ninth Report on the implementation status and the programmes for implementation (as required by Article 17) of Council Directive 91/271/EEC concerning urban waste water treatment, Annex V: National Chapters

4.4 Implementation gap cost

The implementation gap cost assessment covers eight specific implementation gaps, of which the impacts of the quantitative status under the WFD and the Nitrates Directive are not quantified, as is also seen in the table below. Applying the same unit cost for the ecological status under the WFD as in the 2011 study, the ecological status of the WFD has by far the largest implementation gap costs with a range of EUR 3-13 bn. Compared to the gap reported in 2011, which amounted to EUR 5-20 bn, this points however to a reduction of the gap. The UWWTD has the second largest gap cost in the range of EUR 2-4 bn. The other implementation gap costs are comparably small, ranging in the hundreds of million Euros. The total cost estimate excludes the estimate relating to the UWWTD, as it forms a 'basic measure' for the ecological status under the WFD. Hence, the cost under the ecological status of the WFD implicitly includes also the costs of the UWWTD. Due to uncertainties inherent in the calculations of the WFD, BWD, and UWWTD, a low and a high estimate is calculated. The implementation gap costs on the EU-28 level under the water sector consequently add up to a range of EUR 4.9-14.9 bn.

Table 4-20 Summary of the total implementation gap cost on the EU-28 level

Environmental Sector	Legislation	Indicator	Implementation Gap Costs (EUR million)		Comments
			Low estimate	High estimate	
Water	WFD – Ecological Status	Foregone benefit of surface water with 'good' ecological status	3,218	12,969	Measure of foregone benefit, not a damage cost
	WFD – Quantitative status	No quantitative indicator available	-	-	
	EQSD	Foregone benefit of providing 'purified' drinking water from surface water over 'naturally clean' drinking water	371	371	Measure of foregone benefit, not a damage cost
	GWD	Foregone benefit of providing 'purified' drinking water from groundwater over 'naturally clean' drinking water	615	615	Measure of foregone benefit, not a damage cost
	FD	Economic value of damage and loss-of-life (VSL)	-	-	No implementation gap
	ND	No quantitative indicator applied	-	-	Cost of nitrate in drinking water included in EQSD and GWD
	BWD	Loss in labour productivity due to gastrointestinal illness	53	309	
	UWWTD	Damage cost of nitrogen discharged into environment (excl. retention)	2,123	4,247	Excluded from total figure due to double counting with the WFD
		Total – EU-28	**4,257**	**14,264**	Excl. UWWTD estimate above as this cost is implicitly included also in the WFD estimate
		Total comparable with the 2011 study	*3,218*	*12,969*	

Source: own calculations

Water Framework Directive – Ecological Status

Surface waters provide a range of ecosystem services. They provide provisioning services for the extraction of resources (e.g. water for drinking, irrigation, and industrial purposes and power generation), regulating services for the regulation of water (e.g. flood prevention) and purification of water (e.g. filtration, detoxification, carbon storage), and cultural services like recreation and tourism, amenity values, education (MEA, 2003). A poor ecological status negatively impacts these ecosystem services through various pathways that may be individual to each SWB.

The diversity of impacts described above implies that measuring the gap is a complex task. As each Member State, each river-basin, and sometimes even each waterbody has a different specific set of biological quality elements, the associated impacts of significant pressures on the ecological status will differ across the different types of SWBs (see Table 4-1 for the definition of the biological quality elements). The typology to identify SWBs differs further across Member States, which leads to a limited comparability of the waterbodies. A shallow fjord, which is characterised by a low exchange of freshwater, is for example significantly more sensitive to nutrient pollution than open or deep waters. An appropriate assessment of the damage resulting from significant pressures must therefore be location-specific thus requiring an assessment at the river-basin level, - provided that quantified information is at all available. This exercise lies beyond the scope of this study.

For this reason, as well as in order to ensure comparability with the previous assessment, the cost of the implementation gap is assessed in the same way as in the previous assessment thus using the WTP for 'good ecological status'. This means that the cost of the implementation gap represents the foregone environmental benefit of 'good ecological status'. The unit values are adjusted to take into account changes in price-levels over time as well as in differences in price-levels across Member States. As in the case of the previous assessment, this study provides a low and a high estimate, as the WTP estimates are calculated for specific river-basins.

The assessment assumes that the implementation gap cost (i.e. the foregone benefit) is proportionate to the area of SWBs below 'good' ecological status.[19] A second key assumption is that the foregone benefit for freshwaters (i.e. rivers and lakes) is the same for as for marine waters (i.e. coastal waters and transitional waters).

The resulting implementation gap cost on EU-28 level ranges from EUR 3.2 bn to EUR 13.0 bn.

[19] Taking Austria as an example, 60% of the area of SWBs is below 'good ecological status'. The implementation gap cost (i.e. foregone benefit) corresponds therefore to 60% of the total WTP in Austria.

Table 4-21 Implementation gap cost under the Water Framework Directive (WFD) for the ecological status of surface waterbodies (SWB). The cost is based on the foregone benefit of citizens expressed by their WTP for 'good' ecological status. The costs are based on the previous study and have been updated to current prices.

Member State	Total foregone benefit of 'good' ecological status of surface waterbodies	
	Low Estimate (EUR million)	High Estimate (EUR million)
Austria	59	237
Belgium	90	362
Bulgaria	22	88
Croatia	13	51
Cyprus	2	9
Czech Republic	68	274
Denmark	68	274
Estonia	8	32
Finland	29	116
France	439	1770
Germany	820	3304
Greece	not available	
Hungary	58	233
Italy	not available	
Ireland	378	1524
Latvia	12	48
Lithuania	not available	
Luxembourg	7	29
Malta	0	1
Netherlands	191	771
Poland	153	616
Portugal	39	158
Romania	45	181
Slovakia	21	85
Slovenia	7	30
Spain	207	836
Sweden	93	375
United Kingdom	389	1566
EU-27	2830	11403
EU-28	3219	12969

Note: '-' denotes that the target is not applicable; No data is reported on Greece, Ireland, and Lithuania – neither for the 1st RBMP nor the 2nd RBMP.
Source: own calculations; COWI (2011), The costs of not implementing the environmental acquis

Water Framework Directive – Quantitative Status

A poor quantitative status can be associated with increased or decreased groundwater levels, alterations of groundwater flow paths, and even a cut-off of the groundwater flow (OECD, 2015). These changes can impact the availability of water for abstraction in the long term as the abstraction rate exceeds the natural recharge rate, depleting the groundwater level. Abstraction and other factors can lead to a change in the water table, which can affect the availability of water to terrestrial ecosystems that depend on groundwater, as for example rivers, streams and lakes. A third important impact is the saline (or other) intrusion of GWBs, which e.g. reduces the suitability for abstraction and the availability of water for other terrestrially dependent ecosystems as well as agriculture.

The available data on the implementation gap on the quantitative status of GWBs does not allow for a quantification of the specific impacts that fall within the scope of this study. The specific environmental impacts are strongly location-specific, as the characteristics of e.g. the GWB itself as well as the geology and terrestrial ecosystems are individual to each GWB. An assessment would thus require hydrogeologic modelling to provide meaningful conclusions on the impacts. The study is therefore limited to the qualitative description of the impacts. A poor quantitative status can have implications on drinking water suppliers if GWBs become subject to intrusion by salt or other chemical substances. This increases the costs of drinking water purification. The exact magnitude of this implementation gap cost depends strongly on the magnitude of the impact and is thus again a strongly location-specific cost.

Environmental Quality Standards Directive

Next to water pollution that affects ecological quality, chemical substances can contaminate/pollute surface waters. Chemical substances enter surface water naturally or through man-made activities - intentional (e.g. pesticides) and un-intentional (e.g. dioxins) (EC, 2006a). Due to the variety of chemical substances, the impacts are various, ranging from reduction in biodiversity, decreased amenity value of surface waters, exposure of humans to chemical substances during e.g. swimming, increased bioaccumulations in humans, crops, livestock, and game. Whereas the DWD ensures that no chemical substances are consumed in drinking water, the presence of chemical substances requires costly treatment during drinking water preparation. Hazardous and toxic substances accumulate however also in fish, leading to adverse health impacts through the food chain nevertheless.

The impact that is quantified assesses the impact that chemically 'poor' surface water has on drinking water. On the EU level, 36% of the drinking water originates from surface water (see Table 4-22 below). In some Member States like Austria and Denmark, none of the drinking water originates from surface water. Member State with a gap under the EQSD that do not abstract drinking water from surface water exhibit therefore no implementation gap cost – yet they do experience some form of a cost, though not quantifiable in terms of its impact on drinking water quality.

There is no available information on the number of households that receive drinking water from each SWB. In the absence of such information the study therefore makes the simplifying assumption that households either receive drinking water from surface or groundwater – but not both. Further, it is assumed that the number of households receiving drinking water from SWBs in each Member State is proportional to the share of drinking water provided from SWBs. In order to determine an estimate of the number of households receiving drinking water from SWBs with 'poor' chemical status, the number of households receiving drinking water from SWBs with 'poor' chemical status is assumed to be proportionate to the area of surface water with a 'poor' chemical status. The resulting number of households that obtain drinking water originating from SWBs with a 'poor' chemical status amounts to 19.4 million on the EU level, as presented in Table 4-22 below.

The implementation gap cost that results from the supply of drinking water from SWBs with 'poor' chemical status under the EQSD is measured by the negative impact that a 'poor' chemical status has on drinking water quality. This is measured by the foregone benefit of what citizens are willing to pay for 'naturally clean' drinking water over 'purified' drinking water. In other words, the foregone benefit is the marginal increase in the WTP if the supplied drinking water changes from 'purified' to 'naturally clean.' It is important to note that the study which elicited these WTP figures, investigated the WTP for groundwater in Denmark. Groundwater is the exclusive source of drinking water in Denmark (Hasler et al., 2005). The cost calculation therefore makes an assumption about the consumer preferences: the WTP for drinking water from groundwater is the same as from surface water. A second assumption is that the foregone benefit is proportionate to the number of households potentially sourcing 'purified' instead of 'naturally clean' water. Danish consumers put a high value on groundwater quality as the provision of clean groundwater has a long tradition in Denmark, receiving a lot of praise inside of Denmark. This induces a risk that the foregone benefit will be overestimated for other Member States.

The approach does thus not assess the actual damage cost that occurs due to a 'poor' chemical status, which mainly consists of the end-of-pipe costs for drinking water providers to purify drinking water to chemical levels compliant with the DWD. The primary types of chemical pollutants in surface water are nitrates and pesticides. While there are studies that quantify the costs to e.g. reduce nitrate and pesticide contamination of drinking water, these studies do not allow for the monetisation of costs in line with the environmental indicators provided under the EQSD.[20] Taking the example of nitrates, it is only known which waterbodies exceed 50 mg/l, but not to which extent. A second factor that complicates the assessment is the fact that the target levels of chemical substances apply at the water tap. Drinking water purifiers therefore need to reduce the level of e.g. nitrates to levels significantly below this threshold when the drinking water leave the purification plant. Based on the available cost formats in the literature, it is uncertain to which extent the costs for treatment can be attributed to the share of removed nitrate above 50 mg /l.

The resulting implementation gap cost amounts to EUR 372 million on the EU level, of which Germany accounts for nearly one-third.

[20] The most notable and comprehensive study for the cost of removal of nitrates and pesticides is Oelman et al. (2017)

Table 4-22 Implementation gap cost under the Environmental Quality Standards Directive (EQSD), measured by the foregone benefit of naturally clean drinking water over purified drinking water.

Member State	Share of drinking water originating from surface water (%)	Estimated number of households receiving drinking water from surface water with 'poor' chemical status	Annual foregone benefit (EUR million)
Austria	0	0	0
Belgium	40	1891000	44
Bulgaria	65	86000	1
Croatia	0	not available	
Cyprus	58	6000	> 0
Czech Republic	47	718000	9
Denmark	0	0	0
Estonia	51	1000	>0
Finland	43	331000	9
France	29	1267000	28
Germany	15	5540000	120
Greece	71	not available	
Hungary	4	23000	>0
Ireland	87	not available	
Italy	39	829000	19
Latvia	22	10000	>0
Lithuania	0	not available	
Luxembourg	20	42000	1
Malta	56	0	0
Netherlands	39	1523000	33
Poland	24	1043000	14
Portugal	38	26000	0
Romania	64	193000	3
Slovakia	16	9000	0
Slovenia	33	268000	4
Spain	49	628000	12
Sweden	61	2441000	60
United Kingdom	68	488000	15
EU-27	**36**	**16102000**	**357**
EU-28	**36**	**19413000**	**372**

Note: No implementation gap data is available for Greece, Ireland, and Lithuania – neither for the 1st RBMP nor the 2nd RBMP.

Source: own calculations; Hasler et al. (2005), Valuation of groundwater protection versus water treatment in Denmark by Choice Experiments and Contingent Valuation

Groundwater Directive

The impacts of the implementation gap under the GWD are analogous to those of the EQSD above, as the contamination of groundwater with chemical substances only unfolds its damage potential once in contact with ecosystems and humans. The time-dimension for impacts from implementation gaps under GWD may however be considerably longer, as chemical substances first need to enter groundwater bodies, which can take up to several decades.

As in the case of the EQSD, the environmental impact quantified in this study is the need for 'purification' of drinking water from GWBs with a 'poor' chemical status, as opposed to 'naturally clean' drinking water that requires a minimum to no purification. On the EU-28 level, 50% of the drinking water is abstracted from GWBs. Following the same set of assumptions as set out for the EQSD, almost 30 million households in Europe receive drinking water that requires purification. This results in an implementation gap cost of EUR 615 million on the EU-28 level. Latvia is the only Member State with no cost, as it has no GWBs with a 'poor' chemical status.

Table 4-23 Implementation gap cost under the Groundwater Directive (GWD), measured by the foregone benefit of naturally clean drinking water over purified drinking water.

Member State	Share of drinking water originating from groundwater (%)	Estimated number of households receiving drinking water from groundwater with 'poor' chemical status	Annual foregone benefit (EUR million)
Austria	100	60000	1
Belgium	60	1799000	42
Bulgaria	35	471000	5
Croatia	not available		
Cyprus	10	4000	>0
Czech Republic	29	795000	10
Denmark	100	545000	16
Estonia	49	14000	>0
Finland	41	121000	3
France	49	3474000	76
Germany	68	9445000	205
Greece	29	not available	
Hungary	45	319000	5
Ireland	13	not available	
Italy	54	5573000	120
Latvia	64	0	0
Lithuania	93	not available	
Luxembourg	20	33000	>0
Malta	44	65000	1
Netherlands	54	149000	3
Poland	62	648000	9
Portugal	21	23000	>0
Romania	33	332000	5
Slovakia	84	604000	7
Slovenia	67	31000	>0
Spain	50	2733000	53
Sweden	17	42000	1
United Kingdom	13	1681000	50
EU-27	**50**	**22364000**	**565**
EU-28	**50**	**26962000**	**615**

Note: No implementation gap data is available for Greece, Ireland, and Lithuania – neither for the 1st RBMP nor the 2nd RBMP; No data on the share of drinking water from groundwater is available for Croatia; Origin of drinking water is based on the 6th implementation reporting of the Drinking Water Directive

Source: own calculations; EC (2016); Hasler et al. (2005), Valuation of groundwater protection versus water treatment in Denmark by Choice Experiments and Contingent Valuation

Nitrates Directive

The impacts from an implementation gap under the ND is nutrient pollution of surface waters and groundwaters. This leads to the eutrophication of waterbodies, leading to increased algae growth and reduced availability of light and oxygen for other organisms, causing the death of those organisms. The presence of nitrates in drinking water also has an impact on human health, as ingested nitrates break down to nitrites in the human body, which are suspected to be a contributing factor to cancer (EC, 2018a).

The implementation gap reported under the ND provides the number of measuring stations that have a nitrate concentration above 50 mg/l, but not the level by which the concentration is exceeded. It is, on this basis therefore difficult to quantify potential impacts. Unlike the EQSD and GWD, the implementation gap under the ND does not provide information on the area of a given SWB and GWB where a measuring station is located. This provides a comparably less precise estimation of the impact of a nitrate concentration above 50 mg/l on for example drinking water quality. The environmental impact on the drinking water quality of chemically poor drinking water can therefore be calculated with more precision under the EQSD and the GWD. The specific assessment of the implementation gap cost under the ND is therefore meaningless, as the calculations from the EQSD and GWD provide a more precise calculation, since these account for the size of each waterbody (see above).

Bathing Water Directive

The BWD regulates the concentration of faecal organisms in bathing waters, measured by the presence of enterococci and e-coli. These organisms can enter bathing waters through multiple ways, such as sewage effluent discharges, sewage storm overflows, and urban and rural diffuse pollution. Depending on their proximity, these organisms can reach sufficiently high concentrations impacting the human health of bathers (King et al., 2014). The most common impact associated is gastrointestinal illness, which, depending on the severity, can lead to absence from work due to illness. The risk of infection increases with the concentration of faecal organisms – and thus with the decrease of bathing water quality.

The approach to measuring the implementation gap is based on the assessed increase of the risk of illness from swimming in bathing water of 'poor' quality compared to 'sufficient' quality. More specifically, it is the increased risk of suffering from gastrointestinal illness, if a swimmer swims in 'sufficient' compared to 'poor' bathing water quality. The calculation of the impact assumes that the risk of illness is the same for fresh and marine waters and that the risk of illness in 'sufficient' quality is the same as for 'good' quality.[21] The marginal risk corresponds to a probability of 1.2% and the occurrence of illness leads to an absence from work of one day (Colford et al., 2012).

Based on this risk, this study calculates the expected total number of days of illnesses that lead to an absence of work. There are no available statistics that could be used to

[21] No literature could be identified that quantifies the risk of swimming in 'sufficient' bathing water. Therefore, the risk of swimming in 'good' bathing water was used as a proxy. For a thorough overview of available literature quantifying the risk, see King et al. (2014)

identify the number of bathing visits. Therefore, a low and high estimate is established. One study on the recreational use of bathing waters in the Baltic Sea estimated the frequency of bathing visits across neighbouring countries to be in the range of 1.11 to 6.42 bathing water visits per inhabitant per year (Czajkowsi et al., 2015). These values are used to estimate the number of bathing visits per year, which combined with the probability of illness, leads to a total number of days of absence from work due to illness days, as presented in the table below.

The absence from work leads to a loss of labour productivity, presented in the same table. There are no costs in Belgium, Luxembourg, Malta, Romania, and Slovenia, as these countries do not have implementation gaps. The aggregate implementation gap cost amounts to between EUR 53 million to EUR 309 million, depending on the assumed number of visits per capita.

Table 4-24 Implementation gap cost under the Bathing Water Directive (BWD), measured by the expected loss in labour productivity due to illness from bathing water visits

Member State	Expected illness days at work		Expected loss in labour productivity (EUR million)	
	Low (1.11 visits/capita)	High (6.42 visits/capita)	Low	High
Austria	-	-	0	0
Belgium	2000	11000	>0	>0
Bulgaria	10000	58000	1	5
Croatia	2000	10000	1	3
Cyprus	22000	129000	6	33
Czech Republic	3000	15000	>0	1
Denmark	4000	26000	1	6
Estonia	5000	27000	1	3
Finland	24000	137000	4	22
France	47000	271000	13	74
Germany	3000	16000	>0	1
Greece	25000	145000	5	31
Hungary	-	1000	>0	>0
Ireland	1000	8000	>0	>0
Italy	1000	8000	>0	>0
Latvia	-	-	0	0
Lithuania	17000	100000	1	7
Luxembourg	-	-	0	0
Malta	11000	66000	3	17
Netherlands	-	3000	0	1
Poland	69000	400000	5	28
Portugal	5000	26000	>0	3
Romania	-	-	0	0
Slovakia	-	-	0	0
Slovenia	9000	52000	1	4
Spain	4000	24000	1	6
Sweden	14000	79000	4	23
United Kingdom	35000	201000	7	39
	-	-		
EU-27	**236000**	**1364000**	**47**	**270**
EU-28	**271000**	**1566000**	**53**	**309**

Source: own calculations; Colford et al. (2012), Using Rapid Indicators for Enterococcus to Assess the Risk of Illness after Exposure to Urban Runoff Contaminated Marine Water, Supplemental Material, Table 5, 8; Czajkowsi et al. (2015), Valuing the commons: an international study on the recreational benefits of the Baltic Sea

Urban Wastewater Treatment Directive

The discharge of faeces from humans contain a high degree of suspended-solids that contain high levels of biological pollution, nitrogen, and phosphorus (Hernandez-Sancho et al., 2010). The consumption of e.g. human care and medicinal products lead to, among others, an increased discharge of micropollutants, hormones, and active medical ingredients into the environment. All these substances can have negative impacts on the environment and human health, if not properly collected and treated. Not collecting faeces results in poor hygiene, increasing the risk of infections from deadly diseases. Not properly treating discharges can lead to negative impacts on the environment: an increased discharge of nitrogen and phosphorus leads to the eutrophication of waterbodies, micro plastics can enter the food chain, and bathing waters can be polluted with faecal organisms to name a few environmental impacts.

The implementation gap cost under the UWWTD calculated for this study is measured by the amount of nitrogen that is discharged into the environment that otherwise would not have been discharged if appropriately treated.[22] The implementation gap cost is derived from the p.e. load that was not compliant with the respective treatment levels (i.e. treatment in accordance with Articles 3, 4, and 5). For each Member State, an average daily production of nitrogen per p.e. is applied to calculate the amount of nitrogen that is produced through wastewater production (Vigiak et al., 2018). Based on the produced nitrogen load per UWWTD article, typical removal efficiencies of the treatment levels are applied to calculate the load that is discharged due to the absence of appropriate treatment. Some share of the discharged load will be temporarily or permanently retarded in the ecosystem and therefore lead to a reduced load of nitrogen that effectively leads to damages, e.g. in the form of eutrophication. The resulting amount of discharged nitrogen is presented in the table below and amounts to nearly 190 kilo tonnes per year.

Sutton et al. have calculated a range of a damage cost per kg of nitrogen of EUR 14-28 per kg. Adjusting for the different price-levels per Member State, the total annual damage cost on the EU-28 level has a range of EUR 2.1-4.2 bn. Austria and the Netherlands have no implementation gap costs, as both are fully compliant.

[22] There is also an environmental impact of organic pollution and phosphorus. However, there are no credible unit costs available to monetize their impact.

Table 4-25 Implementation gap cost under the Urban Wastewater Treatment Directive (UWWTD), measured by total value of nitrogen that is discharged into the environment due to no proper treatment in accordance with Articles 3, 4, and 5

Member State	Total Nitrogen (tonnes/year)	Damage cost of nitrogen (excl. retention; EUR million)	
		Low	High
Austria	0	0	0
Belgium	1220	19	37
Bulgaria	21178	143	285
Croatia	0	0	0
Cyprus	835	10	19
Czech Republic	1354	14	27
Denmark	202	4	7
Estonia	364	4	8
Finland	491	8	16
France	11742	173	345
Germany	359	5	10
Greece	167	2	4
Hungary	397	4	8
Ireland	3895	60	120
Italy	45668	621	1.241
Latvia	18	>0	>0
Lithuania	16	>0	>0
Luxembourg	95	2	3
Malta	665	7	15
Netherlands	0	0	0
Poland	17063	163	326
Portugal	3801	43	86
Romania	55643	525	1.050
Slovakia	410	4	8
Slovenia	1821	20	40
Spain	20279	258	515
Sweden	386	6	11
United Kingdom	1819	31	62
EU-27	**188068**	**2092**	**4185**
EU-28	**189887**	**2123**	**4247**

Source: own calculations; Sutton et al. (2011), European Nitrogen Assessment, Chapter 22 - Costs and benefits of nitrogen in the environment, Tbl 22; Vigiak et al. (2018), Estimation of domestic and industrial waste emissions to European waters in the 2010s, JRC Technical Reports

4.5 Lessons learnt and recommendations

The monetisation of environmental damage is challenged by a lack of readily available unit damage costs, and a lack of sufficiently detailed data on the state of the environment as part of the implementation reporting of the specific legislations.

The limited availability of unit costs for environmental damages has necessitated the use of somewhat more subjective and site-specific valuations in the form of willingness to pay estimates (i.e. willingness to pay for a good ecological status under the WFD, and willingness to pay for drinking water under the EQSD and GWD). This posed a challenge when generalising such values to a national level and transferring those values to other Member States (commonly referred to as 'benefit transfer'), as the economic and cultural factors that influence a person's willingness to pay are often site-specific. This study has conducted a benefit transfer of the values by adjusting for the price level of household consumption expenditures, and therewith accounted to some extent for differences in economic factors.

In those cases where willingness to pay values were used, the reported 'costs' mirror foregone benefits, which reflect a hypothetical value of a non-occurred benefit, as opposed to a cost that actually materialises (which is the case where damage costs are used). The literature on (environmental) valuation grows constantly, and future studies may therefore want to pay close attention to new developments that enable the calculation of environmental damage costs based on the reported implementation gap, so the calculation relies less on willingness to pay data.

The available data on the reported implementation gap under the EQSD and GWD does not provide actual concentrations of chemical substances in waterbodies. This limited the study's ability to estimate specific damage costs. A nitrate concentration that is 20 mg/l over the threshold of 50 mg/l has for example a higher marginal impact on human health than a concentration of 5 mg/l over the threshold. As a result, the implementation gap costs needed to be calculated with willingness to pay values. Ideally, the data on the implementation gap would thus provide measured concentrations, enabling a reflection of environmental damage – as opposed to foregone benefits - resulting from observed implementation gaps. However, this would most likely require a change to the reporting provisions under the applicable legislation and hence, constitutes a demanding task.

As elaborated in Annex 2 of this study, no implementation gap cost has been calculated for the MSFD, owing to inconsistencies in the reporting on the implementation gap. Expecting that future reporting under the MSFD enables a quantification of an implementation gap, future studies may want to pay close attention ensuring that the monetisation of damage costs – or foregone benefits – accounts only for factors that can be attributed to the MSFD, to avoid a potentially misleading monetisation of the implementation gap.

A final recommendation is that future studies utilise, to the extent relevant, the results of the ongoing 'Blue 2 study', which investigates, among others, the cost of not implementing EU water policy. [23] Taking account of the study's results in future work can help increase coherence in the approach towards the valuation of EU water policy, increasing the added value of environmental valuation studies for European policy makers and adding legitimacy to the results of both studies.

5. Waste

5.1 EU environmental policy and law

Generally, EU legislation on waste seeks to encourage waste prevention, specify reuse and recycling rate requirements for selected waste streams, to minimise disposal within compliant landfills, and to eradicate disposal in non-compliant landfills. From its starting focus on tackling the environmental impact of polluting wastes, the EU's waste policy has developed in breadth and clarity since the previous study. The driving principle at the heart of the EU's waste policy remains the waste hierarchy, which sets

[23] http://ec.europa.eu/environment/blue2_en.htm

out fundamental priorities for waste management when shaping waste policy and managing waste at the operational level. Furthermore, the narrative around the waste hierarchy has now been more holistically expanded across whole product and material lifecycles, through new EU legislation adopted in 2018 under the Circular Economy Action Plan. The vision is to move to a climate-neutral, circular economy where pressure on natural and freshwater resources as well as ecosystems is minimised.

As part of the Circular Economy Action Plan, four legislative amendments have been made to the following legal acts, adopted into the EU environmental acquis as of 22 May 2018:[24]

- The Waste Framework Directive;
- The Landfill Directive;
- The Packaging Directive;
- And directives on end-of-life vehicles (ELVs), batteries and accumulators, and waste electrical and electronic equipment (WEEE).

5.2 Environmental target

The growth in ambition across these revised legal text marks a significant step forward in environmental policy, seeking to move towards a more sustainable economy where circularity is built into both business models and into product design so as to minimise the creation of, and impacts associated with, waste. Future recycling targets are considerably enhanced and definitions are clarified and tightened. This includes 2035 targets for municipal waste of a minimum 65% recycling, and maximum 10% landfilling. Furthermore, the priorities given to waste prevention, preparation for reuse, and recycling are reinforced.

Concerning the waste stream specific legislation, the updates made to specific Directives look to ensure effective producer responsibility systems are put in place within Member States, plus a number of cases of revised higher future targets are also implemented. In addition, since the last study, many of the target dates have now arrived and/or incrementally higher targets already apply (for instance, a 25% collection rate for batteries and accumulators must have been met from September 2012, rising to 45% by September 2016).

Waste Framework Directive

The overarching legislative framework for handling waste in the EU is covered by The Waste Framework Directive. This framework has been put in place to increase resource efficiency and consequently reduce the negative impacts that disposal of these resource materials has on the environment and health. Under the Directive, a target for reuse and recycling will come into force in 2020, whereby 50% of materials such as paper, metal, plastic and glass in the municipal waste stream will have to be recycled. The 2020 obligations allow Member States to select from four different calculation methods to meet this target, including a focus just on household dry recycling materials, through to the option to focus on all municipal waste.

Longer term targets mentioned above have also been brought in within the 2018 revisions to the Directive, doing away with the four calculation methods and culminating in a 65% reusing and recycling target for total municipal waste by the target date of 2035. Beyond quantifiable targets, the Directive also sets principles on how waste should be dealt with in Member States; encouraging both the 'waste hierarchy' and the 'polluter pays' principle.

[24] http://europa.eu/rapid/press-release_IP-18-3846_en.htm

A summary of environmental targets under the Waste Framework Directive are shown in Table 5-1.

Table 5-1 Environmental targets: The Waste Framework Directive

Legislation	Environmental target description	Current target	Max future target
The Waste Framework Directive (EU) 2018/851	Targets on the preparation-for-reuse and recycling of municipal waste	Not yet in force: 50% by 2020	65% by 2035 (and allowing time derogations)
	Target on the recovery of construction and demolition waste (includes preparation for reuse, recycling and other material recovery including backfilling operations)	Not yet in force.	70% by 2020
	Reduce generation of food waste	-	Halving per capita food waste at the retail and consumer levels by 2030

Landfill Directive

The Landfill Directive seeks to reduce the harmful environmental and health impacts from landfilling waste by applying strict technical requirements to landfill sites. This involves a reduction target for biodegradable municipal waste sent to landfill, and a limit on the total municipal waste which can be landfilled, though the latter target does not come into effect until 2035. A summary of environmental targets under the Landfill Directive are shown in Table 5-2.

Table 5-2 Environmental targets: The Landfill Directive

Legislation	Environmental target description	Current target	Max future target
Landfill Directive (EU) 2018/850	Limit on the amount of municipal waste landfilled	-	Max 10% of MSW allowed to landfill by 2035
	Limit on the fraction of biodegradable waste to landfill	Many now at the 35% limit compared to 1995 levels (target for 2016), some have derogations and so are at the 50% level	35% of amount landfilled in 1995
	Landfill compliance	Zero non-compliant landfills / landfilling	-

Packaging Directive

This Packaging Directive aims to limit the production of packaging waste; instead promoting recycling, reuse and other forms of waste recovery as an option rather than disposal, which should be considered as a last resort. The Directive covers all packaging waste placed on the European market. Quantifiable targets were set with a target date of 2008, firstly for reuse and recycling of all packaging by weight, then a target for specific packaging materials. Once again, as part of the EU Circular Economy Package, stricter targets have been adopted for future years within the 2018 revision to the Directive. A summary of environmental targets under the Packaging Directive are shown in Table 5-3.

Table 5-3 Environmental targets: The Packaging Directive

Legislation	Environmental target description	Current target	Max future target
Packaging Directive (EU) 2018/852	Targets on the recycling of packaging waste overall	No later than 31st December 2025 a minimum of 65% by weight of all packaging waste will be recycled	No later than 31 December 2030 a minimum of 70 % by weight of all packaging waste will be recycled
	Targets on the recycling of specific materials	No later than 31st December 2025: 50% plastic, 25% wood, 70% ferrous metals, 50% aluminium, 70% glass, 75% paper and cardboard	No later than 31st December 2030: 55% plastic, 30% wood, 80% ferrous metals, 60% aluminium, 75% glass, 85% paper and cardboard

WEEE Directive

The WEEE Directive is designed to prevent WEEE by requiring Member States to recover, reuse or recycle electrical and electronic equipment (EEE). The Directive includes three quantifiable targets: a total WEEE collection target, a recovery target for different categories of WEEE and a recycling target for different categories of WEEE. The different types of WEEE currently fall under one of ten categories, which will be reformed into six categories for targets set for 2019 onwards. Under the Directive, producers are also required to cover the costs of collecting, treating and sustainably disposing of WEEE. A summary of environmental targets under the WEEE Directive are shown in Table 5-4.

Table 5-4 Environmental targets: The WEEE Directive

Legislation	Environmental target description	Current target (in force from 2019)	Max future target
WEEE Directive	Minimum rates for separate collection of WEEE	65% of EEE put on the market OR 85% 85% of WEEE generated on the territory of that Member State.	-
	Targets on recovery of types of WEEE	Dependent on type of WEEE - between 75%-85% (categories of WEEE change 2019+)	-
	Targets on recycling of types of WEEE	Dependent on type of WEEE - between 55-80% (categories of WEEE change 2019+)	-

Batteries Directive

The Batteries Directive promotes a high rate of collection and recycling of waste batteries and accumulators and seeks to reduce the environmental impacts of all aspects of the life-cycle of batteries and accumulators, including their recycling and disposal. This is achieved through two quantifiable targets: a total collection target for portable batteries and accumulators of 45% by September 2016, and a target for the recycling efficiency of three specific types of batteries (lead-acid, nickel-cadmium and other batteries). These targets have not been updated past the targets set for 2016. Member States must also promote and maximise the collection of batteries, ensuring to use the best techniques available to treat and recycle the collected batteries. A summary of environmental targets under the Batteries Directive are shown in Table 5-5.

Table 5-5 Environmental targets: The Batteries Directive

Legislation	Environmental target description	Current target	Max future target
Batteries Directive	Targets on collection rates	Member States shall achieve the following minimum collection rates: (a) 25 % by 26 September 2012; (b) 45 % by 26 September 2016.	-
	Recycling efficiencies per type of battery	"By no later than September 2011: lead-acid batteries and accumulators 65% by average weight; nickel-cadmium batteries and accumulators 75% by average weight; other batteries and accumulators 50% by average weight.	-

End of Life Vehicles (ELV) Directive

The ELV Directive sets out measures to prevent and limit waste from ELVs and their components and ensures that, where possible, these parts and materials are reused, recycled or recovered. The Directive has established separate targets for 'recovery and reuse' and 'recycling and reuse', with the former being a more ambitious target than the latter. There has been no amendment to the 2015 targets, which are carried over as the current targets in this study. A summary of environmental targets under the ELV Directive are shown in Table 5-6.

Table 5-6 Environmental targets: The ELV Directive

Legislation	Environmental target description	Current target	Max future target
ELV Directive	Target on reuse and recovery target	No later than 1 January 2015, for all end-of life vehicles, the reuse and recovery shall be increased to a minimum of 95% by an average weight per vehicle and year.	-
	Target on reuse and recycling target	Within the same time limit, the re-use and recycling shall be increased to a minimum of 85% by an average weight per vehicle and year.	-

Waste Shipment Regulation

The Waste Shipment Regulation lays down procedures for the transboundary shipments (i.e. cross border transport) of waste. The Regulation bans the export of hazardous wastes to non-OECD countries, as well as placing a ban on the export of waste for disposal.

It is noted here that the Waste Shipment Regulation has been undergoing detailed ongoing evaluation and review. At the time of writing, the consultant's report has not yet been finalised and we are unable to include conclusions on the implementation status and costs which this may provide. The nature of the impacts, however, are expected to remain the same as was discussed qualitatively within the previous 2011 report, as per the recap provided in Section 5.3 below.

Table 5-7 Environmental targets: The Waste Shipment Regulation

Legislation	Environmental target description	Current target	Max future target
Waste Shipment Regulation	No target, but a prohibition on uncontrolled shipments of waste which would result in the waste not being treated or disposed in an environmental sound way. Restriction on shipment of hazardous waste outside the EU.	See left	-

5.3 Implementation gap

Introduction to detailed implementation gap data

Waste management was among the four policy fields identified in the 2017 Environmental Implementation Review as the fields with the main challenges and most pressing implementation gaps across Member States.

Implementation gaps for waste have been calculated as the difference between the EU legislative targets and actual Member State performance. These are expressed within this Section here as a difference in percentage terms for the rate, and difference in tonnage for the weight of waste.

For Member State performance against the Waste Framework Directive and Landfill Directive targets, data from central sources (Eurostat data and implementation reports etc.) is incomplete or not available, and so we have attempted to fill such data gaps with information obtained within prior consultancy assignments for the European Commission (referenced where appropriate below). In addition, where instances of non-reporting by certain countries was observed in the recent data for waste stream specific legislations, in these cases it has been necessary to use data from the latest year available.

Summary of detailed implementation gap data

Data on waste implementation gaps varies widely across the range of legislative targets. For some – notably MSW recycling rates – data is generally strong, with detailed Eurostat data supported by surveys and modelling undertaken to support the Commission's Circular Economy Package. For the minor waste stream directives (WEEE, batteries and ELVs), there is less detailed information and much more uncertainty, particularly around sub-targets on specific WEEE or battery types. In Table 3-33 below, the implementation gaps are calculated based on the potential additional tonnage to be treated, diverted or prevented in non-compliant countries (see the relevant subsections below for full data). This is because Member States can (and often do) go beyond the EU waste targets. For example, Member States collectively recycle or recover 67% of packaging waste, meaning the EU's rate is over the 55% target. However, there are some individual Member States which do not meet the target, meaning that there is still an implementation gap to close.

Table 5-8 Implementation Gap Summary

Environmental Sector	Indicator	Current Gap	Future Gap	Uncertainty
Waste	Recycling of MSW	The gap in non-compliant countries equates to 7% of total MSW	The gap in non-compliant countries equates to 16% of total MSW	Good data available
	Share of waste on non-compliant sites	Estimates on number of illegal landfills vary from 0.4% to 15%. The 2011 report assumed the figure to be 15% at the time	Target is the same as today. The gap can be assumed to be gradually decreasing as ECJ rulings are enforced, new landfills are established, and proper controls are put in place	The estimate is very uncertain as no data is compiled on the share of waste going to substandard sites. Nonetheless this is a well-known and high-profile issue
	Landfill of MSW	The gap in non-compliant countries is 5,510 tonnes – 4% of the 1995 BMW level	The gap in non-complaint countries equates to 17% of MSW	Good data available – outside of the illegal landfills noted above
	Recycling of packaging waste	The gap in non-compliant countries equates to 0.1% of total packaging waste generated	The gap in non-compliant countries equates to 2.1% of total packaging waste generated	Good data available
	ELV	The recovery gap in non-compliant countries equates 3.0% of total ELV waste generation. The recycling gap equates to 0.5% of ELV waste generation	N/A (no increased future targets)	Medium
	WEEE	The collection gap in non-compliant Member States equates to 13.6% of generation	N/A	Data availability and quality = medium, some Member States good
	Batteries and accumulators	The collection gap in non-compliant Member States equates to 2.2% of generation	N/A (no increased future targets)	Data availability and quality = medium, some Member States good
	Food waste prevention	No current target, objective is for 2030 only – one of the UN SDGs	Significant waste prevention required to meet the 50% reduction target	Medium certainty – quite approximate and historic figures used within this current report to represent the current situation, from which 50% prevention is calculated, but order of magnitude probably OK
	Waste shipment	2011 report supposed that maybe 20% of all shipments are illegal. WSR review ongoing, no new data available at this time	N/A (rules in force already)	Medium (it is well documented that there are many illegal shipments -although the true extent is not known)

The Waste Framework Directive (EU) 2018/851

The implementation gap for the recycling target set under the Waste Framework Directive was calculated as the percentage difference between the 2020 target and the projected 2020 performance of Member States as indicated in the Early Warning Report, authored by Eunomia in 2018 (Eunomia, 2018a). This is a slight simplification of the actual situation which may arise in 2020, as Member States still have time to take additional actions to close the implementation gap. However, since the 2020 target is now reasonably close, and a projected dataset is available for possible Member State performance at this date, then it is considered worthwhile to include this within the assessment for the 'current' (/imminent) implementation gap here, as shown in Table 5-9. It must however be acknowledged that further newly programmed actions taken in individual Member States up until the target data could have an effect to reduce these gaps to some degree from those projected by the 2018 study. The negative/grey values observed in the table represent where the target is expected to has be exceeded and there is no predicted implementation gap.

Regarding the 2020 municipal recycling target, it should be noted that different methods are in principle not directly comparable due to the different elements included or excluded in the calculations. This also adds a layer of complexity to the implementation gap costing analysis.

Table 5-9 Implementation gap for recycling rates of Member States against 2020 MSW 50% Target

Member State	2020 Target			
	Chosen Calc. Method	Calculation method covers	Implementation gap (kt)	Implementation gap %
Belgium	Method 3	n/a	-339	-7.4%
Bulgaria	Method 4	Total MSW	271	9.0%
Czech Republic	Method 2	Pa+Pl+G+M	-15	-1.0%
Denmark	Method 1	n/a	-121	-2.7%
Germany	Method 4	Total MSW	-7,969	-15.6%
Estonia	Method 2	Assumed Pa+Pl+G+M	45	11.0%
Ireland	Method 1	n/a	-52	-2.0%
Greece	Method 2	Pa+Pl+G+M	349	15.0%
Spain	Method 4	Total MSW	2,751	13.0%
France	Method 2	n/a	-3,239	-9.4%
Croatia	Method 2	Pa+Pl+G+M	148	17.0%
Italy	Method 2	n/a	-2,137	-8.0%
Cyprus	Method 2	Pa+Pl+G+M	44	18.0%
Latvia	Method 4	Total MSW	124	16.0%
Lithuania	Method 2	Pa+Pl+G+M	0	0.0%
Luxembourg	Method 2	n/a	-5	-1.5%
Hungary	Method 2	Pa+Pl+G+M	107	8.0%
Malta	Method 1	Pa+Pl+G+M	57	22.0%
Netherlands	Method 2	n/a	-53	-0.6%
Austria	Method 2	n/a	-1,726	-36.5%
Poland	Method 2	Pa+Pl+G+M	122	3.0%
Portugal	Method 2	Assumed Pa+Pl+G+M	620	13.0%
Romania	Method 4*	Total MSW*	1,531	31.0%
Slovenia	Method 4	Total MSW	182	13.0%
Slovakia	Method 4	Total MSW	411	23.0%
Finland	Method 4	Total MSW	194	7.0%
Sweden	Method 2	n/a	-499	-11.4%
United Kingdom	Method 3	Hhld waste	1,066	4.0%
EU-27			**6,956**	
EU-28			**8,022**	

Source: Eunomia (2018a) Study to Identify Member States at Risk of Non-Compliance with the 2020 Target of the Waste Framework Directive and to Follow-up Phase 1 and 2 of the Compliance Promotion Exercise, Final report to DG Environment, European Commission

*Note: Romania is considering changing to Method 2, but no data on its performance according to Method 2 is currently available.

Key: Hhld = Household, Mun = Municipal, Pa = Paper, Pl = Plastic, G = Glass, M = Metal

In relation to the UN Sustainable Development Goal to halve per capita food waste at the retail and consumer levels by 2030, as reflected within the 2018 Waste Framework Directive, official data from individual Member States is not yet available. Member

States will be required to monitor food waste annually, starting in 2020, according to a harmonized methodology to be adopted in 2019. In the interim, data from the 2016 EU-fusions report for the European Commission (FP7) and Coordination and Support Action (CSA) is shown in Table 5-10, which is proposed to be used as a loose estimate of the compliance gap to the 2030 target. The quantifications are based on data from certain countries only, and therefore it is not possible to give figures at the Member State level.

Table 5-10 Data used for estimate of (future target) implementation gap for EU retail & consumer food waste reduction potential by 2030, measured here against 2012 data

Sector	EU food waste (million tonnes) with 95% confidence interval	EU food waste (kg per person) with 95% confidence interval
Primary production	9.1 ± 1.5	18 ± 3
Processing	16.9± 12.7	33 ± 25
Wholesale and retail	4.6 ± 1.2	9 ± 2
Food service	10.5 ± 1.5	21 ± 3
Households	46.5 ±4.4	92 ± 9
Total food waste	87.6 ± 13.7	173 ± 27
Total retail & consumer food waste in 2012	**61.6 ± 7.1**	**122.0 ± 14.0**
Estimate of compliance gap against 2030 target	**30.8**	**61.0**

Source: IVL Swedish Environmental Research Institute (2016) EU-fusions: Estimates of European food waste levels, Report for the European Commission (FP7) and Coordination and Support Action (CSA), *https://www.eu-fusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf*

For the construction and demolition waste 'material recovery' target of 70% by 2020 (which includes preparation for reuse, recycling and other material recovery including backfilling operations), the latest Eurostat data showed that all Member States other than Cyprus, Slovakia and Sweden were attaining the target. It has been reported that issues with the quality of reported data, and around interpretation of the definition of and monitoring of backfilling, is problematic for a true analysis of implementation under this target (Eunomia, 2014). These same data issues are the reason that the targets were not reviewed within the Circular Economy Package, with any updates to the targets instead deferred to the end of 2024 to allow time for more experience and better availability of reliable data on C&D waste (EC 2014d, SWD(2014)0207). Actions taken by the Commission in the interim include development of pre-demolition guidelines to boost high-value recycling in the sector, as well as the EU construction and demolition waste protocol with the aim of increasing confidence in the C&D waste management process and trust in the quality of C&D recycled materials (EC 2018d, EC 2016e). The 2011 edition of this report found that the overall costs in terms of not realised environmental benefits for C&D waste are relatively small. The value as recycled material is relatively low and there is not a large GHS emission avoidance potential. Since 2011, according to the Eurostat data, ten additional countries have met their implementation gaps on this target - although Sweden was meeting the target rate in 2011 and has since slipped to 61%. This implies that the already relatively low impact of not attaining the construction and demolition recycling target has likely shrunk even further between 2011 and 2019.

Landfill Directive (EU) 2018/850

The implementation gaps for the Landfill Directive quantitative targets are calculated as the difference in tonnage between the target performance and actual performance using 2015 Implementation Report data, which is the most up to date data provided by Member States themselves. The dataset from this source is incomplete, so for a number of countries, missing data was filled from latest available data from a range of sources including EEA reports and Member State factsheets.

Table 5-11 Implementation gap for the reduction target of biodegradable municipal waste sent to landfill

Member State	Current implementation gap		Future implementation gap	
	Tonnes of biodegradable waste (kt)	%	Tonnes of biodegradable waste (kt)	%
Belgium	-1,452	-35%	-1,448	-35%
Bulgaria*	494	22%	831	37%
Czech Republic*	71	5%	301	20%
Denmark	-635	-35%	-635	-35%
Germany	-9,944	-35%	-9,944	-35%
Estonia*	-103	-32%	-55	-17%
Ireland	110	9%	110	9%
Greece*	1,801	86%	2,116	101%
Spain	1,424	12%	1,424	12%
France	-808	-4%	-808	-4%
Croatia*	492	65%	605	80%
Italy	-267	-2%	-267	-2%
Cyprus*	115	44%	154	59%
Latvia*	86	19%	155	34%
Lithuania*	-155	-21%	-46	-6%
Luxembourg	-31	-21%	-31	-21%
Hungary	-425	-18%	-425	-18%
Malta*	49	34%	70	49%
Netherlands	-759	-32%	-759	-32%
Austria	-936	-35%	-936	-35%
Poland*	-796	-18%	-139	-3%
Portugal*	-85	-4%	253	11%
Romania*	868	18%	1,588	33%
Slovenia*	-144	-22%	-47	-7%
Slovakia*	-1	0%	140	15%
Finland	-126	-6%	-126	-6%
Sweden	-671	-26%	-671	-26%
United Kingdom*	-10,145	-28%	-4,792	-13%
EU 27	**5,510**		**7,748**	
EU 28	**5,510**		**7,748**	

Main source: Eunomia (2018b) Final Implementation Report for Directive 1999/31/EC on the Landfill of Waste, Report to the European Commission

Note: * denotes countries which have a time derogation for 2016 target

Current targets within the Landfill Directive are focussed on the amount of biodegradable municipal waste sent to landfill. Data within the Member State Landfill Directive implementation reports is limited as only 12 Member States have supplied data, so this has been supplemented from other national sources, evaluation studies, and factoring of historic data to provide a complete dataset [noting that this is not an official dataset endorsed by Member States, Eurostat, or the Commission]. The data summarised in Table 5-11 shows there is a current 5,510kt implementation gap across the EU-28 for meeting this target. Greece provides the highest contribution to the EU implementation gap and is also the furthest away from meeting their target, as they sent more waste to landfill in the current performance year (2015) than the baseline year for the target (1995).

Table 5-12 Implementation gap for target limiting overall municipal waste sent to landfill

Member State	Implementation gap against current target		Implementation gap against future (2035) target	
	Tonnes of total MSW (kt)	%	Tonnes of total MSW (kt)	%
Belgium	No such target in force		-438	-9%
Bulgaria			1,563	54%
Czech Republic			1,431	40%
Denmark			-400	-9%
Germany			-4,400	-9%
Estonia			2	0%
Ireland			275	11%
Greece			3,879	72%
Spain			9,622	47%
France			4,247	12%
Croatia			1,120	67%
Italy			4,420	15%
Cyprus			356	65%
Latvia			436	54%
Lithuania			252	20%
Luxembourg			25	7%
Hungary			1,516	41%
Malta			207	73%
Netherlands			-758	-9%
Austria			-361	-7%
Poland			4,166	36%
Portugal*			1,695	35%
Romania			3,054	59%
Slovenia			-18	-2%
Slovakia			1,047	55%
Finland			-187	-7%
Sweden			-411	-9%
United Kingdom			2,995	9%
EU 27			**41,186**	
EU 28			**42,306**	

Source: Eurostat database (env_wasnun), accessed October 2018.
Note: * denotes use of data from 2015

The long-term future target within the latest Landfill Directive includes a limit on total MSW sent to landfill, which will come into force from 2035. Table 5-12 shows a 42,306kt implementation gap across the EU-28 when considering current performance against this future target.

In addition to the performance targets, all landfilling within the EU must be within compliant facilities. Failure to implement this aspect of the legislation can have significant impact. Although cases of illegal landfill are expected to have reduced in many areas of the EU, it is clear that violations still exist. For instance, Spain was issued with an ultimatum by the European Commission to take action against the presence of over 1,500 illegal dumps on the 12th November 2018.[25]

Packaging Directive

To calculate the implementation gap for the recycling rate of packaging by weight, the % difference between the target rate and the actual rate was calculated. Following this, the difference between the tonnage necessary to be recycled in each Member State to meet the target and actual tonnage recycled was also calculated. Data is available for 2016 from Eurostat. Again, the negative/grey values observed in the table represent where there is no implementation gap and the target has been exceeded. Implementation gaps for the overall packaging recycling targets are shown in Table 5-13 for each country. For the material by material implementation gaps, the data is summarised at the EU-28 and EU-27 (excluding UK) level in Table 5-14.

[25] https://www.euroweeklynews.com/2018/11/12/spain-could-face-court-of-justice-action-for-illegal-landfills/#.W-sJtTGYRhE

Table 5-13 Implementation gap for recycling overall packaging waste by weight

Member State	Implementation gap against current overall recycling target for packaging		Implementation gap against future (2030) overall recycling target for packaging	
	Tonnes of waste (t)	%	Tonnes of waste (t)	%
Belgium	-300,943	-16.9%	-211,907	-11.9%
Bulgaria	5,054	1.2%	26,114	6.2%
Czech Republic	-118,459	-10.3%	-60,954	-5.3%
Denmark	-130,962	-14.0%	-84,190	-9.0%
Germany	-1,034,810	-5.7%	-127,082	-0.7%
Estonia	20,061	9.0%	31,206	14.0%
Ireland	-19,815	-2.0%	29,722	3.0%
Greece*	34,075	4.6%	71,113	9.6%
Spain	-383,427	-5.3%	-21,703	-0.3%
France	-126,914	-1.0%	507,656	4.0%
Croatia	23,649	10.3%	35,130	15.3%
Italy	-241,436	-1.9%	393,922	3.1%
Cyprus*	4,676	6.3%	8,388	11.3%
Latvia	16,895	7.3%	28,466	12.3%
Lithuania	-16,438	-4.5%	1,826	0.5%
Luxembourg	4,467	3.5%	10,849	8.5%
Hungary	182,979	15.3%	242,776	20.3%
Malta*	13,518	23.9%	16,346	28.9%
Netherlands	-238,782	-7.6%	-81,689	-2.6%
Austria	-24,149	-1.8%	42,932	3.2%
Poland	394,626	7.0%	676,502	12.0%
Portugal	67,854	4.1%	150,602	9.1%
Romania*	127,103	9.1%	196,940	14.1%
Slovenia*	-4,624	-2.0%	6,935	3.0%
Slovakia	-4,145	-0.8%	21,763	4.2%
Finland	2,129	0.3%	37,608	5.3%
Sweden	-42,053	-3.2%	23,655	1.8%
United Kingdom	34,426	0.3%	608,200	5.3%
EU 27	**897,086**		**2,560,451**	
EU 28	**931,513**		**3,168,651**	

Source: Eurostat data

Table 5-14 Implementation gaps for recycling packaging waste by weight

Packaging Material	Member States Combined	Implementation gap against current material specific recycling targets for packaging (t)	Implementation gap against future (2030) material specific recycling targets for packaging (t)
Plastic	EU-27	1,091,448	1,733,544
	EU-28	1,206,763	1,961,913
Wood	EU-27	45,602	220,062
	EU-28	45,602	220,062
Ferrous metal	EU-27	246,669	556,470
	EU-28	357,396	740,819
Aluminium	EU-27	1,234,462	1,599,577
	EU-28	1,501,414	1,940,151
Glass	EU-27	230,830	484,837
	EU-28	305,248	679,284
Paper & card	EU-27	63,762	881,895
	EU-28	63,762	1,024,291

Source: Eurostat data

WEEE Directive

The implementation gaps under the WEEE Directive were calculated as the % difference between the target and actual performance, and the difference between the tonnage necessary to be collected or recycled to meet the target and actual tonnage reported. Eurostat data from 2016 was used for these calculations. The negative values show Member States which do not have an implementation gap. Dashes are used where data is not available.

Table 5-15 shows that most Member States, for whom the data is available, have exceeded the collection rate target for WEEE. However, as of January 2019, new and much more ambitious collection targets take effect and only 4 Member States are currently exceeding this target.

Table 5-15 Implementation gaps for collection rate of WEEE

Member State	Implementation gap against current overall collection rate target for WEEE (2016-2018)		Implementation gap against future overall collection rate target for WEEE (2019+)	
	Tonnes	%	Tonnes	%
Belgium	7,193	2.4%	67,259	22.4%
Bulgaria	-32,959	-52.0%	-20,262	-32.0%
Czech Republic	-9,967	-5.5%	26,189	14.5%
Denmark	-4,311	-2.9%	25,346	17.1%
Germany	1,742	0.1%	348,919	20.1%
Estonia	-6,246	-42.1%	-3,275	-22.1%
Ireland	-11,636	-13.2%	6,040	6.8%
Greece	4,671	3.6%	30,632	23.6%
Spain	5,102	0.9%	118,255	20.9%
France	-4,781	-0.3%	314,892	19.7%
Croatia	-20,253	-49.1%	-11,998	-29.1%
Italy	-	-	-	-
Cyprus	-	-	-	-
Latvia	3,443	18.7%	7,147	38.7%
Lithuania	480	1.6%	6,501	21.6%
Luxembourg	-854	-7.2%	1,525	12.8%
Hungary	-17,077	-18.5%	1,406	1.5%
Malta	-	-	-	-
Netherlands	-9,364	-2.9%	55,107	17.1%
Austria	-8,630	-5.1%	25,252	14.9%
Poland	-3,061	-0.6%	99,272	19.4%
Portugal	-13,482	-10.8%	11,442	9.2%
Romania	-	-	-	-
Slovenia	-	-	-	-
Slovakia	-5,427	-10.7%	4,701	9.3%
Finland	-2,928	-2.3%	22,503	17.7%
Sweden	-52,610	-21.4%	-3,449	-1.4%
United Kingdom	-239,169	-14.7%	86,766	5.3%
EU 27	**22,631**		**1,172,388**	
EU 28	**22,631**		**1,259,154**	

Source: Eurostat

In relation to the recycling and recovery targets, most Member States report that they are in compliance with their targets, and the data indicates only small implementation gaps. The data is summarised for the whole EU-27 or EU-28 [the data is the same since the UK is in compliance] in Table 5-18.

Table 5-16 Implementation gaps for recycling and recovery rates for WEEE

WEEE Material	Member States Combined	Implementation gap against material specific recycling targets for WEEE (tonnes)	Implementation gap against material specific recovery targets for WEEE(tonnes)
1: Large household appliances	EU-27 / EU-28	1,848	2,272
2: Small household appliances	EU-27 / EU-28	0	317
3: IT and telecommunications equipment	EU-27 / EU-28	4,004	7,251
4: Consumer equipment and photovoltaic panels	EU-27 / EU-28	0	1,708
5: Lighting equipment	EU-27 / EU-28	5	22
5a: Gas discharge lamps	EU-27 / EU-28	257	0
6: Electrical and electronic tools	EU-27 / EU-28	0	386
7: Toys, leisure and sports equipment	EU-27 / EU-28	0	3
8: Medical devices	EU-27 / EU-28	15	61
9: Monitoring and control instruments	EU-27 / EU-28	0	13
10: Automatic dispensers	EU-27 / EU-28	175	322

Batteries Directive

To calculate the implementation gap for the targets stipulated in the Batteries Directive, the % difference between the target and actual performance was calculated, followed by the difference between the tonnage necessary to be collected or recycled in each Member State to meet the target and the actual tonnage reported. These calculations are based on the most up-to-date data on the Eurostat batteries database. This means that for the collection rate target, data from 2016 is used (unless otherwise stated), and for the battery recycling targets, 2015 data is used. The negative values show countries which do not have an implementation gap. Dashes are used in the table where data is not available. No further future targets apply in the case of batteries, so the current implementation gap also remains relevant for the future implementation gap assessment.

Table 5-17 Implementation gap for collection rate of batteries and recycling efficiency of battery types (Target 2)

Member State	Implementation gap against 45% collection rate target		Implementation gap against recycling efficiency targets (lead-acid target 65% by average weight; nickel-cadmium target 75% by average weight; other batteries and accumulators target 50% by average weight)					
	Number (t)	%	Lead acid (t)	%	Nickel Cadmium	%	Other (t)	%
Belgium	-1,146	-25.7	-	-15.9	-	-6.6	-	-13.4
Bulgaria	-26	-3.5	-	-32.8	-	-	-	-18.9
Czech Republic	-280	-7.0	-	-8.5	-	-19.6	-	-10.4
Denmark	15	0.4	-	-15.0	-	-3.9	-	-9.3
Germany	-533	-1.2	-	-20.1	-	-3.5	-	-26.3
Estonia	59	14.4	-	-14.2	-	-	-	-4.3
Ireland	-71	-3.0	-	-25.0	-	-3.5	-	-33.4
Greece	-	-	-	-	-	-	-	-
Spain	803	6.8	-	-16.5	-	-3.6	-	-30.4
France	154	0.5	-	-16.8	-	-5.9	-	-14.1
Croatia	-186	-55.2	-	-11.6	-	0.4	-	-16.6
Italy	2,609	9.7	-	-26.4	-	-3.3	-	-10.0
Cyprus	35	17.0	-	-5.4	-	-0.6	-	-12.5
Latvia	85	15.0	-	-5.0	-	-1.0	-	-2.0
Lithuania	-55	-7.7	-	47.2	-	-	-	-
Luxembourg	-33	-18.4	-	-25.0	-	-5.6	-	-8.9
Hungary	-141	-8.1	-	-26.2	-	-	-	-10.2
Malta	15	17.8	-	-13.9	-	-	-	-
Netherlands	-322	-4.0	-	-13.0	-	-4.0	-	-6.0
Austria	-187	-4.2	-	-19.5	-	-6.6	-	-32.2
Poland	732	6.0	-	-11.5	-	-24.5	-	-17.4
Portugal	58	3.4	-	-5.5	-	-19.2	-	-31.4
Romania	-	-	-	-16.7	-	-10.3	-	-
Slovenia	67	9.0	-	-12.3	-	-3.4	-	-
Slovakia	-26	-2.6	-	-27.3	-	-5.2	-	-11.1
Finland	-28	-1.0	-	-17.9	-	-4.7	-	-46.0
Sweden	-6	-0.1	-	-9.2	-	-1.5	-	-17.4
United Kingdom	0	0.0	-	-23.1	-	-	-	-49.5
EU-27	**4,631**							
EU-28	**4,631**							

Source: Eurostat database

For the collection rate target, Table 5-17 shows the total implementation gap across all Member States of 4,631t. Negative values are also included, which shows by how many tonnes Member States have exceeded the target. Italy has the largest implementation gap, followed by Spain.

For the recycling efficiency targets, data is only available for the recycling efficiency as a percentage rate and not for the equivalent tonnage. As a result, the total implementation gap across the EU cannot be measured. However, the % difference between the target and actual rate reported still allows us to compare individual Member State performance against targets. Table 5-17 shows (where there is data available) only two instances of an implementation gap, according to the reported Eurostat data.

ELV Directive

The implementation gaps for the targets set under the ELV Directive have been calculated as the percentage difference between the target rate and actual rate reported, and the difference between the tonnage necessary to meet the targets and the actual tonnage reported within the Eurostat data. The most up-to-date data from Eurostat is used, which is from 2016 unless otherwise stated. The negative values show countries which do not have an implementation gap and have instead exceeded the set target.

Table 5-18 Implementation Gap for recovery and reuse (Target 1) and recycling and reuse (Target 2) of ELVs in Member States

Member State	Implementation gap against recovery and reuse target		Implementation gap against recycling and reuse target	
	Number (t)	%	Number (t)	%
Belgium	-1,668	-1.4%	-8,458	-7.1%
Bulgaria	-552	-0.6%	-8,839	-9.6%
Czech Republic	-560	-0.4%	-7,416	-5.3%
Denmark	-2,121	-2.1%	-3,835	-3.8%
Germany	-12,604	-3.0%	-18,068	-4.3%
Estonia	734	5.2%	-113	-0.8%
Ireland	2,290	2.2%	-1,041	-1.0%
Greece	-5,922	-13.0%	-6,898	-15.0%
Spain	10,285	1.6%	-2,571	-0.4%
France	2,207	0.2%	-20,976	-1.9%
Croatia	-851	-4.5%	-1,683	-8.9%
Italy	134,676	12.4%	27,154	2.5%
Cyprus	92	1.8%	-270	-5.3%
Latvia	41	0.5%	-767	-9.3%
Lithuania	-111	-0.4%	-2,747	-9.9%
Luxembourg	-21	-1.0%	-21	-1.0%
Hungary	-100	-0.8%	-1,303	-10.4%
Malta**	1,417	50.0%	1,133	40.0%
Netherlands**	-1,961	-1.0%	-2,158	-1.1%
Austria	-862	-1.9%	-997	-2.2%
Poland*	-9,868	-2.0%	-47,887	-9.7%
Portugal	2,448	2.9%	1,266	1.5%
Romania*	1,631	4.2%	-39	-0.1%
Slovenia**	233	3.7%	-57	-0.9%
Slovakia	-836	-2.4%	-3,867	-11.1%
Finland	-2,835	-2.3%	2,712	2.2%
Sweden	963	0.4%	-4,094	-1.7%
United Kingdom	34,897	2.8%	-17,449	-1.4%
EU-27	**157,018**		**32,266**	
EU-28	**191,915**		**32,266**	

Source: Eurostat

Note: * denotes 2015 data, ** denotes 2014 data

For recovery of ELVs, Table 5-18 shows that there is an implementation gap of 191,915t. Yet, just over half of Member States have exceeded this target. Italy represent the largest contribution to this gap, followed by the United Kingdom. However, in percentage terms, the Member State furthest away from meeting the target is Malta. For recycling of ELVs there is an implementation gap of 32,266t. This target has been met and exceeded by most Member States, however Italy are the greatest contributor to this implementation gap and Malta are furthest away from reaching the % rate target. Overall, this data indicates there is a larger implementation gap across Member States for 'recovery and reuse' of ELVs than for 'recycling and reuse'.

As was also the case under the Batteries Directive, no further future targets apply in the case of ELVs, so the current implementation gap also remains relevant for the future implementation gap assessment.

Waste Shipment Regulation

There is reported data on the prevalence of illegal shipments, but clearly it is difficult to ascertain the precise level of illegal shipments of waste. This is highlighted by the fact that some Member States reported no illegal shipments of waste, which seems highly unlikely, and instead implies gaps within waste shipment inspections.

IMPEL has undertaken projects to attempt to determine the true level of illegal shipments of waste; the 2011 edition of this report noted that some 19% of total trans-frontier shipments of waste were found to be illegal between 2008 and 2009.

There are reasons to believe that the level of illegal waste shipments may have changed since 2011. Previous data indicated 37% of illegal shipments involved WEEE and ELVs sent to Africa or poorly sorted dry recyclables sent to Asia (Bipro, 2009). The illegal trade in WEEE has been a focus for both the EU and Interpol since 2011 with the Countering WEEE Illegal Trade (CWIT) project, whilst the Chinese government's Operational National Sword has added stringency to end destination checks on mixed dry recycling. These issues may be elaborated within the forthcoming report on the evaluation of the Waste Shipments Regulation[26], and any quantitative findings ought to be considered to supplement the results presented below.

5.4 Implementation gap cost

Implementation gap impacts

Summary of implementation gap impacts

There are a number of quantifiable impacts associated with waste management, ranging from lost value of potentially recyclable material through to health impacts from emissions. The discussions and tables below summarise the quantifiable impacts, but there are many other potential advantages associated with attaining the future waste management targets which have not been possible to quantify, notably:

- Health and environment benefits due to illegal activity (illegal landfill, illegal exports):
  - Illegal landfilling of waste or sub-standard management practices causing unknown damage to the environment, due to mismanagement of emissions to land, water and air.
- Not realised market benefits:
  - Circular Economy benefits (growth in repair industries, development of secondary materials markets, business opportunities from additional materials recycling and circular business models, growth in competitiveness etc.) beyond the environmental and health costs above which are more linked to recycling targets.
  - Reduced costs of extraction of raw materials.

[26] http://ec.europa.eu/environment/waste/shipments/evaluation_of_the_wsr.htm

- Spillover effects:
  - Potentially increased use of more polluting power sources where non-recycled waste is landfilled rather than undergoing energy recovery.
- Uncertainty and market distortions:
  - Uneven implementation can lead to different regulatory costs for companies across the EU and affects fair competition.
- Litigation costs for Member States:
  - For instance European Court of Justice and Member State legal costs, plus fines payable by Member States, relating to illegal landfill etc.
- Administrative costs for industry:
  - The intention of this from the 2011 report was that different implementation leads to different administrative requirements for companies operating across the EU (though it was stated that there is no hard evidence for this).

Material Lost to the Economy

A primary direct impact of not meeting the various waste targets set out in EU legislation is the loss of millions of tonnes of material that would otherwise be recycled, representing a significant loss in material value which we are able to place an approximate value on. In addition, this also leads to increased greenhouse gas and air quality emissions from additional landfill or incineration facilities.

Non-implementation of the 2020 Waste Framework, Packaging and Landfill Directive targets is expected to result in some 8 million tonnes of material not recycled, with some 5 million tonnes of this being biodegradable waste sent to landfill. For the 2035 targets, this rises to 20 million tonnes of waste not recycled, and 42 million tonnes of extra landfill.

The food waste reduction targets set out in the Waste Framework Directive currently have an implementation gap of some 30.8m tonnes (as indicated within Table 5-10 above). This has a significant impact in terms of lost value of the food.

Environmental and Human Health Impacts

Treatment of this waste has various associated impacts beyond the simple loss of material value. For example, disposal and energy recovery of waste have far higher levels of greenhouse gas emission compared to recycling or reuse. Table 5-19 summarises the additional GHG emissions associated with not implementing future waste targets, taken from Eunomia modelling which compares a baseline scenario of no change from 2019 to a scenario in which all major waste targets are met by all Member States in 2035. It is not possible to apportion these targets to the individual directive targets.

Table 5-19 Additional GHG Emissions, Baseline Scenario vs Full Implementation

Member State	Additional GHG Emissions (kt CO_2e)
Austria	-239
Belgium	-183
Bulgaria	-275
Croatia	-309
Cyprus	-186
Czech Republic	-1,611
Denmark	-243
Estonia	-32
Finland	5
France	-2,096
Germany	-296
Greece	-1,130
Hungary	-204
Ireland	-619
Italy	-2,026
Latvia	-69
Lithuania	-91
Luxembourg	-31
Malta	-100
Netherlands	-438
Poland	-701
Portugal	-579
Romania	-1,405
Slovakia	-460
Slovenia	-12
Spain	-2,331
Sweden	-1,004
United Kingdom	-3,982
EU-27	**-16,662**
EU-28	**-20,644**

In addition to this, the calculated impact of the compliance gap for the future (UN SDG related) food waste reduction targets at an EU level is around 77m tonnes of greenhouse gasses.

However, greenhouse gas emissions are not the only potential negative impact of poor waste management. A key principle of EU waste legislation is protecting human health and the environment from the various risks associated treating and disposing of waste. This is an issue for non-compliant landfilling of waste, where risks include not just methane and other GHG emissions, but also the potential for leachate from waste into the environment, as well as public health problems. These issues are controlled in compliant landfills, but there are no such guarantees for illegal landfills. Furthermore, even minor waste streams can pose risks; for example batteries, which contain various hazardous substances such as nickel, lead or cadmium.

Compliance Gap Impacts under the WEEE, ELVs and Batteries Directives

Whilst the most substantial tonnages of material are associated with the Waste Framework Directive, Packaging Directive and Landfill Directive targets, the minor waste streams covered by other directives can also represent a significant loss of value if targets are not met. For WEEE in particular precious metals and other rare materials used in manufacture are lost if the product is disposed of, whilst potential reuse of components from ELVs represents a significant foregone benefit where an implementation gap exists.

Implementation gap costs

Summary of implementation gap costs

Table 5-20 presents the key findings from the assessment of waste implementation gap costs. Further detail on the various aspects are provided in the subsections that follow.

Table 5-20 Implementation Gap Cost Summary (summarised from discussions below), EUR/annum

Environmental Sector	Indicator	Implementation Gap Costs Against Current Targets	Implementation Gap Costs Against Future Targets	Comments
Waste	Targets as contained in the revised directives on waste (the CEP)	EUR 1.7 bn	EUR 12 bn	Largely foregone material value, some GHG and other AQ impacts
	Food waste prevention Sustainable Development Goal	n/a	EUR 92 bn	Largely wasted material value and GHG impacts
	Landfill compliance (illegal landfill)	EUR 3m to EUR 1.3 bn	Future target same as current	The large range is based on the wide range of estimates as to number of illegal landfills (0.4% to 15%)
	ELV Directive	EUR 0.15 bn	Future target same as current	Lost material value and potential reuse of parts value
	WEEE Directive	EUR 1.4 bn	Future target same as current	Lost material value (including precious metals) and potential reuse value
	Batteries Directive	Unknown	Future target same as current	-
	TOTAL	**Circa EUR 4 bn**	**Circa EUR 107 bn**	

There is only a relatively small difference between the calculated implementation gap for the 2011 report (around EUR 90 bn) and the current report. However, the EUR 107 bn figure given above accounts for EUR 92 bn cost of not implementing the Food Waste Sustainable Development Goal which was not incorporated into legislation in 2011, and thus not considered for that report. This indicates a very large difference between the results of the 2011 report and the current report relating to the Waste Framework, Packaging, Landfill, WEEE, Batteries and ELV Directives. This is largely due to two factors; the benefits of waste prevention and the cost of not-realised benefits from recycling.

Since 2011, there is evidence that decoupling of waste generation from GDP has taken place, and therefore it may be taken that compliance with the general objective for waste prevention has been achieved. This accounts for some EUR 15 bn of the 2011 figure.

The 2011 report also contained some EUR 45 bn of lost material value due to not achieving recycling targets. Calculations using the difference in recycling tonnages between 2019 and 2035 and typical current market prices have instead arrived at a figure of EUR 8 bn. There is not enough information on the calculations used in the 2011 work to determine why a much higher figure was previously derived. For this current report, the lost material value was calculated from the material specific modelling of Member State municipal and packaging waste management within the 'European Reference Model on Waste Generation and Management', set against current market prices.

Implementation gap cost evaluations against existing targets

Major Waste Directives

Much of the benefit of the existing targets has already been realised; this is due to the relative levels of performance and the imminent deadline for those targets. However, there remains a potential implementation gap of some EUR 1.7 bn from not-attainment of the existing Waste Framework Directive, Packaging Directive and Landfill Directive targets, as shown below. Table 5-21 demonstrates the potential value of material lost to the economy from non-implementation of the 2020 MSW recycling targets, based on performance modelling conducted by Eunomia and material values sourced from WRAP.

Table 5-21 Material Value associated with 2020 WFD Implementation Gap

Member states	Implementation Gap Cost (EUR million)
Austria	0
Belgium	0
Bulgaria	53
Croatia	35
Cyprus	11
Czech Republic	0
Denmark	0
Estonia	9
Finland	37
France	0
Germany	0
Greece	82
Hungary	24
Ireland	0
Italy	0
Latvia	19
Lithuania	0
Luxembourg	0
Malta	13
Netherlands	0
Poland	24
Portugal	127
Romania	445
Slovakia	83
Slovenia	22
Spain	553
Sweden	0
United Kingdom	177
EU-27	**1,538**
EU-28	**1,715**

In addition to the quantitative targets, the Landfill Directive contains a stipulation on how to manage waste sent to landfill, but some waste is landfilled illegally in sites that do not conform to these standards. By definition, it is difficult to monitor the amount of waste placed in illegal landfills, or the amount to which this may have changed since the 2011 edition of this report. However, assuming the same unit cost figures for environmental damage and containment and clean-up of illegal landfills, it is possible to determine how the reduction in overall landfill rates may have impacted the costs of illegal landfilling. The 2011 report estimated a total cost of around EUR 4.5-5.5 bn; assuming illegal landfilling has reduced at the same rate as legal landfilling, this amount could now be around EUR 4-4.5 bn. In reality, specific actions taken to close down illegal landfills, and infraction proceedings undertaken by the Commission, may have reduced illegal landfilling at a faster rate. Because of this, the figure of EUR 4-4.5 bn is likely an upper limit to the potential cost of non-implementation of these elements of the Landfill Directive.

WEEE Directive

For the WEEE Directive, there is a potential maximum EUR 0.5 bn cost to not meeting the 2019 WEEE collection target in foregone reuse benefits alone. This is in addition to a potential EUR 0.5 bn value from recycling and recovery of glass, plastics and metals from WEEE not suited to reuse. In addition to this, the Waste and Resources Action Programme estimates that there are 30 grams of precious metals disposed per tonne of WEEE (WRAP 2012), leading to a potential loss of around 35 tonnes of these materials each year due to non-implementation of the WEEE targets, constituting 25.1t of silver, 7.6t of gold, and 2.5t of platinum group metals. At current market prices, these lost materials are worth some EUR 0.3 bn.

ELV Directive

The potential cost of non-implementation of the ELV Directive targets is much lower than the major waste directives and the WEEE Directive, due to most Member States performing close to or above target levels. The remaining implementation gap represents a potential cost of some EUR 146m, comprising EUR 118m in the financial value of potential reuse of parts (particularly from 'premature' ELVs written off before the end of their natural lives), and EUR 28m in lost material value (based on the typical composition of ELVs (BioIS 2006) and current WRAP material prices).

Batteries Directive

Very little information is available on the potential costs of non-implementation of the Batteries Directive. There are valuable metals that can be recovered and so a potentially high value of material lost through non-implementation of the targets. The environmental costs include the saved energy and GHS from use of virgin raw materials instead of recycled material. Furthermore, the risk of hazardous substances entering the environmental means high costs if the collection rate is low. However, the implementation gap for this waste stream is small – just 4,631 tonnes overall – and as such impacts and costs are likely to be correspondingly minor.

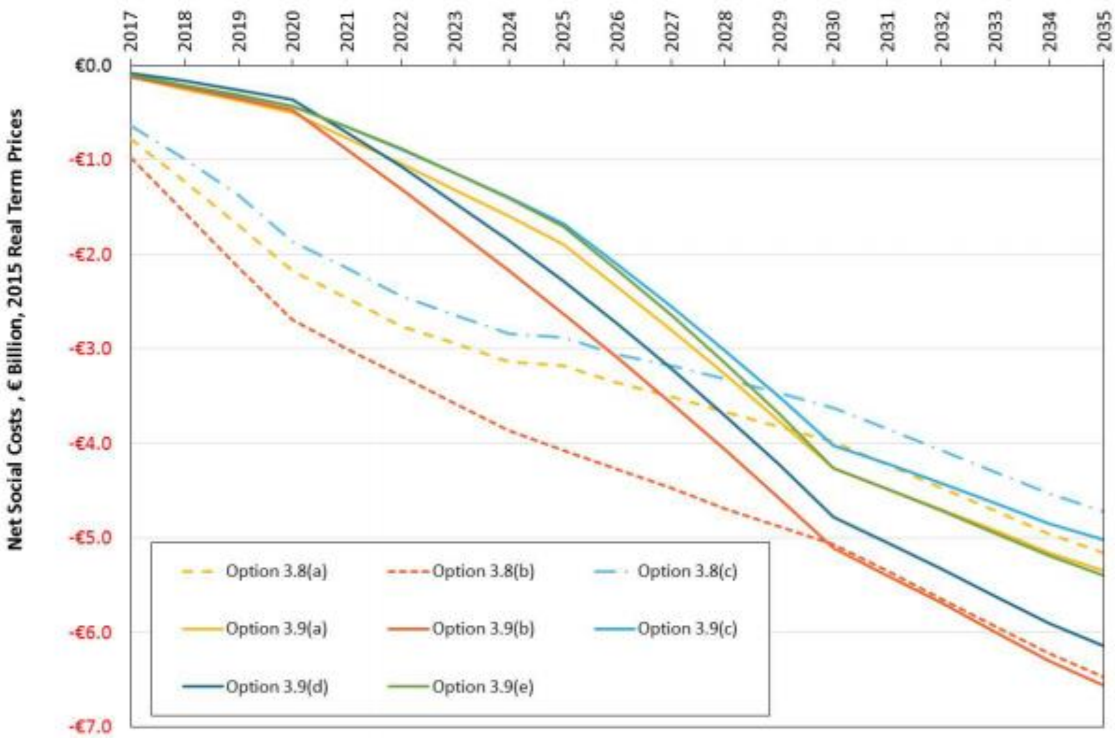
Waste Shipment Regulation

There are potentially significant environmental and human health costs associated with illegal transport of waste to end destinations with inadequate treatment facilities, particularly for hazardous waste such as WEEE. These costs are in addition to economic losses for EU treatment facilities and legitimate waste shipment companies, which are undercut by illegal shipments to unlicensed, inadequate and dangerous treatment facilities in third countries.

Implementation gap cost evaluations against future targets

Analysis undertaken in support of the impact assessment on the review of EU waste management targets within the Commission's Circular Economy Package is of interest to consider here (EC 2015c). Taken directly from this source, Figure 5-1 summarises the net social costs (comprised of both financial and environmental costs) of two options compared to a modelled 'business as usual' baseline. These two options (3.8 and 3.9) both centred around 65% MSW recycling targets and associated landfill reduction and packaging recycling targets. The closest option in the Impact Assessment to the adopted package is Option 3.9(c), which measures the impact of a 65% MSW recycling target combined with a 10% landfill reduction target as eventually adopted. However, the Impact Assessment examines these combined with a packaging recycling target of 75% (with 70% being adopted) and a deadline of 2030 (with 2035 being adopted) and, as such, the costs presented in the Impact Assessment are not directly analogous to the adopted package of targets. The Impact Assessment also includes costs which are not in scope of this work, and as such is not directly comparable to the figures provided above. However, it serves to demonstrate the potential difference caused by relatively small policy variations; the difference between the lowest and highest cost scenarios shown is just 5% in the MSW recycling target, but this equates to EUR 1.5 bn difference per annum by 2035. One important note about the impacts of waste legislation is that it is difficult to measure each piece of legislation in a vacuum. For example, a landfill ban alone may simply push waste into energy recovery, with different impacts compared to a scenario where material is instead sent to recycling or prevented entirely. For this reason, the Commission's impact assessment considers the entire package of potential waste legislation together. These interconnections also have an impact when considering the net cost of any of the specific targets; for example, meeting the MSW recycling targets in the Waste Framework Directive may imply progress towards or attainment of targets in the Packaging, Landfill, WEEE or Batteries Directives etc. Nevertheless, since it is arguably possible to meet the individual policy objectives for each waste stream individually (i.e. it is possible for Member States to meet municipal waste targets without any additional WEEE recycling etc.) then we consider the legislations separately and the implementation gap costs as additive.

Figure 5-1 Net Social Costs and Benefits of Waste Legislation (from CEP Impact Assessment Supplement)



Source: European Commission (2015c) Additional analysis to complement the impact assessment SWD (2014) 208 supporting the review of EU waste management targets *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015SC0259&from=EN*

Figure 5-1 indicates that the overall benefit of applying EU legislation – both financial and social – is roughly EUR 5 bn per annum for the chosen option (Option 3.8(c)). However, this Impact Assessment includes some costs out of scope for this report and does not allow us to isolate the benefits of interest (i.e. the value of materials associated with forgone recycling). Nevertheless, this source does provide an estimated cost of externalities at roughly EUR 4 bn/annum (current performance compared to the long-term targets). Included in these benefits are GHG and air quality benefits. Table 5-22 shows the monetised impacts of additional GHG emissions associated with not implementing the targets - calculated from recently updated scenarios within the European Reference Model on Waste Generation and Management (which itself was used within the impact assessment) - assuming a CO2e price of EUR 169/t (this being the social cost of carbon, average value at 1% pure rate of time preference, from the IPCC summary of literature - data converted and updated to 2019 prices, source: (IPPC, 2014)).

Table 5-22 Monetised GHG impacts associated with not implementing future CEP targets

Member State	Forgone GHG Benefits (EUR million)
Austria	40
Belgium	31
Bulgaria	47
Croatia	52
Cyprus	31
Czech Republic	272
Denmark	41
Estonia	5
Finland	0
France	354
Germany	50
Greece	191
Hungary	35
Ireland	105
Italy	342
Latvia	12
Lithuania	15
Luxembourg	5
Malta	17
Netherlands	74
Poland	118
Portugal	98
Romania	237
Slovakia	78
Slovenia	2
Spain	394
Sweden	170
United Kingdom	673
EU-27	**2,816**
EU-28	**3,489**

Air quality benefits in the range of EUR 0.4 bn are also expected to be achieved with full implementation of the targets, bringing the total monetised benefits of meeting the targets in GHG and AQ terms to EUR 3.9 bn.

Other social and economic benefits associated with meeting the targets include increased employment as waste is diverted to more intensive treatments than incineration or landfill, increased public health and safety, and reductions in marine litter. These additional costs are not monetised in the Commission's Impact Assessment, nor is information available on the precise degree to which meeting the various targets would improve performance in these metrics.

In addition to these forgone benefits, there is value in the material disposed which would otherwise be recycled into the economy. For dry materials alone, these costs equate to some EUR 8.2 bn across the EU-28, as shown in Table 5-23.

Table 5-23 Evaluation of foregone material value against future waste targets

Member State	Foregone Material Value (EUR million)
Austria	186
Belgium	135
Bulgaria	63
Croatia	109
Cyprus	38
Czech Republic	149
Denmark	116
Estonia	37
Finland	34
France	1,151
Germany	842
Greece	191
Hungary	161
Ireland	222
Italy	1,161
Latvia	43
Lithuania	9
Luxembourg	13
Malta	19
Netherlands	158
Poland	631
Portugal	228
Romania	178
Slovakia	87
Slovenia	4
Spain	860
Sweden	201
United Kingdom	1,181
EU-27	**7,026**
EU-28	**8,207**

The combination of these material losses and the potential externalities equate to an overall cost for non-implementation of the CEP of EUR 12.2 bn per annum. In addition to this are the costs from the implementation gaps in the material-specific waste directives discussed above, which together are potentially in excess of EUR 1.5 bn.

The final element of cost is associated with the Waste Framework Directive goal to halve 'per-capita food waste' at the retail and consumer levels by 2030. This was quantified above to reflect an implementation gap of 30.8m tonnes per year across the EU. The value of a tonne of post-farm-gate food waste has been estimated at around EUR 2,280 per tonne (WRAP, 2018). In addition, each tonne of food waste is associated with up to 4.2 tonnes of greenhouse gas emissions (source: Defra, 2011), evaluated against the social cost of carbon taken at EUR 169/t (as above). This equates to a total annual cost for the current implementation gap of some EUR 92 bn in lost value and monetised GHG emissions.

5.5 Lessons learnt and recommendations

Of the investigations presented above for waste, where specific quantitative targets are in place within the various pieces of EU legislation, appropriate data is commonly also compiled by Member States, and reviewed and published by Eurostat. This allows for a direct evaluation of implementation gaps. In a number of cases, it has been possible to calculate costs on the basis of data produced as part of Impact Assessments on the directives themselves. One challenge has been however that often the calculated and published data presents costs and benefits together only, thus not allowing for the relevant cost data to be isolated (i.e. the foregone benefits). Fresh evaluations have been conducted as part of this current review to mitigate this, and we have been aided by having access to the European Reference Model on Waste Generation and Management used for the Impact Assessment behind the 2018 revised directives on waste.

One area which presented a singular difficulty was where Commission Decision 2011/753/EU introduced rules relating to municipal recycling targets in the 2008 Waste Framework Directive, upon which Member States could choose from several different calculation methods. This has meant that consistent data is not directly available to allow an assessment, and indeed this allows for different levels of environmental performance between Member States selecting different methods. Nonetheless, this issue ought not to occur in future assessments of this type, since future municipal recycling targets (for 2025 and beyond) are on a common basis.

The greatest challenge for the evaluation remains understanding the level of illegal activity (including but not limited to illegal landfill, and illegal shipments which lead to improper management of waste, environmental damage and lost economic value). There is a current lack of sources of information on these issues, which prevents a thorough and accurate assessment of the scale of non-implementation and associated costs. The Commission has been carrying out an evaluation of the Waste Shipment Regulation over recent years, and the forthcoming consultant's evaluation will be of interest. The Regulation itself is due for review by the end of 2020, and it can be anticipated that this should improve the future identification and measurability of waste crime, while at the same time improving implementation. Nevertheless, should greater visibility of waste crime be achieved, then more sizeable costs may become apparent than have been able to be identified as part of the current study.

6. Chemicals

6.1 EU environmental policy and law

The overall EU chemicals policy to ensure a high level of protection of human health and the environment is spearheaded by the REACH Regulation (EC) No 1907/2006 and the CLP Regulation (EC) No 1272/2008. REACH supports the phase out of chemicals, with a focus on hazardous chemicals, by providing for the registration, evaluation, authorisation, and restriction of chemicals – e.g. by establishing procedures for collecting and assessing information on the properties and hazards of substances. The CLP is about requirements when placing chemicals on the market. It does this by providing for the classification and labelling of hazardous chemical substances and mixtures to ensure that consumers and workers are informed about the hazard of chemicals, the nature of the hazard and how to handle these chemicals in a safe way.

6.2 Environmental target

Hence, the two key pieces of EU legislation are more about control in connection with using and placing chemicals on the market rather than about providing specific environmental targets. This was also the finding of the 2011 study. In any case, only part of chemicals – i.e. those of a high tonnage manufactured or imported (1000 tonnes or more per year), and of high concern or toxicity had to be registered by 1 December 2010. Furthermore, 100 tonnes or more had to be registered by 1 June 2013, while the deadline for 1 tonne or more was 1 June 2018. Requirements have thus increased since 2011, implying increased implementation efforts.

Similarly, the deadline for the CLP substance classification was 1 December 2010, while it was 1 June 2015 for mixtures.

6.3 Implementation gap

Both legislations - REACH and CLP – are more about the control of the use and placing on the market of chemicals, rather than about providing specific environmental targets. Hence, we cannot measure an implementation gap as the difference between a given chemicals pollution limit or reduction target and the corresponding pollution status.

Instead, an angle from which to assess implementation gaps is that of whether the control requirements have been implemented in the Member States and whether the control arrangements are effective. With respect to comparison with the 2011 study, it should be mentioned that both Regulations were relatively new at that time and neither had to be fully implemented by 2011 – but both must be so by now (2018). We do assess implementation gaps from this angle and with outset in the EC (2018e and 2018f) evaluation and the ECHA (2018a and 2018b) evaluation/progress reports. In addition, and similarly to the 2011 study, we address the assessment of implementation gaps from the angle of adverse health and environmental conditions caused by chemicals.

The 2018 review of REACH concludes that it is fully operational and overall achieves its objectives (EC, 2018e). The review concludes further that the impact on the protection of human health and the environment will first become visible well into the future, i.e. after several more years to come (EC, 2018f). The evidence finds that REACH delivers on the expected outcomes: the generation of information on substances that is passed along the supply chain and used to better assess and manage chemical risks. REACH is nevertheless subject to a couple of implementation issues, as identified by the review of the European Commission and/or ECHA. These relate to issues that do not indicate the presence of an implementation gap. These are for example issues with ensuring a level playing field with non-EU companies, the availability of resources for Member States for enforcement, or the delayed updating of registration dossiers (EC, 2018e and 2018f; ECHA, 2018a and 2018b). Overall, both evaluations demonstrate that while REACH is fully operational and effective in its achievement of the objective on the protection of human health and the environment, there are elements that point to some remaining implementation issues. They relate to enforcement and registration/authorisation process but are not such that they have an impact on REACH in achieving its environmental target. Based on this evidence, the review concludes that REACH is not subject to an implementation gap.

With respect to the CLP regulation, the European Commission, in 2017 issued a regulatory fitness check (EC, 2017h). The findings of the fitness check study are that the CLP can generally be considered to be effective. For example, with respect to the hazard classification of substances and mixtures under CLP, the regulation contributes to ensure a high level of protection for human health and the environment, which is also reflected by the fact that many stakeholders are satisfied on this legislative aspect. However, there are some minor challenges where more consideration is needed, like for the classification of terrestrial toxicity and immunotoxicity. In terms of the labelling requirements, the CLP delivers on its objectives, but has scope for improvement: most stakeholders view that hazard communication under the CLP has a positive impact on human health. Whereas the impact on the environment is less clear, as only a small share of stakeholders indicates the hazard communication to be effective in the environmental domain. Similar observations can be made for other aspects, such as the identification of properties of concern, the classification of combination of effects, incentive to reduce exposures and access to substances with more favourable risk profile, and the reduction in exposures as well as the incidence of accidents and diseases. Similar to the case of REACH, the findings imply that there are some, but no critical, implementation challenges that cannot be considered a gap.

Based on the findings above, it is concluded that both REACH and CLP have no implementation gap.

6.4 Implementation gap cost

The literature lists many health impacts from chemicals pollution, hereunder cancer, neurotoxicological disease, asthma, reduced female and male reproductive disease, and allergic reaction. REACH essentially provides the mechanisms to reduce those impacts. Given that the REACH and CLP exhibit not implementation gap, there are however no associated implementation gap impacts nor costs. Therefore, no further analysis is conducted.

6.5 Lessons learnt and recommendations

Although not undertaken under this study, as no gap has been identified, there is a challenge in quantifying the implementation gap, as there is no quantitative indicator that can be used to determine the implementation gap. Whereas it is possible to obtain a qualitative description of existing challenges, as done above, it is problematic to translate any identified gap into a meaningful indicator. One solution mitigating this challenge is conducting analyses of the implementation gap costs, based on hypothetical assumptions about the gap. Thereby, implementation gap costs can be derived for several hypothesised scenarios that illustrate the potential cost. Given that such a cost would merely serve illustrative purposes, these costs should not enter the final calculation.

A second possible challenge is the attribution of the environmental impacts of an implementation gap under European chemicals policy as a whole and under the individual pieces of chemical legislation, as the associated damages often have a cumulative effect on health and the environment. Careful considerations must be made in the attribution of such damages, including estimating an implementation gap cost for EU chemicals policy as a whole, rather than for the individual legislative pieces.

7. Industrial emissions and major accident hazards

7.1 EU environmental policy and law

Four key pieces of legislation have been identified for the industrial emissions and major accident hazards policy area. These are:

- Directive 2010/75/EU on Industrial Emissions (IED);
- Directive 2015/2193/EU on the limitation of emissions of certain pollutants into the air from Medium Combustion Plants (MCP Directive);
- Regulation (EU) 2017/852 on use, storage, trade of Mercury, and management of Mercury waste (Mercury regulation); and
- Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances (Seveso III Directive).

In addition, the Ambient Air Quality Directives (AAQD) and National Emissions Ceiling Directive (NECD) both include limits on various air pollutants, some of which are generated partly through industrial emissions.

Given that the Air and Noise policy area above already included the total implementation gap costs for five key air pollutants - SOx, NOx, $PM_{2.5}$, NMVOCs and NH_3 - covered within the NEC Directive, this will not be included in the implementation gap costs estimated in this chapter. This serves to avoid double counting. However, the potential contribution to the implementation gaps and related costs, due to emissions to air from the industrial sources for these pollutants, are discussed below in Section 7.3 and Section 7.4, respectively.

7.2 Environmental target

Industrial Emissions Directive (IED)

The IED requires each installation to operate under a permit issued by the relevant competent authority in the respective Member States, and to comply with the conditions set therein. When setting the permitting conditions, the emission limit values must be set at a level to ensure that pollutant emissions do not exceed the levels associated with the use of BAT conclusions. However, there may be some exceptional cases where it is proven that this would lead to disproportionate costs compared to environmental benefits (Article 15(4), Article 32 and Article 33).

The industrial activities covered in the IED are the following:

- Energy production and distribution;
- Metal production and processing;
- Minerals extraction;
- Chemicals production;
- Waste management; and
- Other sectors, such as, pulp and paper production, slaughterhouses and the intensive rearing of poultry and pigs.

The IED sets minimum requirements for large combustion plants, waste incineration, solvent using sectors and titanium dioxide production. Requirements for specific sectors are identified in BAT conclusions adopted as Implementing Decisions under the IED. The IED specifies in its annex II the minimum set of polluting substance to be addressed. When setting emission limit values in permits, competent authorities must consider these on a case-by-case basis. This means that they may take account of a wide range of factors including the:

- type of facility;
- size of plant;
- type of inputs used;
- production process used; and
- annual operating hours.

Total pollutant emissions from an installation will depend many factors, including the operating hours, throughput, and fuel mix; as such the estimation of these factors from the emission limit values is not straightforward. Pollutant emissions from large installations must however be reported under the European Pollutant Release and Transfer Register (E-PRTR).

To assess the implementation gaps, an assessment is made of specific requirements of the IED (e.g. setting permitting conditions, provisions for derogations, monitoring compliance with permitting conditions), including how effectively these are implemented in different Member States.

The IED requires each facility (covered by the scope of the directive) to operate under a permit issued by respective competent authorities specifying the maximum allowed level of emissions for various pollutants. Consequently, this can lead to two types of implementation gaps:

1. For all facilities, competent authorities are setting permitting conditions that allow emissions at the maximum level defined by BAT-AELs (i.e. upper limit of BAT-AELs) without taking into consideration the circumstances where individual facilities could achieve a lower emission limit; and
2. Facilities which breach their permitting conditions, by emitting more than the allowed level.

An analysis of the potential implementation gaps as regards the stringency of permits would require a comparison of a large sample of permits for various industrial sectors across different Member States, given large variations in production processes across sectors and Member States. It is not possible, within the scope of the present study, to undertake a comprehensive analysis of the stringency of the large number of permits. Therefore, the analysis is restricted to a limited number of permits in a few Member States and for one particular subsector. This analyses thus serves as an example of the assessment of the potential implementation gaps – in this particular case. This is further elaborated in Section 7.3 below.

Examination of infringement cases could be another approach to analyse implementation gaps from the perspective of non-compliance with permitting conditions. Based on the information extracted from the Commission's webpage on infringement decisions, however out of the 290 active cases concerning one of the seven policy areas covered within this research, only 3 are related to industrial emissions.[27]

Another approach to analysing this implementation gap could be via consideration of emissions from specific types of facilities that are not compliant with the permitting conditions, assuming that data on facilities which are not compliant with permitting conditions are available. However, while there is data available on emissions at the individual facility level (via the E-PRTR database), the data on facilities that are not complying with permitting conditions are not presently available.

In view of the above deficiencies, we have therefore focussed our analysis on specific industries in individual Member States which experience compliance issues as regards the IED.

When analysing the implementation gap in respect of controlling emissions from industrial facilities to air, one important consideration is that the potential impact of certain key pollutants emitted above limit values from industrial facilities is already, in effect, being considered to a certain extent as part of the wider exploration of the impacts of air pollution, discussed under Section 2.2. The targets discussed in that section – relating to the NECD – are therefore also relevant to the analysis of industrial emissions. These impacts are discussed further in Section 7.3.

Besides emissions to air, the IED also requires setting limit values at facility level for emissions to water for various heavy metals and organic micro-substances. The same issues apply in relation to determining the implementation gap in relation to these impacts as was the case for emissions to air. In addition, challenges may arise where the emissions to water are treated at an external waste water treatment plant. With regards to emissions to water, we have therefore analysed the trends in emissions to identify and assess potential implementation gaps.

It is further noted that Article 15(4) of IED allows competent authorities to set, under certain specific circumstances, less strict emission limit values in the permit than the emission levels associated with the BAT-AELs which are stipulated in the Directive. Where this is the case, facilities are allowed to emit a higher quantity of specific pollutants above the level set in the Directive without this being considered as non-compliant with the IED. In addition, Article 32 and Article 33 allow further time-limited flexibility arrangements (including less strict emission limit values) for large combustion plants, in cases where implementing BAT-AELs would lead to disproportionately high costs compared to the environmental benefits. As such, the facilities which have been granted a derogation under one of the above provisions within the IED are not seen as contributing to the implementation gap in a strict sense (assuming that they are operating under their respective permitting conditions). However, there is a social cost associated with not operating under the ELVs defined by the BAT conclusions. A complete understanding of the impacts of the implementation gaps for the IED therefore potentially requires some consideration of these derogations.

The IED also requires competent authorities to conduct regular inspections of the installations for monitoring and enforcing compliance with the directive. As such there may be further implementation gaps for some Member States in terms of the compliance assurance process for the IED. Environmental compliance assurance in this respect includes the efforts made by public authorities in Member States to ensure that industries fulfil obligations related to their emissions to the environment. However, given that most authorities do not provide any information regarding their

[27] http://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/infringement_decisions

compliance assurance activities, it is not be possible to estimate the associated implementation gaps and costs in this regard.

Finally, one the key objectives of the IED is to ensure that the public has a right to participate in the permitting decision-making process, and to be informed of its consequences. This requires publication of information on permit applications, issued permits and the results of the monitoring of emissions to be publicly available and easily accessible. Potential implementation gaps in regard to availability and accessibility of permitting information is discussed further below.

Medium Combustion Plant (MCP) Directive

The MCP Directive covers emissions from medium sized combustion plants (defined as having a thermal input between 1 and 50 MWh), which are not covered under the IED. However, the emission limits specified in the MCP Directive for existing MCPs have not come into force yet, while there will be a relatively small number of new MCPs affected, and thus the targets covered by the MCP Directive cannot be included in the current implementation gap assessment.

Mercury Regulation

Due to the recent entry into force of certain provisions, there are currently limited targets in place through which successful implementation might be measured. In addition, major sources of emission to air of mercury from industrial facilities are largely covered by the Industrial Emissions Directive. We have therefore excluded Regulation (EU) 2017/852 from the scope of this project.

Seveso III Directive

The Seveso III Directive contains a wide variety of provisions that enhance the safety culture in establishments that fall within the scope of the directive. These provisions consist of measures like drafting a major accident prevention policy (MAPP), implementing safety management systems, drawing up (internal) emergency plans, publishing safety reports and the organisation of inspections. Furthermore, it contains provisions on the prevention of domino effects and on land use planning - aimed at ensuring the objective of preventing major accidents, at limiting the consequences of such accidents for human health and the environment, and at ensuring potential impacts are taken into account in land-use policies. Finally, the Seveso-III Directive also contains provisions related to information to the public, public consultation and participation in decision-making. The Seveso_III Directive however lacks limit values or targets against which success might be measured in a relatively straightforward manner.

A study undertaken by AMEC (2017b) has considered the implementation of the directive by European countries. The study concludes that overall the Seveso II Directive is mostly well implemented by the Member States, and that, from the responses provided by Member States, it appears that processes and structures are in place for implementing the Directive.

With regards to estimating the cost of non-implementation, one potential measure that could be used is the estimated reduction in risk of major industrial accidents occurring in European countries as a result of the directive, and the associated monetary value of that reduction in risk. To facilitate this, one would need to compare the trends in number of accidents with and without the directive being in place. However, it is not easy to establish how many accidents there would have been in the absence of the directive. As the authors of the aforementioned study noted:

"…there are no countries outside the EU that have a similar national reporting requirements based on a common definition of a major accident. From our analysis, it is not possible to conclude whether the EU is performing better than non-EU regions in reducing chemical accident risk. In order to compare the trends and the impact of policy on chemical accident risk, it would be necessary to have equivalent reporting regimes at national level in non-EU countries based on a similar definition of major accidents."

Undoubtedly, the subsequent implementation of the various Seveso Directives (I to III) since 1982, has had indirect positive spin-off effects on the prevention of large environmental accidents. One indirect effect could, for example, be that Seveso establishments pay lower insurance premiums due to the well-established safety and risk management culture within the company.

The correct implementation of the Seveso Directive also results in avoided damage costs, similar to those illustrated in Table 8.6 (examples of environmental liability cost estimates for major past incidents/accidents in the EU described in Section 8.4). An illustration of the huge costs of industrial accidents is illustrated by the 2001 explosion in Toulouse of a fertiliser producing factory that are included in the scope of the Seveso Directive.

The explosion occurred in a storage hangar for ammonium nitrate, and caused a crater with a diameter of around 50 m and depth of 7-10 m. The explosion registered the equivalent of an earthquake measuring 3.5 on the Richter scale; it had an estimated power equivalent to 20-40 tons of TNT. The area was levelled on a 150-200 m radius, causing 29 deaths as well as thousands of wounded people, along with the destruction or damage to approx. 30.000 flats, 4280 industrial and business premises, 29 high schools and 200 administrative buildings[28]. Two thirds of the city's windows were shattered. The complete environmental consequences of the catastrophe are still not yet fully known, but the total damages paid by insurance groups so far exceeds EUR 1.5 bn[29].

The Seveso III Directive will be excluded from further consideration of implementation gaps and cost of non-implementation under this policy area.

7.3 Implementation gap

The policy area: industrial emissions was not included as a separate policy area in the previous study, and was instead included as a part of the policy area for air emissions, as well as under the policy area on waste relating to emissions from incinerators. As such, it is not possible to compare the output from the previous study with that derived from this analysis.

As discussed in Section 7.2, how effectively the different requirements of the IED are implemented in different Member States is used to assess potential implementation gaps. The following subsections focus on individual requirements of the IED and discuss the potential implementations gaps that could arise therein.

Stringency of Permits

To analyse the potential implementation gaps as regards stringency of permits would require comparison of a large sample of permits for various industrial sectors across different Member States. However, given the large number of permits and time

[28] https://forums.forteana.org/index.php?threads/toulouse-21-september-2001-the-azf-disaster.36635/
[29] https://en.wikipedia.org/wiki/AZF_(factory)

limitations of the project, the following analysis is restricted to one subsector – cement production. The subsector was chosen as an example based on bilateral discussion with DG Environment, and the analysis presented below should not be generalised to other industrial sectors or to all Member States.

Permits are usually published on websites of MS competent authorities. The websites of 14 competent authorities (13 Member States and Norway) were interrogated and permits were retrieved from Norway and 6 Member States. A maximum of 3 permits was obtained for each country. Each of the permits specify ELVs for multiple air and water pollutants covered within the cement industry, for multiple emissions points within the bounds of the facility. Table 7-1 presents the distribution of permits and emission points across the 7 countries.

Table 7-1 Number of permits and emissions points analysed for different Member States

Country	Number of Permits Analysed	Number of Emission Points
Ireland	3	78
Norway	2	34
Bulgaria	2	80
UK (England)	3	69
Denmark	1	59
France	1	9
Czech Republic	3	77
Total	**15**	**406**

Source: COWI/Eunomia analysis

The cement production sector includes a number of BAT conclusions covering various air and water pollutants. The pollutants covered by the different BAT conclusions along with the number of emissions points for each BAT reference are presented in Table 7-2. It can be observed that the highest number of emissions points in the analysed permits were for dust (196 emissions points), followed by heavy metals and organics, with each covering 69 emissions points. For NOx, SOx and NH_3, the number of emission points were 29, 23 and 18, respectively.

Table 7-2 Number of emissions points under different BAT conclusions

BAT Number and Pollutants Covered	Number of Emissions Points
BAT16 - Dust (Chanelled)	45
BAT17 - Dust (Kiln Firing)	19
BAT18 - Dust (Cooling/Milling)	132
BAT19 - NOx (Preheater kiln)	15
BAT19 - NOx (lepol/long rotary)	14
BAT20 - NH_3 (Slip)	18
BAT21 - SO2	23
BAT25 – HCl	23
BAT26 – HF	23
BAT27 - PCDD/F	23
BAT28 – Hg	23
BAT28 - Cd and Ti	23
BAT28 - Other Heavy Metals	23

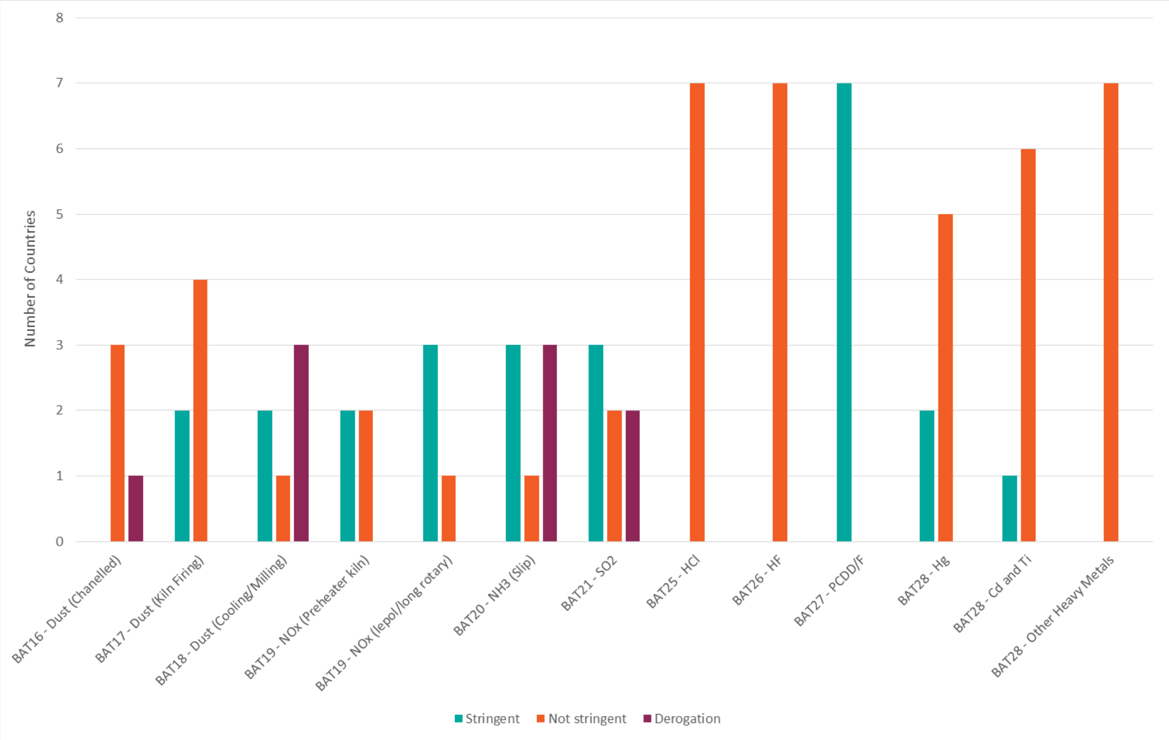
Source: COWI/Eunomia analysis

To analyse the stringency of Member States in setting permitting conditions, the ELVs set for each emissions point was compared against the upper range of the respective BAT-AEL range, and categorised into three groups:

- Specific: ELVs are set below the BAT-AEL upper range;
- Minimal: ELVs are set at the BAT-AEL upper range; and
- Derogations: ELVs are set above the BAT-AEL upper range, which implies the emissions point is subject to derogation under Article 15(4) of the IED.

Figure 7-1 presents the distribution of the above groups across different BAT references. It can be observed that all 7 countries have set specific ELV for PCDD/F under BAT Conclusion 27. However, all 7 countries have set ELVs at the upper range of the BAT reference (i.e. minimal) for HCl, HF and various heavy metals (excluding Hg, Cd and Ti). It should also be noted that 9 derogations were encountered covering dust, SO2 and NH_3.

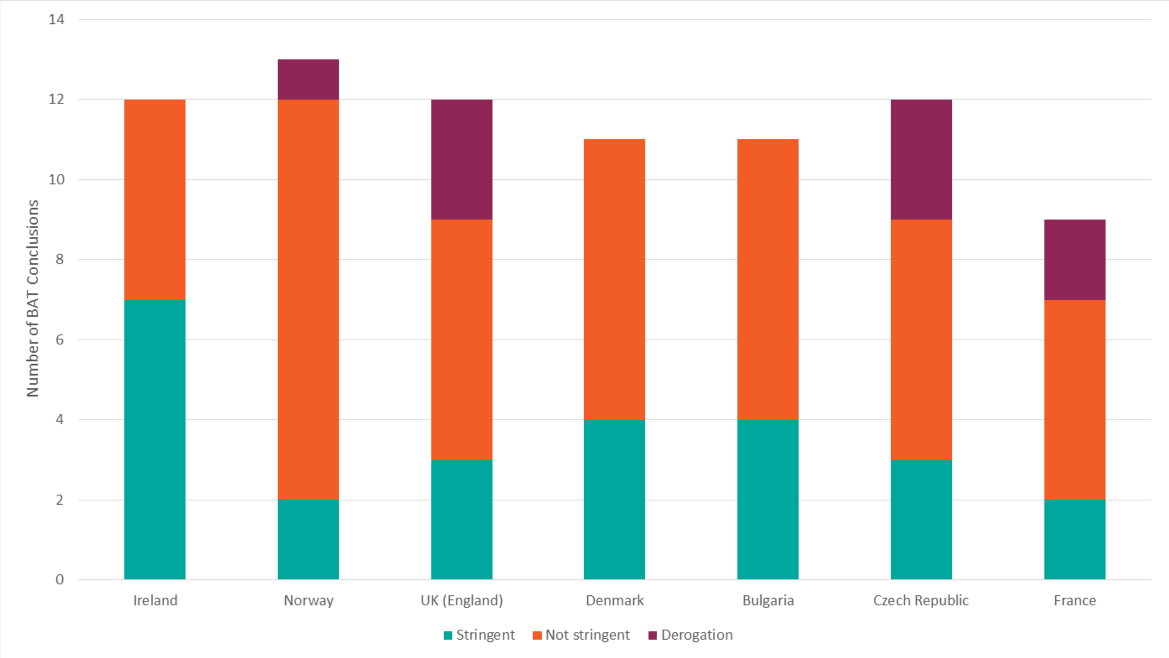
Figure 7-1 Distribution of permit stringency across BAT conclusions



Source: COWI/Eunomia analysis

The emissions points within each of the above groups were also aggregated by country to examine how stringently each country is setting the ELVs for different BAT conclusions. The results are presented in Figure 7-2. It can be observed that Ireland has set specific ELVs for the highest number of BAT conclusions (7), followed by Denmark and Bulgaria, each with 4 BAT conclusions set below the upper limits. Both Norway and France have set specific ELVs for the lowest number of BAT conclusions (2 each). In terms of derogations, the UK (England) and Czech Republic have 3 derogations approved each.

Figure 7-2 Distribution of permit stringency across countries



Source: COWI/Eunomia analysis

Based on the analysis of a limited set of permits for the cement industry covering 7 countries, it can be observed that although for majority (58%) of BAT conclusions within the cement production industry ELVs are set at the upper range of respective BAT conclusions, for about a third of the BAT conclusions they are set at a specific level. However, given the small number of countries and permits that could be analysed, we cannot robustly quantify how stringent the ELVs are set in different Member States. Moreover, as explained above, the above analysis should be treated as an example, and should not be generalised for other industrial sectors and/or other countries.

It should be noted that while setting minimal permitting conditions is not an implementation gap in the strict sense, as long as they are set within the BAT-AEL range, such a systematic approach would not respect the intention of the IED s. However, there could be a social cost associated with this, as setting less stringent ELVs for an installation in a MS compared to similar installations in other Member States could impact result in unfair competition and lost profit or market share to companies elsewhere in the EU. Quantification of such costs would be very difficult.

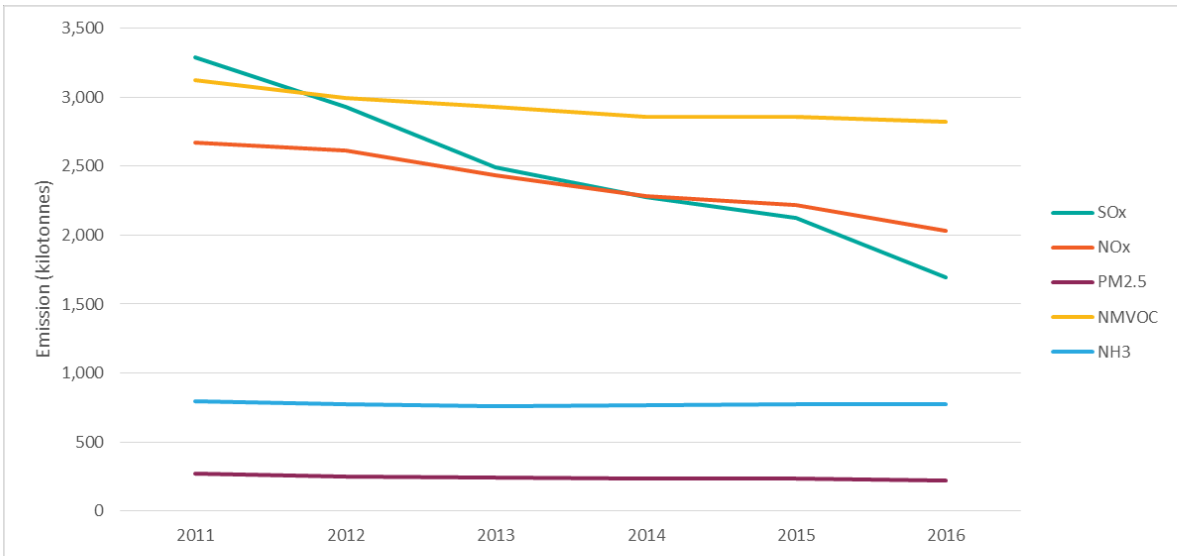
Emissions to Air

When analysing the implementation gap in respect of controlling emissions from industrial facilities to air, one important consideration is that the potential impact of certain key pollutants emitted above legal limits from industrial facilities is already, in effect, being partially considered as part of the wider exploration of the impacts of air pollution, discussed under Section 2.3. These impacts are being assessed in relation to the NEC Directive, and the pollutants covered are nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO_2), ammonia (NH_3) and fine particulate matter ($PM_{2.5}$). The NEC Directive sets limits for each country for the tonnage of pollutant that may be emitted. The pollutants may be emitted from a number of different sources; for all of the pollutants included within the Directive, industrial sources contribute to the total amount that may be emitted. Care therefore needs to be taken not to double-count the impact of these pollutants when assessing the impact of the implementation gap in respect of industrial emissions. Nevertheless, many other pollutant emissions to air - such as heavy metals - are not covered by the NECD, and IED installations are responsible for a high share of them.

To understand the contribution of industrial emissions to air pollutants included within IED, it is useful to analyse the trends in emissions, based on EEA data on national emissions reported to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention). When mapping the sectors/activities in the LRTAP data to specific sectors/activities covered by IED, we have used the approach described in the recent industrial emissions policy country profile reports (Ricardo-AEA, 2018c).

Figure 7-3 illustrates the trends in emissions from industrial sources across all 28 European Member States from 2011 to 2016 for the air pollutants covered within the NEC Directive. It can be observed that SOx displayed the highest downward trend, followed by NOx and NMVOCs. Emissions of $PM_{2.5}$ and NH_3 remained more or less constant over the entire period.

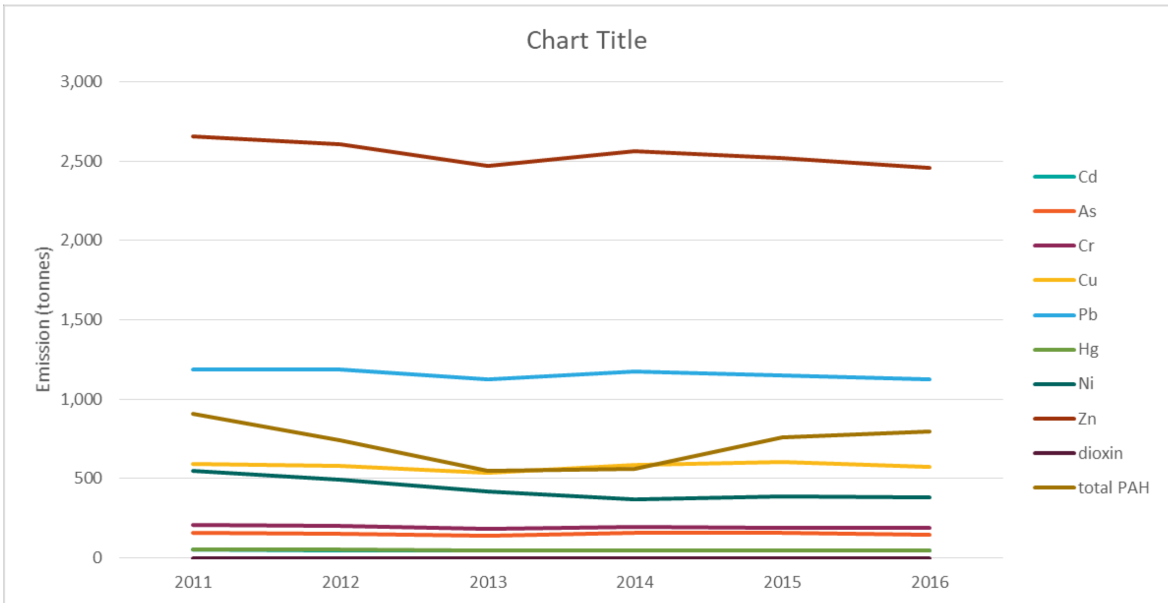
Figure 7-3 Trends in emissions to air for key pollutants from IED activities in EU-28 (2011 – 2016)



Source: CLRTAP Data and COWI/Eunomia analysis

Emission trends for heavy metals, dioxins and PAH from industrial sources across all European countries for the same period are presented in Figure 7-4. Emissions for all of these pollutants appear to be decreasing or remained constant over the period with the exception of PAH, which displayed a decreasing trend till 2013 and an increasing trend thereafter.

Figure 7-4 Trends in emissions of heavy metals and organic substances to air from IED activities in EU-28 (2011 – 2016)



Source: CLRTAP Data and COWI/Eunomia analysis

Table 7-3 presents trends in the relative contribution of industrial activities covered by the IED to the total national emissions for the abovementioned pollutants, using data from the LRTAP database. For SOx, of which industry (mainly large combustion plants) is the main source of emissions, it can be observed that the relative share has decreased from 80% in 2011 to 71% in 2016. Moreover, relative shares of Ni and PAH also displayed considerable decrease between 2011 and 2014, then increased slightly afterwards, while staying below the 2011 level. Relative share of PCDD/F, on the other hand, jumped to 90% in 2013 then came back towards the original level (60%) in the following year. For other pollutants, the relative share remained mostly constant.

Table 7-3 Relative contribution of industry to the total national emissions to air for EU-28 (2011 – 2016)

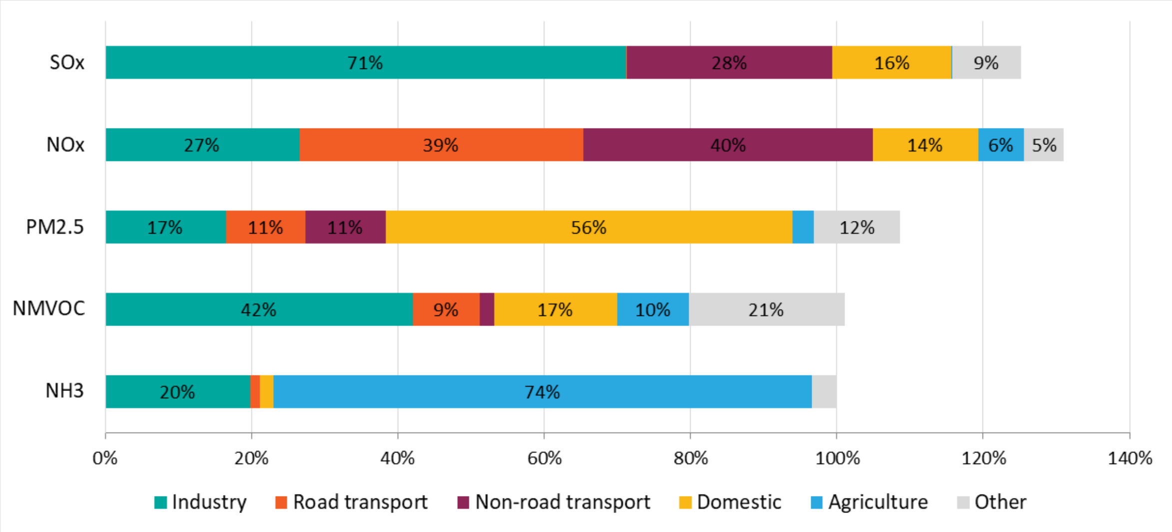
Pollutant	2011	2012	2013	2014	2015	2016
SOx	80%	79%	77%	77%	76%	71%
NOx	29%	30%	29%	28%	28%	27%
$PM_{2.5}$	18%	17%	17%	18%	17%	17%
NMVOC	42%	41%	41%	42%	42%	42%
NH_3	21%	20%	20%	20%	20%	20%
Cd	71%	69%	69%	71%	69%	69%
As	87%	86%	85%	87%	87%	87%
Cr	59%	58%	57%	57%	56%	55%
Cu	16%	16%	15%	15%	16%	15%
Pb	69%	69%	68%	69%	69%	68%
Hg	81%	79%	79%	79%	80%	80%
Ni	70%	66%	63%	59%	64%	64%
Zn	42%	42%	40%	41%	40%	39%
PCDD/F	59%	56%	90%	60%	57%	56%
Total PAH	46%	41%	34%	35%	42%	43%

Source: CLRTAP Data and COWI/Eunomia analysis

Figure 7-5 presents the relative shares of emissions of the five key air pollutants from different sectors in 2016.[30] It can be observed that the relative contribution of pollution from the industrial sector for the pollutants SOx and NMVOCs is higher than that of the other sectors. On the other hand, for $PM_{2.5}$ and NH_3, the relative share of emissions from the industrial sector is significantly lower compared to the highest contributing sectors for these pollutants (the domestic and agriculture sectors, respectively). Finally, for NOx, the relative share of industrial emissions is reasonably substantial (27%), but is nonetheless less significant than the relative shares of road transport (39%) and non-road transport (40%).

[30] The national totals reported in the CLRTAP dataset are estimated based on total fuel inputs, while the sectoral emissions associated activity data reported by the EEA member countries. So the sectoral emissions might not sum to total emissions, and consequently, the relative shares estimated using the CLRTAP dataset might not sum up to 100%.

Figure 7-5 Relative shares of emissions of the five key air pollutants from different sectors in EU-28 (2016)

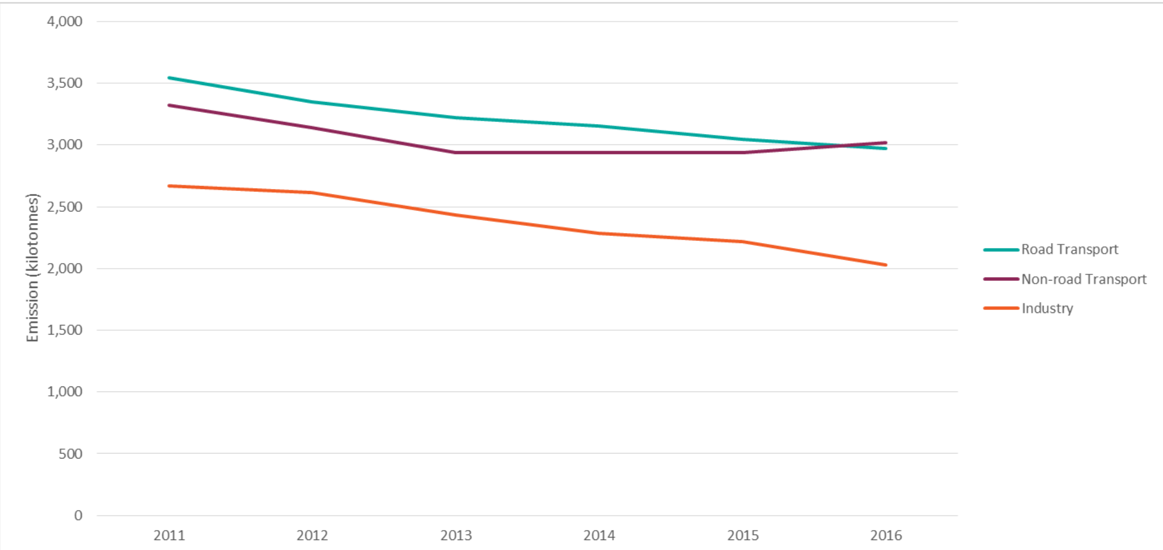


Source: CLRTAP Data and COWI/Eunomia analysis

Given the decrease in emissions of NOx from the industrial sector between 2011 and 2016 (as shown in Figure 7-3), it is useful to consider the trend for industrial pollution alongside the respective trends for road and non-road transport sectors. This is presented in Figure 7-6.

Figure 7-6 shows that, while levels of emission of NOx from the industrial sector and the road-transport sector decreased between 2011 and 2016, emissions from the non-road transport sector decreased only till 2013 and increased slightly thereafter. Moreover, NOx emission levels from the industrial sector were lower than from the other two sectors over the entire period. These graphs indicate that the industrial sector has been relatively successful in reducing emissions of NOx in the EU region.

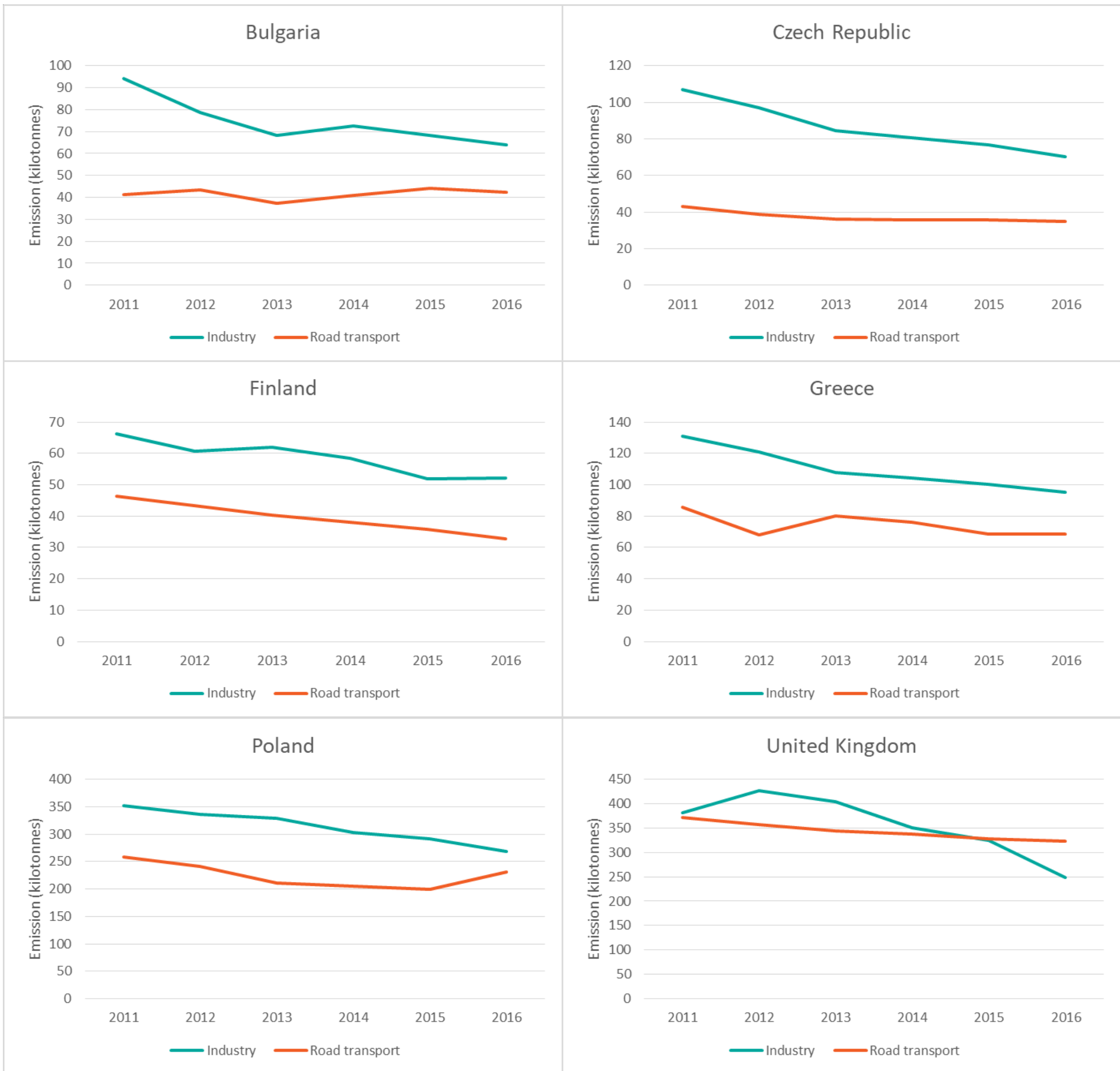
Figure 7-6 Trends in NOx emissions from industry, road transport and non-road transport sectors in EU-28 (2011 – 2016)



Source: CLRTAP Data and COWI/Eunomia analysis

However, trends in pollution reduction across sectors are more variable at the MS level. Figure 7-7 presents relative trends in NOx emissions from the industry and road-transport sectors for Bulgaria, Czech Republic, Finland, Greece, Poland and the UK. The data relating to these countries indicates decreasing trends in NOx emissions from the industrial sector. However, with the exception of the UK, the countries in this group had higher NOx emission from the industrial sector than that emitted from the road-transport sector over the entire period between 2011 and 2016. For the UK, the level of emission of NOx from industry was higher than that emitted from road transport till 2015, with a lower contribution seen after this point. Alongside this, it is noted that the decline in NOx pollution is steeper than the respective changes in NOx emission from road transport.

Figure 7-7 Trends in NOx emissions from industry and road transport sectors in selected Member States (2011 – 2016)



Source: CLRTAP Data and COWI/Eunomia analysis

The above data suggests that some countries may be achieving the NEC Directive limits due to success in controlling pollution from non-industrial sources, whilst at the same time emitting higher levels of pollution from industrial sources. To explore this issue further, we now focus our analysis on specific industries in individual Member States which are experiencing issues with compliance with the IED.

Specific IED Implementation Gaps are identified in the draft 2019 Environmental Implementation Reviews (EIRs) currently being undertaken by DG Environment of the European Commission, and in Industrial Emissions Policy Country Profiles completed earlier this year (Ricardo-AEA, 2018a). These sources identified the following challenges in respect of industrial activities regulated as part of the IED:

- The failure of 7 MS to implement the BAT conclusion of the IED prohibiting the use of mercury cell techniques by chlor alkali plants. The failure of 7 MS to timely prohibit the use of the mercury cell technique in chlor-alkali installations - in breach of the BAT conclusions which became fully enforceable on 11 December 2017, as well as in breach of the Mercury Regulation which includes the same prohibition and the same deadline - was successfully addressed. Failure to do so would result in additional mercury pollution to air and water. The 7 MS in question were:

    - Belgium;
    - France;
    - Germany;
    - Italy;
    - Sweden;
    - Finland; and
    - Spain.

  Data from the literature indicates the median release of mercury to air (following abatement) from such plants is 0.0065 g mercury per tonne of annual chlorine capacity. The corresponding release to water is, however, higher at 0.02 g mercury per tonne of annual chlorine capacity (Mihaiescu et al., 2012).

- In France, ongoing air pollution from the Arkema Lacq/Mourenx manufacturing facility on the industrial site of Lacq. The facility produces fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms, and emitted 135 tonnes of NO_x and 1,510 tonnes of SO_x in 2016 (as reported in E-PRTR database).

- For Poland, the management of pollution from the Belchatow and Elektrownia Turow power plant both of which are fuelled by lignite. Data from E-PRTR shows that in 2016, these facilities emitted 698 and 537 tonnes PM_{10}, respectively. These, and other industrial facilities, have contributed to infringement proceedings being brought by the Commission against Poland for failures to meet the PM_{10} limits defined in the ambient air quality directive in zones across the country (although it is noted that the majority of the pollution is considered to come from domestic burning and low stack sources). The area in which these two plants are located also includes other types of facilities emitting a range of pollutants including SO_2 and NO_2 as well as PM_{10} and heavy metals (Pb, Cd, Ni, Cr) not covered by the NEC Directive. The area is also a source of transboundary pollution, contributing to raised pollution levels in neighbouring countries such as Germany and the Czech Republic. Both Poland and the Czech Republic are examples of countries where there is a greater contribution to NOx pollution from industry than from transport.

- Persistent breaches of the limit values in the ambient air quality directive for PM_{10} in the Ostrava/ Karviná/ Frýdek-Místek regions of the Czech Republic caused by emissions from a high density of metal sector installations. A factor contributing to these breaches is transboundary movement of emissions from

Poland as described in the point above. The breaches also resulted in emissions of benzene, benzo(a)pyrene and arsenic, which are not covered by the NEC Directive.

In the case of the latter two examples, it is not clear from the documentation to what extent each issue was caused by individual facilities exceeding the limit values within the IED.

Emissions to Water

As is discussed in Section 7.2, there are no national targets for emissions to water. As such, it is not possible to quantitatively estimate the associated implementation gap. Instead we have analysed the current state of emissions to water from industrial activities covered by IED, and the trends in emissions for various water pollutants between 2011 and 2016 in order to assess potential implementation gaps qualitatively.

Data on emissions to water has been obtained from the E-PRTR database, although it is noted that there is no data on total national emissions to water available from this source. In addition, data on emissions to water reported under the E-PRTR covers a broader set of industrial activities than those covered by the IED. To estimate the emissions to water from various IED activities, E-PRTR industrial activities were mapped to IED activities using the approach described in the recent industrial emissions policy country profile reports (Ricardo-AEA, 2018c).

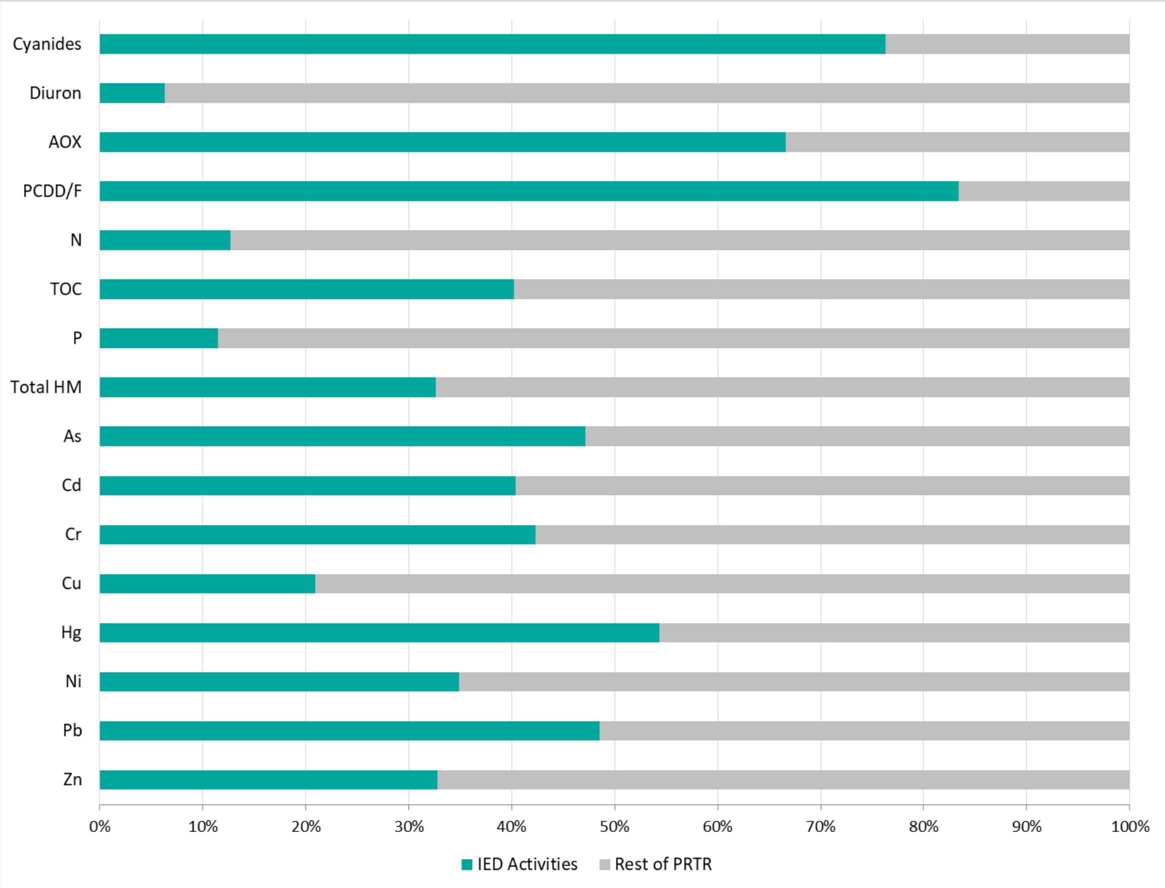
It should be noted that several limitations - relating to the use of E-PRTR data on emissions to water - were discussed in the methodology paper of the industrial emissions policy country profile reports (Ricardo-AEA, 2018c). These are:

- The E-PRTR dataset is an underestimation of actual emissions due to the use of reporting thresholds.
- The E-PRTR reporting may not be consistent between facilities and Member States as there is scope for variation in the application of its reporting rules.
- The completeness of the data varies across countries and across emission types (e.g. air, water, soil). The completeness check carried out for 2014 by the EEA revealed that out of 33,084 facilities across the EU, only 3,627 facilities reported emissions to water (ETC/ACM, 2016b). Many water pollutants, such as persistent organic pollutants (POPs), are very rarely reported by installations. Moreover, many facilities report inconsistently over time (e.g. no report one year, and a positive report in a subsequent year).
- Facilities carrying out multiple E-PRTR activities are required to report emissions resulting from the main activity, which can result in underestimation of emissions. Moreover, it may be difficult to distinguish the source of emissions where multiple activities are carried out in a facility, leading to inaccuracies in the reporting arising from source attribution (AMEC, 2016).

In addition, some of the pollutant releases from facilities are not recorded as emissions to water as these are transferred to urban waste water treatment plants (UWWTPs), and thus recorded as pollutant transferred. As a result, reported emissions to water are an underestimation of the total pollutant releases to the water. Moreover, as these pollutant releases are transferred for further treatment through UWWTPs, these are unlikely to be abated. Given the above limitations, the following analysis on implementation gaps relating to emissions to water based on the reported E-PRTR data should be interpreted with caution.

Figure 7-8 presents, for the key water pollutants, the relative contributions from IED activities when compared to total emissions to water arising from all industrial activities within the EPRTR. Data is presented for 2016 in the EU-28.

Figure 7-8 Relative contributions from IED activities in total emissions to water from all E-PRTR sectors in EU-28 (2016)

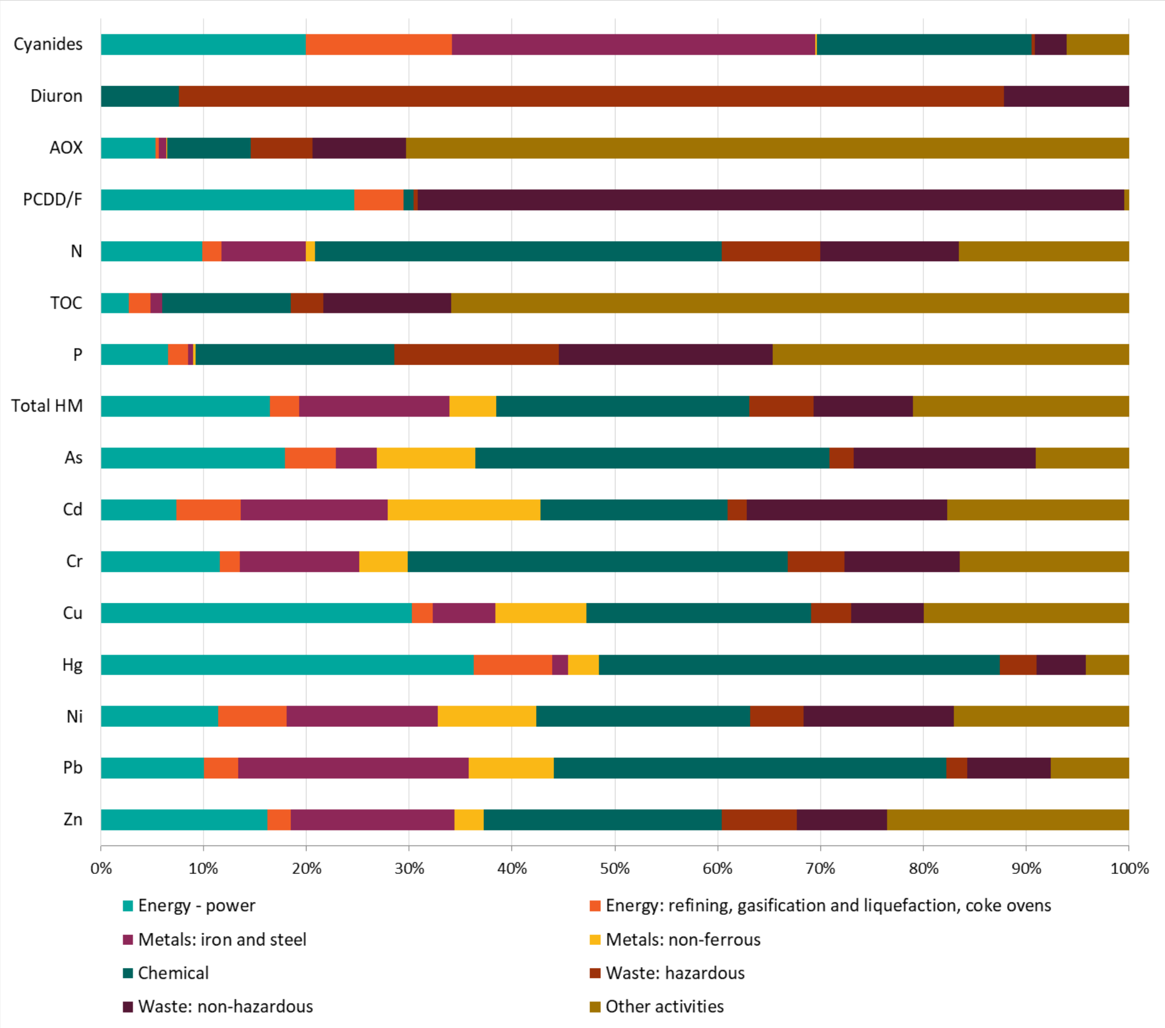


Source: E-PRTR data and COWI/Eunomia analysis

It can be observed that IED activities contribute over 65% of the total E-PRTR emissions to water for PCDD/F, Cyanides, and AOX. However, over 85% of emissions to water for Nitrogen, Phosphorus and Diuron come from non-IED activities. For emissions of heavy metals to water, IED activities contribute 20%-55% of the total emissions to water.

More detail on the relative contributions to water pollution from specific activities covered by IED is presented in Figure 7-9. It can be observed that the ferrous metal industry (iron and steel production) is the most significant contributor to emissions of cyanides (with a contribution of approximately 35%), while the most significant contributor to emissions of AOX, phosphorus and total organic carbon comes from the group labelled on the graph as "other activities", which include food and drink industry, paper and pulp production, intensive pig and poultry rearing, textiles dyeing, and the tanning of hides. Non-hazardous waste treatment is the activity most responsible for emissions of PCDD/F (with a contribution of approximately 70%). For total heavy metal, high levels of emissions are generated by the chemical industry (over 25%), "other activities" (over 20%) and power generation (over 15%). It can thus be seen from this data that water pollution arises from a wide range of industrial activities.

Figure 7-9 Relative contributions to emissions to water of different IED activities in EU-28 (2016)

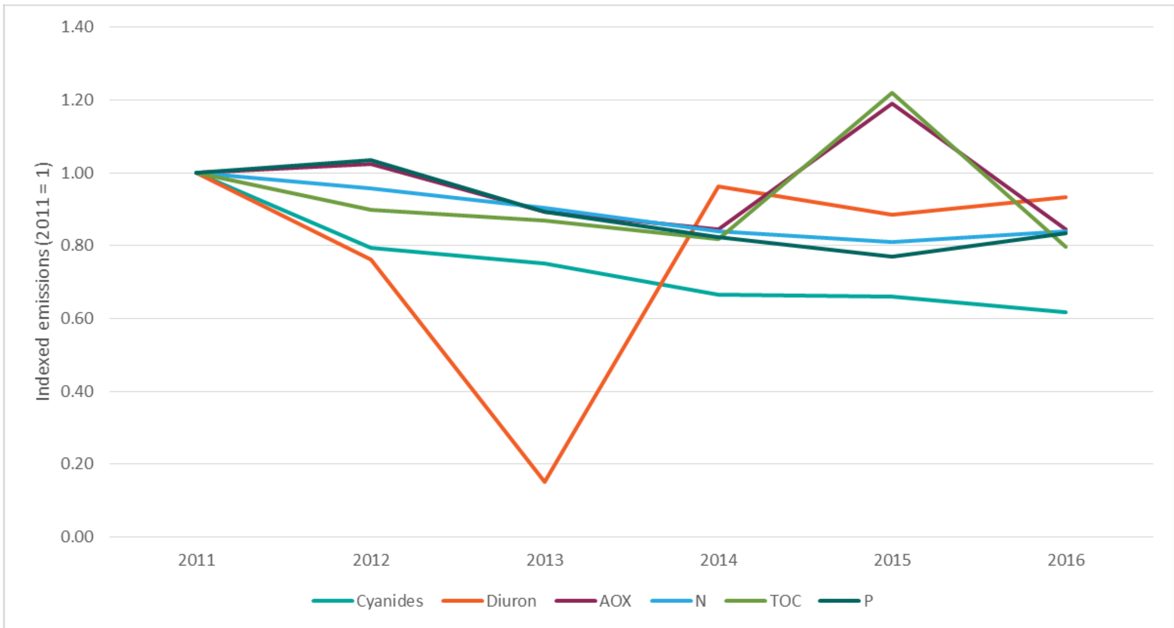


Source: E-PRTR data and COWI/Eunomia analysis

Trends in indexed emissions (2011 = 1) of different organic substances and heavy metals are presented in Figure 7-10 and Figure 7-11, respectively. The graph shows that there has been a decrease in water pollution levels in relative terms for most pollutants, although the data suggests significant year-on-year variations for some pollutants. Emission of cyanides displayed the greatest decrease (~40%) between 2011 and 2016, followed by TOC (over 20%), AOX, nitrogen and phosphorus (over 15% for all three), although both TOC and AOX displayed a 20% increase (compared to 2011 levels) in 2015. Emissions of diuron decreased by approximately 85% in 2013, but increased again in 2014, which suggests that it could be a data issue rather than an actual decrease in emissions.

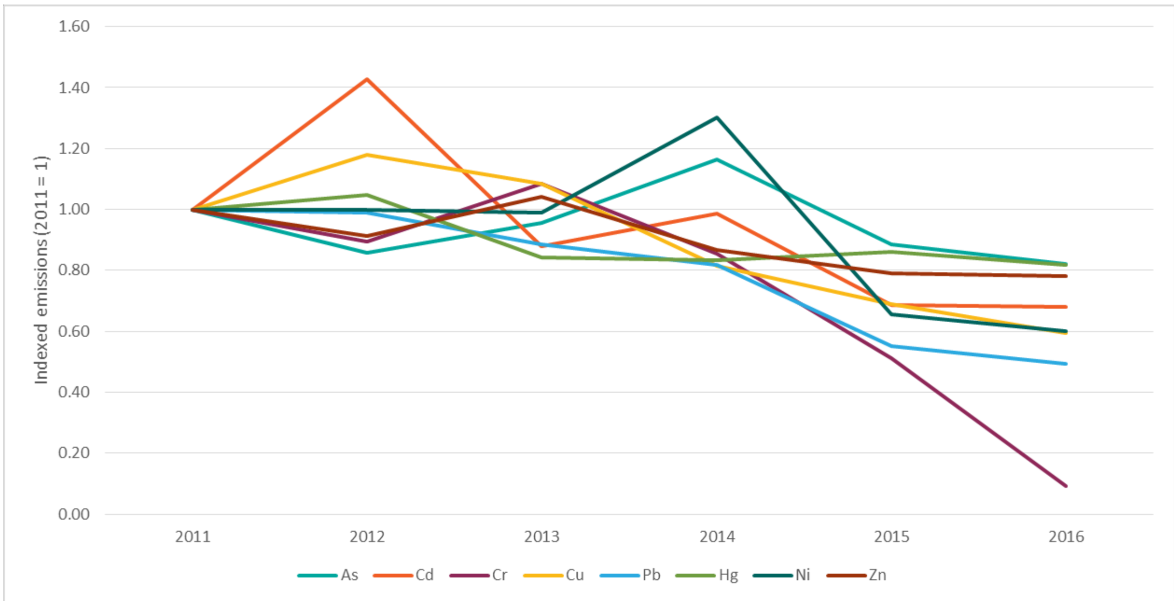
For heavy metals, as observed in Figure 7-11, chromium displayed the greatest decrease (90%) between 2011 and 2016, followed by lead (50%). Emissions of other heavy metals also displayed substantial decreases ranging from just below 20% to 40% compared to 2011 levels.

Figure 7-10 Trends in indexed emissions of organic substances to water in EU-28 (2011 – 2016, indexed to 2011 = 1)



Source: E-PRTR data and COWI/Eunomia analysis

Figure 7-11 Trends in indexed emissions of heavy metals to water in EU-28 (2011 – 2016, indexed to 2011 = 1)



Source: E-PRTR data and COWI/Eunomia analysis

The above data indicate that since the implementation of IED, the industrial sector has been relatively successful in reducing emissions to water in the EU region, given that the overall levels of pollution for all pollutants appear to have declined. However, given the limitations of using E-PRTR data on emissions to water that were discussed above, it is difficult to determine the exact trends in emissions to water from IED activities. Furthermore, it is difficult to distinguish whether the reduction in emissions to water is due to higher abatement activities due to the implementation of the IED, or as a result of a reduction or change in industrial activities.

A review of the Industrial Emissions Policy Country Profiles developed by Ricardo in 2018, which aimed to identify challenges in respect of emissions to water from industrial activities covered by the IED, revealed that only one MS is facing difficulty in controlling emission to water (Ricardo-AEA, 2018a). This relates to the following problems identified for France:

- Ongoing water pollution from the disposal of bauxite residues at sea in alumina production from the Alteo Gardanne Facility in Gardanne; and
- High emissions of nitrate negatively affecting to the soil quality, with the problem being further aggravated by the intensive pig and poultry rearing sector.

Given that the other Member States are not faced with particular problems related to emissions to water from industrial sources, it appears that the overall extent of the problem in EU-28 might be relatively small.

However, it is difficult to draw definite conclusions in respect of a potential implementation gap in respect of water pollution from IED activities given the lack of target level of emissions for the specific pollutants, as well as due to the limitations around using E-PRTR data on emissions to water discussed above.

Article 15(4) Derogations

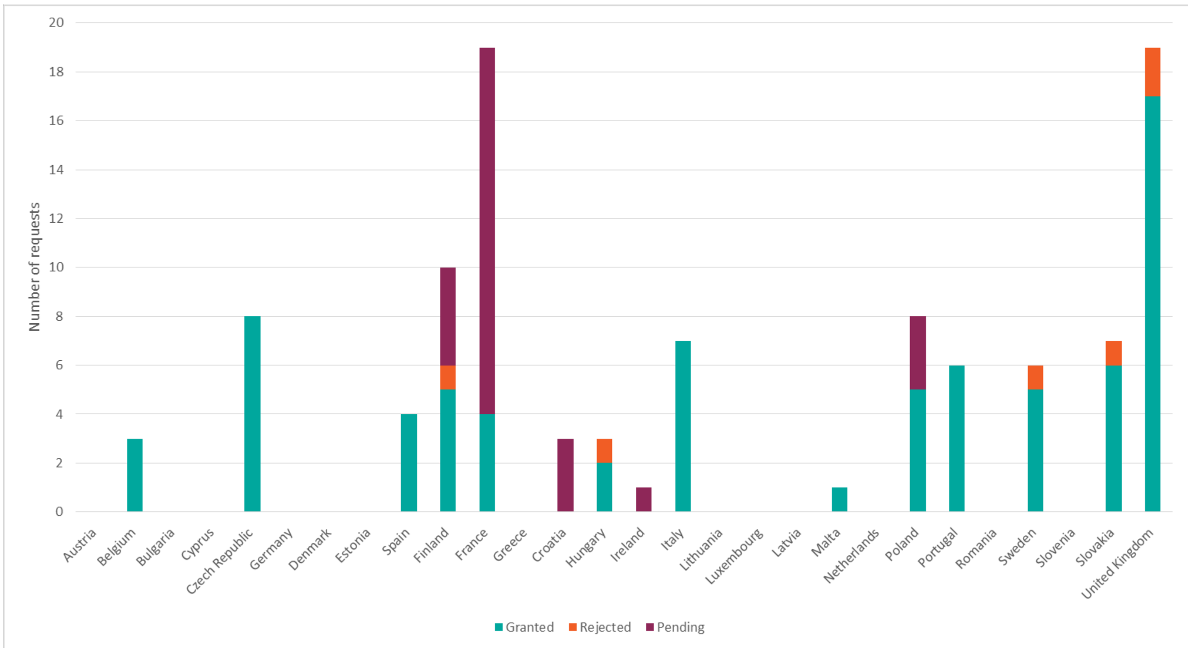
As discussed in Section 7.2, the various flexibility provisions in the IED (Article 15(4), Article 32 and Article 33) could be a source of potential implementation gaps, and therefore these need to be considered further. Here we focus on Article 15(4), while the next subsection discusses provisions for large combustion plant under Article 32 and Article 33.

As regards the derogations from the ELVs in line with BAT conclusions under Article 15(4) of IED, AMEC (2018) has undertaken a study for DG Environment assessing Member State derogation procedures, focusing on a selection of derogation case studies to illustrate their application. The study noted that - at the time of reporting - 105 derogation requests for specific facilities had been made, out of which 73 were granted, 6 were rejected and the remaining 26 were still under consideration.

Figure 7-12 presents the number of derogation requests by MS, which shows that UK and France have received 19 requests each. Out of the 19 requests to the UK, 17 requests have been granted while 2 requests were rejected. For France, on the other hand, 4 requests had been granted, while the remaining 15 were still under consideration. Requests have also been made to the following key countries:

- Finland – 10 requests;
- Czech Republic – 8 requests;
- Poland – 8 requests;
- Italy – 7 requests; and
- Slovakia – 7 requests.

Figure 7-12 Number of derogations requested at facility level in EU Member States (2012 – 2016)



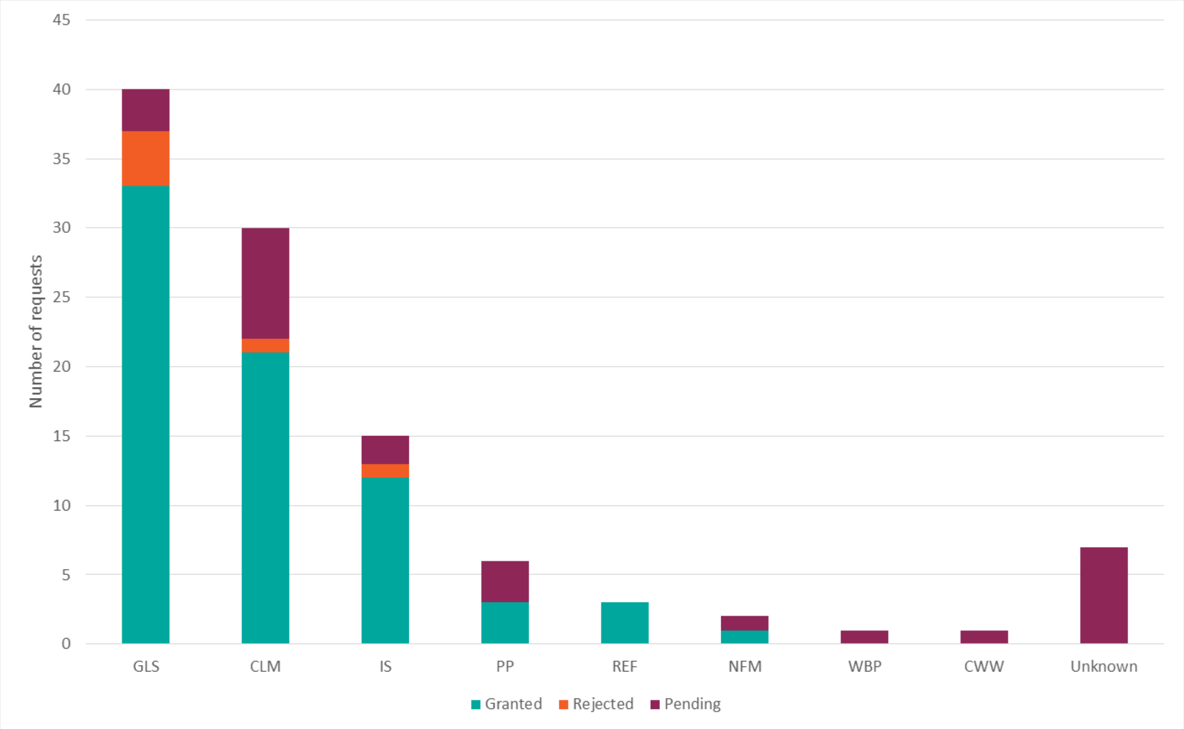
Source: AMEC (2018)

Figure 7-13 presents the number of derogations requested at facility level for each sector. The majority of the derogations have been requested for industries involved in the Manufacture of Glass (GLS) (40 requests) and Cement, Lime and Magnesium Oxide Manufacturing (CLM) (30 requests). Other sectors that have made derogation requests are:

- Iron and Steel Production (IS) (15 requests);
- Production of Pulp, Paper and Board (PP) (6 requests);
- Refining of Mineral Oil and Gas (REF) (3 requests);
- Non-ferrous Metals Industries (NFM) (2 requests);
- Wood-based Panels Production (WBP) (1 request); and
- Common Waste Water and Waste Gas Treatment (CWW) (1 request).

For 7 pending requests, the sector making the requests was unknown.

Figure 7-13 Number of derogations requested at facility level for each sector



Source: AMEC (2018)

It should be noted that the facilities which have been granted a derogation under Article 15(4) of the IED are not contributing to the implementation gap in a strict sense (as long as they are operating under their respective permitting conditions). Moreover, as noted by some stakeholders during the stakeholder workshop for this project, these derogations often reflect allowance for deviations from BAT conclusions due to particular location specific requirements (e.g. certain production processes might not be feasible in certain locations). However, there could be some implementation gaps in cases where derogations were granted based on inaccurate assessment of the derogation criteria or failure to correctly implement the requirements of Article 15(4) by the Member States.

To request a derogation for a particular installation under Article 15(4), it must be shown that one of the three criteria set in the article applies and this results in the cost of compliance for that installation being disproportionately higher than the environmental benefits that could have been achieved through compliance with the IED ELVs. The AMEC report found that there is substantial variation across derogation requests from different Member States, covering the types of benefits and costs included in the evaluation as well as the method used for assessing the disproportionality of costs and benefits (e.g. cost-benefit analysis, cost-effectiveness calculations, etc.). The report also found that, in a small number of cases, Member State practices were not fully in line with the requirements of Article 15(4). However, accurate estimation of the implementation gap in respect of assessment of the derogation criteria would require further research involving a thorough examination of all of the derogation requests, which is not within the scope of this exercise.

Flexibility Provisions for Large Combustion Plants

The IED also includes several provisions allowing for flexibility in respect of the legislation as it is applied to large combustion plants, to facilitate the transition from the Large Combustion Plants Directive (LCPD) to the IED. The two main provisions are:[31]

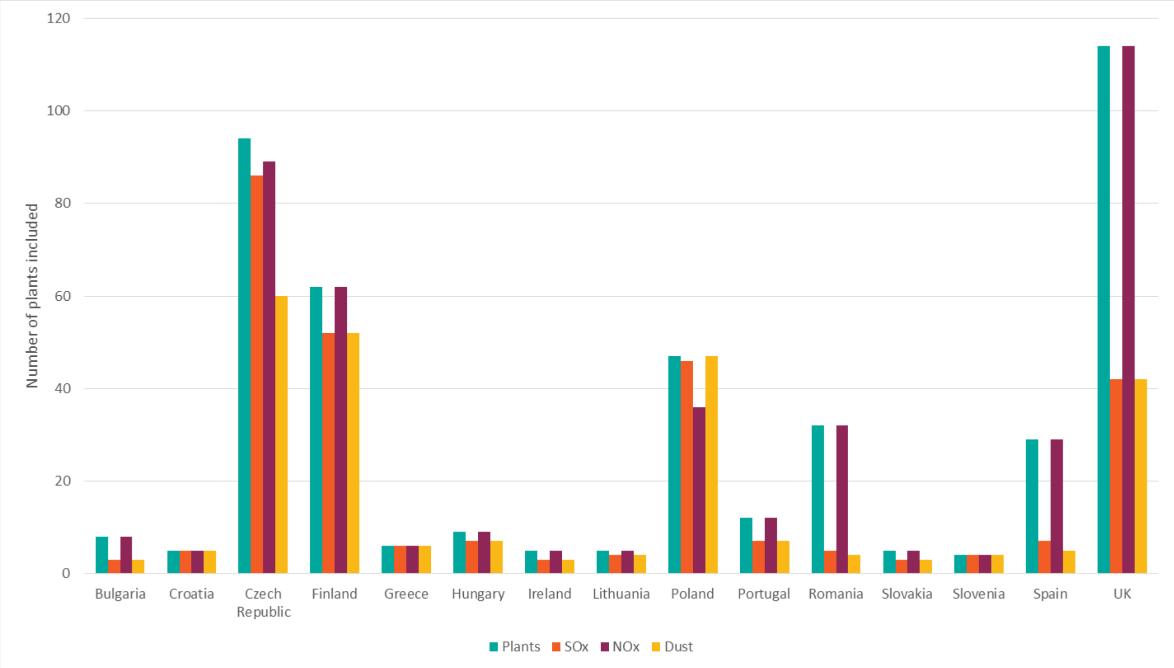
1. Article 32 – Transitional National Plans (TNPs), which are established at MS level. Plants included within the TNP are granted more time (until mid-2020) to comply with the ELVs specified in the IED; and
2. Article 33 – Limited Life Time Derogations (LLTD), apply to large combustion plants that are nearing the end of their life time. In this case it is deemed uneconomic to retrofit them with the abatement equipment required to comply with the IED ELVs.

TNPs allow emissions of NOx, SOx and dust (at least one of the three pollutants) to be emitted from the specified plant at levels above the ELVs specified within the IED. The Commission decision documents on TNPs published in CIRCABC indicate that 15 Member States are currently using TNPs, covering a total of 436 plants across Europe.[32] Figure 7-14 presents the distribution of plants and the allowance for the above 3 pollutants across the Member States. The country with the highest number of plants operating under a TNP is the UK (with 114 plants). This is followed by Czech Republic with 94 plants, Finland with 61 plants, and Poland with 47 plants. Across the 3 pollutants which the IED permits to be covered by a TNP, the highest number of provisions relates to NOx pollution (421 plants), while there are substantially lower provisions for SOx and dust (280 and 252 plants, respectively).

It should be noted that all of the Member States with a large number of LCPs included in TNPs were also identified as the Member States emitting higher levels of NOx from the industrial sector than the road-transport sector (Figure 7-7). This suggests that a portion of the high NOx emissions from the industrial sector could be explained by the NOx emissions above the IED ELVs from large numbers of LCP in these Member States.

[31] In addition there are two more flexibility provisions for LCPs in the IED, where Article 34 covers LCPs that are part of small isolated systems, and Article 35 covers LPCs supplying to a public district heating network. These were excluded from the analysis given the small number of installations/countries using these provisions.
[32] IED Article 32 – Approved Transitional National Plans. Available at: EUROPA > European Commission > CIRCABC > env > ied > Library > Information on LCPs > Article 32 - TNPs > _Commission Decisions – Accessed 31 January 2019

Figure 7-14 Number of plants and pollutants included in TNPs of different Member States



Source: CIRCABC and COWI/Eunomia analysis

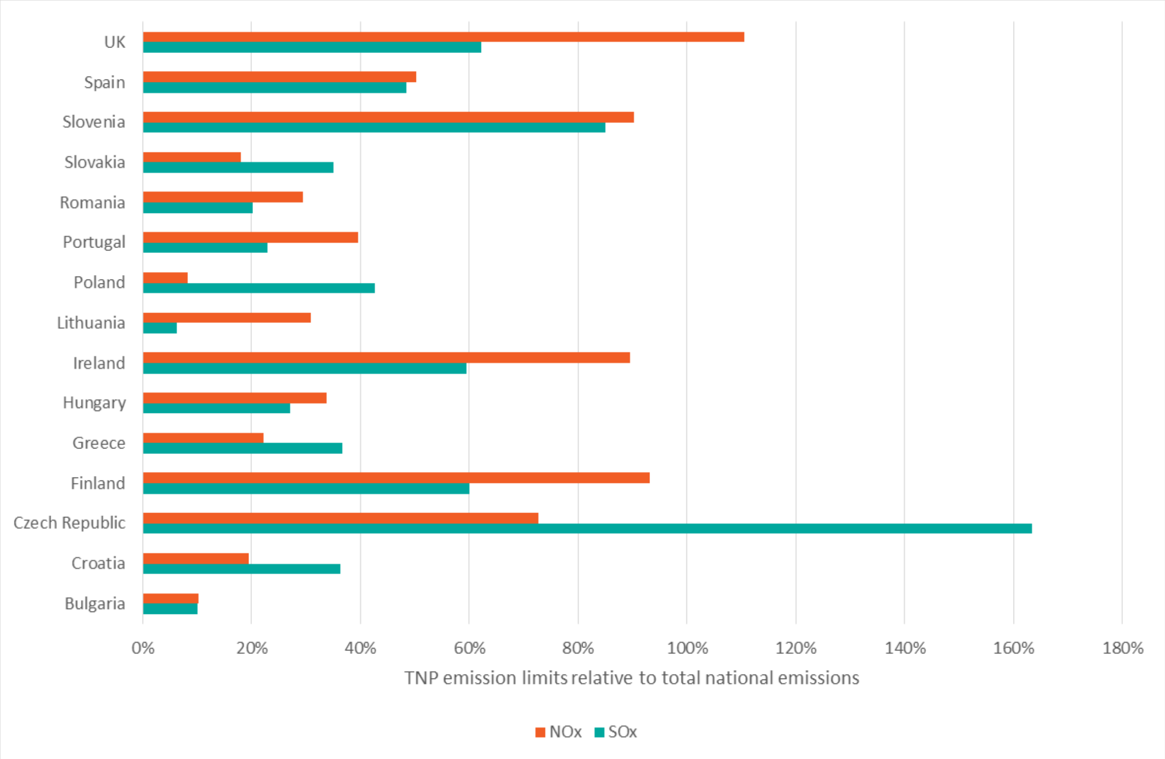
TNPs are subject to an overall emissions ceiling, which declines linearly between 2016 and 2020. To understand the impacts of TNPs on emissions of NO_x and SO_x in different Member States, we need to compare the emissions ceilings in TNPs with total emissions for these pollutants for each individual MS using TNPs.

Figure 7-15 presents the 2016 TNP emission ceilings for NO_x and SO_x (compiled from the Commission decision documents on TNPs published in CIRCABC[33]), shown in relative terms against the total amount emitted in 2016 for the 15 Member States that are using TNPs. It can be observed that, for the UK, Slovenia, Ireland, Finland and Czech Republic, the TNP emission ceilings for NO_x are over 70% of their total NO_x emissions for 2016. Similarly, for SO_x, the emissions ceiling in 2016 under the TNP for Czech Republic is 160% of total national emissions in 2016, followed by Slovenia with a TNP emissions ceiling that is equal to 85% of the total national SO_x emissions.

For all 15 Member States, on an average, the emissions ceilings in 2016 for SO_x and NO_x under the TNPs are equal to 51% and 36% of the total national emissions for these pollutants, respectively. The above data indicates that there could be a significant amount of industrial emissions of SO_x and NO_x above the amount if the IED ELVs are complied with due to the TNP provisions. However, as with Article 15(4), these breaches in ELVs are not implementation gaps in a strict sense, as they are allowed by the legislation.

[33] IED Article 32 – Approved Transitional National Plans. Available at: EUROPA > European Commission > CIRCABC > env > ied > Library > Information on LCPs > Article 32 - TNPs > _Commission Decisions – Accessed 31 January 2019

Figure 7-15 TNP emission ceilings 2016 for NOx and SOx relative to total NOx and SOx emissions from IED activities in 2016 of different Member States



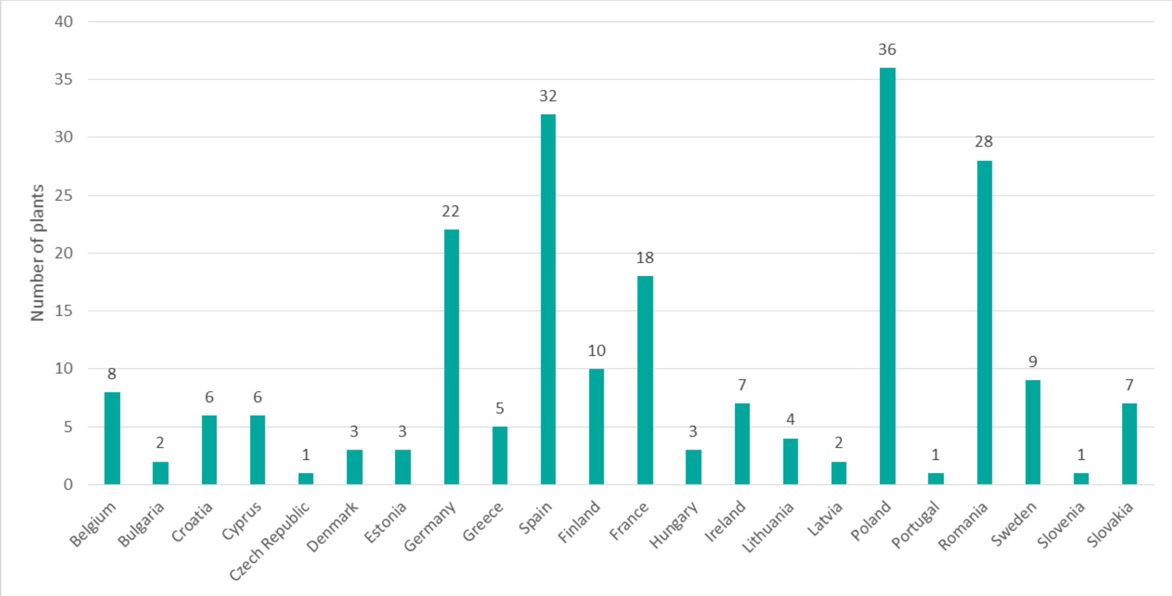
Source: CIRCABC, LRTAP data and COWI/Eunomia analysis

In regards to the LLTD provisions, these allow existing plants to continue to operate for a limited number of operating hours while complying with the weaker ELVs under the LCPD (until the end of 2023), without additional investment in abatement measures. After 2023 at the latest, these plants must be shut down or be upgraded to meet the conditions for a new plant. Currently 24 Member States are using the LLTDs. [34]

Figure 7-16 presents the number of plants operating under LLTD in each of these countries. It can be observed that Poland has the largest number of plants (36) operating under LLTD, followed by Spain (32 plants), Romania (28 plants), Germany (22 plants) and France (18 plants). Information on number plants operating under LLTD in Italy and the UK were not available. Of these countries, Poland is included within the six identified previously as having a greater contribution to total NOx pollution from industry than from road pollution (Figure 7-7). Poland is also making use of the TNP provision, although the contribution to total NOx pollution from plants making use of this provision is relatively small.

[34] IED Article 33 – Final list of plants operating under Limited Life-time Derogations. https://circabc.europa.eu/sd/a/952a062c-189b-48f7-9a35-60189b92b467/Article%2033%20plants%20final%20list.pdf

Figure 7-16 Number of plants operating under LLTDs in different Member States



Source: CIRCABC and COWI/Eunomia analysis

Public participation in decision making

One of the distinguishing features of the IED is ensuring that the public has a right to participate in the permitting decision-making process, and to be informed of its consequences. While it will be very difficult to quantitatively estimate potential implementation gaps in regards to ensuring public participation, one possible indicator for considering this aspect is the public availability of information related to permitting, including consideration of the ease with which this information can be accessed by the public.

A recent EEB (2017) report has made an assessment of the availability of permitting information and its accessibility for all Member States and Norway. The report scored each MS based on several criteria, including the completeness and quality of permit-related information, the availability of inspection and compliance reports and ease of use of the websites for accessing the permitting information. The results are presented in Figure 7-17.

Figure 7-17 Quality and accessibility of permitting information across EU-28 and Norway

			Ease of use						Permit-related information						Inspection and compliance reports			Additional plant information						Overall appreciation	
		FINAL TOTAL SCORE	search function rating (/5)	intallation type (1)	permit status (1)	location (1)	extra filters (/2)	TOTAL EASE OF USE	operating permit (/5)	consilodated permit (1)	useful format (1)	all sample permits available (-10/2)	permits under review (1)	TOTAL PERMIT INFO	inspection (5)	compliance (5)	TOTAL INSP. & COMP. REPORTS	Baseline/site remidiation reports (2)	Emissions monitoring (/3)	Plant outputs (2)	Plant inputs (2)	Quality of additional information (/5)	TOTAL ADDITIONAL INFO	Overall appreciation (/5)	TOTAL OVERALL APPRECIATION
1	Ireland	49	5	1	1	1	2	10	5	1	1	2	1	10	5	3	8	2	1	2	2	4	11	5	10
2	Norway	43	3	1	0	1	2	7	5	1	1	2	0	9	5	3	8	0	1	2	2	4	8	5	10
3	Bulgaria	39	5	0	1	1	2	9	4	1	1	2	1	9	4	4	8	0	0	2	2	3	7	3	6
4	Denmark	33	2	0	0	1	0	3	4	1	1	2	1	9	4	3	7	0	1	1	1	3	6	4	8
5	Italy	31	3	0	1	0	0	4	4	0	0	2	1	7	3	2	5	0	2	2	2	3	9	3	6
6	Czech Republic	29	2	1	0	0	0	3	4	1	1	2	1	9	3	3	6	0	1	1	1	2	5	3	6
7	Latvia	28	2	1	0	0	0	3	5	0	1	2	1	9	0	0	0	0	1	2	2	3	8	4	8
8	Belgium (Wallonia)	26	4	1	0	1	2	8	4	1	0	2	0	7	0	0	0	0	0	0	0	3	3	4	8
8	France	26	4	1	0	1	2	8	3	0	0	2	0	5	2	2	4	0	0	1	0	2	3	3	6
10	Sweden	25	1	0	0	0	2	3	4	0	0	2	1	7	0	0	0	0	3	2	2	2	9	3	6
10	Malta	25	2	0	0	0	0	2	4	1	1	2	1	9	2	2	4	0	0	2	2	2	6	2	4
12	Lithuania	24	1	0	0	0	0	1	5	1	1	2	1	10	0	0	0	0	0	2	2	3	7	3	6
12	Slovakia	24	4	1	0	1	2	8	4	0	1	2	0	7	0	0	0	0	0	1	1	1	3	3	6
14	Belgium (Flanders)	21	1	0	0	0	0	1	4	1	1	2	0	8	0	0	0	0	0	0	0	4	4	4	8
15	UK (England)	20	1	0	0	0	0	1	4	1	1	2	1	9	0	0	0	0	0	1	1	2	4	3	6
16	UK (N. Ireland)	18	0	0	0	0	0	0	4	1	1	2	0	8	0	0	0	0	0	1	1	2	4	3	6
17	Slovenia	15	1	0	0	0	0	1	4	0	0	2	0	6	0	0	0	0	0	0	0	2	2	3	6
18	Portugal	11	1	0	0	0	0	1	3	0	0	2	1	5	0	0	0	0	0	0	0	1	1	2	4
19	Greece°	9	3	1	0	1	0	5	3	1	1	-10	0	-5	0	0	0	0	0	2	2	1	5	2	4
20	UK (Wales)°	7	1	0	0	1	0	2	3	1	1	-10	0	-5	0	0	0	0	0	1	1	2	4	3	6
21	Romania°	2	1	0	0	0	0	1	3	0	0	-10	1	-6	0	0	0	0	0	1	1	1	3	2	4
22	Finland†	-1	4	1	1	1	0	7	0	0	0	-10	0	-10	0	0	0	0	0	0	0	0	0	1	2
23	Austria°	-5	1	0	0	1	0	2	0	0	0	-10	0	-10	1	0	1	0	0	0	0	0	0	1	2
24	Cyprus†	-6	1	0	0	0	0	1	0	0	0	-10	1	-9	0	0	0	0	0	0	0	0	0	1	2
24	UK (Scotland)†	-7	0	0	0	0	0	0	0	0	0	-10	0	-10	0	0	0	0	0	0	0	1	1	1	2
26	Hungary†	-8	0	0	0	0	0	0	0	0	0	-10	0	-10	0	0	0	0	0	0	0	0	0	1	2
27	Spain*	-10	0	0	0	0	0	0	0	0	0	-10	0	-10	0	0	0	0	0	0	0	0	0	0	0
27	Netherlands*	-10	0	0	0	0	0	0	0	0	0	-10	0	-10	0	0	0	0	0	0	0	0	0	0	0
27	Germany*	-10	0	0	0	0	0	0	0	0	0	-10	0	-10	0	0	0	0	0	0	0	0	0	0	0
27	Belgium (Brussels)†	-10	0	0	0	0	0	0	0	0	0	-10	0	-10	0	0	0	0	0	0	0	0	0	0	0
27	Poland†	-10	0	0	0	0	0	0	0	0	0	-10	0	-10	0	0	0	0	0	0	0	0	0	0	0
27	Luxembourg†	-10	0	0	0	0	0	0	0	0	0	-10	0	-10	0	0	0	0	0	0	0	0	0	0	0

†Denotes countries or regions where no single website could be located where IED permits could be directly downloaded

* Denotes countries where at least some permitting information was found on a regional website but for which no national level website could be located

° Denotes countries and regions where websites that offered permits for download were located, but where permits themselves were missing

This scoring is in no way meant to reflect the adequacy of permit conditions set. It only reflects the quantity and user friendliness of access to the information found at a given point in time in relation to spot samples assessed and based on common assessment criteria. The assessment could be different if carried out with a wider range of reference plants from across the sectors covered by the IED. The EEB looks forward to responses from Member States and permitting authorities.

Source: EEB (2017)

The report concluded that only three countries (Ireland, Norway and Bulgaria) have a good system of providing permitting related information, while only ten other Member States met the minimum requirements of the EU laws. All of the remaining Member States – indicated in red within the table - were deemed to have failed to meet the minimum requirements in regards to information provision to the public. This indicates that there is a potential implementation gap in respect of the IED's information provision requirements for these countries. However, it is difficult to quantify the impacts of the gap.

7.4 Implementation gap cost

As discussed above, any estimate of the implementation gap costs made for the five NEC Directive pollutants will not be included in the total implementation gap costs for these pollutants given the overlap with the Air and Noise policy area. However, attempts have been made below to estimate potential contribution to the implementation gaps and costs due to emissions to air from the industrial sources for these pollutants, along with implementation gap costs for other pollutants.

As discussed in Section 7.2 for some Member States and some pollutants a significant contribution to air pollution arises from industrial activities included within the IED. Table 7-4 presents the total emissions to air from IED activities in EU-28 in 2016 for each of the pollutants covered within the NEC Directive, heavy metals and organic micro-substances.

Table 7-4 Total emissions to air from IED activities in EU-28 in 2016 (kilotonnes)

Pollutant	Emissions
NEC Directive Pollutants (kilotonnes)	
SOx	1,692
NOx	2,028
$PM_{2.5}$	222
NMVOC	2,823
NH_3	774
Metals and Organics (tonnes)	
As	150
Cd	49
Cr	189
Hg	46
Ni	383
Pb	1,122
PCDD/F	0.0017
Total PAH	795

Source: CLRTAP Data and COWI/Eunomia analysis

The EEA (2014a) has produced estimates of the damage costs relating to air pollution arising from European industrial facilities. These costs take into account the specific characteristics of industrial pollution – such as the height of the stack through which the pollution is emitted – as well as characteristics of the European country such as population density. Data has been developed for the key air pollutants and estimates were originally developed in 2005 prices. These damage costs were converted to 2018 prices using MS specific price inflation data for estimating impacts in current year prices (these are not presented here to save space).

The EEA report also provided damage costs estimates for some of the heavy metals and organic micro-substances in 2005 prices. However, the damage costs for As, Cd, Hg and Pb were also estimated in a more recent study, which found the costs to be significantly higher than the earlier EEA estimates (Nedellec and Rabl, 2016). Table 7-5 presents the damage costs for EU-28 from these two sources converted to 2018 prices.

Table 7-5 Damage costs for heavy metals and organic substances, EUR/kg (2018 prices)

Pollutant	EEA Estimates (EUR/Kg)	New Estimates (EUR/Kg)
As	349	5,713
Cd	29	138,969
Cr	38	
Hg	910	22,937
Ni	3.80	
Pb	965	29,343
PCDD/F	27,000,000	
PAH	1,279	

Source: EEA (2014a), Nedellec and Rabl (2016), COWI/Eunomia analysis

The above damage costs can be used to generate estimates of the total cost of emissions to air arising from IED activities for each MS, which are presented in Table 7-6. The total estimated costs for the five main pollutants arising from industrial activity in Europe range from between EUR 65 bn and EUR 186 bn. Similarly, for heavy metals and organic micro-substances, the total estimated cost is EUR 37 bn. Adding the figures for both groups of pollutants, the total estimated cost of emissions to air from industrial activities in Europe is between EUR 101 bn and EUR 222 bn.

This estimate relates to the impacts on society arising from overall levels of industrial emission to air, rather than that associated with the implementation gap for these pollutants arising from the IED. The latter cannot easily be quantified, for reasons which have been discussed earlier in this section. However, if the potential implementation gaps discussed in Section 7.3 above is 10% of the total costs of air pollution from IED activities, this would result in a substantial cost to society (in the order of EUR 10 bn to EUR 22 bn, of which **EUR 3.7 bn** is associated with potential implementation gap for emission of heavy metals and organic micro-substances to air).

Table 7-6 Total costs of emissions to air in 2016 from IED activities, million EUR (2018 prices)

Member State	NEC Directive Pollutants		Heavy metals and organics	Total	
	Low	High		Low	High
Austria	996	2,878	557	1,552	3,434
Belgium	1,989	5,813	1,116	3,105	6,929
Bulgaria	1,498	4,576	1,026	2,524	5,602
Croatia	541	1,581	67	607	1,648
Cyprus	37	78	15	52	93
Czech Republic	2,515	7,195	231	2,746	7,426
Denmark	343	970	86	429	1,056
Estonia	311	884	852	1,164	1,736
Finland	337	934	621	958	1,555
France	4,756	13,290	1,818	6,575	15,109
Germany	14,606	43,111	6,188	20,794	49,299
Greece	814	2,283	269	1,083	2,552
Hungary	1,174	3,440	126	1,300	3,567
Ireland	236	655	87	323	742
Italy	5,206	15,815	6,123	11,329	21,938
Latvia	122	350	18	140	368
Lithuania	231	655	11	242	667
Luxembourg	80	224	32	111	256
Malta	9	26	17	26	42
Netherlands	1,859	5,375	318	2,177	5,693
Poland	12,408	34,748	6,931	19,340	41,680
Portugal	998	2,842	2,215	3,214	5,057
Romania	3,327	9,662	639	3,966	10,301
Slovakia	751	2,106	1,090	1,841	3,196
Slovenia	285	841	115	400	956
Spain	3,759	10,150	3,972	7,731	14,122
Sweden	348	974	360	708	1,334
United Kingdom	5,001	14,078	1,964	6,965	16,042
EU-28 (EUR bn)	**64.5**	**185.5**	**36.9**	**101.4**	**222.4**

Source: COWI/Eunomia analysis

In addition to the costs of emissions to air, there would be costs associated with emissions to water from industrial activities. Estimating these costs would require damage cost estimates for various emissions to water. However, given that damage costs for emissions to water are extremely difficult to calculate[35], there are no robust damage cost estimates for water pollutants that could be used to quantify the costs associated with emissions to water.

Finally, there could be other costs associated with poor implementation in regards to:

- Various flexibility provisions in the IED (Article 15(4), Article 32, Article 33, etc.); and
- Potential higher emissions due to lack of stringency of permitting conditions.

As discussed above, although these are not implementation gaps in respect of industrial emissions in a strict sense, they would still impose a cost to the society. However, it is not possible to quantify these costs given various data limitations.

7.5 Lessons learnt and recommendations

This policy area covers several EU legislations (IED, MCP Directive, Mercury Regulation and Seveso III Directive) involving different types of potential implementation gaps. However, for the majority of these implementation gaps, it is difficult to quantify the extent of the gap and associated costs. This was either due to the absence of a robust quantitative indicator for the extent of poor implementation or due to unavailability of the data that is required to estimate the implementation gap and/or associated costs. Some of these limitations are discussed below along with recommendations for further research.

When analysing potential implementation gaps in relation to stringency of permits, we have restricted our analysis to only one subsector – cement production – given the time limitations of the study. A comprehensive analysis of these implementation gaps would require comparison of a large sample of permits for various industrial sectors across different Member States. It is recommended that further work is undertaken to quantify the extent of implementation gaps in this regard. Moreover, when accessing permits for the cement production facilities in Europe for our analysis, we were not able to retrieve permitting information for the majority of the Member States. Any further research in this area will benefit from increasing efforts by competent authorities to make permits publicly available and easily accessible in line with the requirements of the IED.

Potential implementation gaps in terms of emissions to water from industrial sources are analysed using data from the E-PRTR database, which is subject to several data limitations (as discussed in Section 7.3). Given these data limitations, it is not possible to identify exact trends in emissions to water from industrial sources for quantification of potential implementation gaps. Moreover, the E-PRTR dataset provides actual emissions reported by individual facilities, but not the allowed emission limits specified in their respective permits. It would be useful to have this information presented in the E-PRTR database along with reported emissions, as this will allow for analysis of facilities that are not complying with their respective permitting conditions.

We were not able to estimate any implementation gap costs for emissions to water from industrial sources, given that there are no robust damage costs estimates for

[35] The main complexity arises from site dependency i.e. dependency of the effects of pollutants on the characteristics of the water body (e.g. type of usage, flow rates, existing concentration levels, etc.). In addition, non-linearity of the exposure-response relationship (e.g. there could be safe threshold level of concentration) complicates matters further. Another problem concerns the varied nature of pollutant effects that are likely to be significant in terms of overall externalities per unit emission (unlike air emissions where the main impacts arise from health damages).

emissions to water. Further research is needed to establish damage costs for various water pollutants. Moreover, the damage costs for industrial emissions to air provided in the EEA (2014b) report were estimated using data from 2012. A more accurate quantification of implementation gap costs for emissions to air will be obtained once updated damage cost estimates become available.

There could be potential implementation gaps in relation to application of derogations under Article 15(4), Article 32 and Article 33 of the IED, where these derogations were granted based on inaccurate assessment of the derogation criteria or failure to correctly implement the requirements of these articles by the Member States. However, currently no data related to these are available, and further research is recommended to analyse potential implementation gaps in this respect. Moreover, there is no data available on monitoring and enforcements activities undertaken by the competent authorities for ensuring compliance with permitting conditions. Further research in this area is needed to understand the extent of implementation gaps in relation to monitoring and enforcements required by the IED.

Finally, quantification of the implementation gap and associated costs for the Seveso III Directive requires an estimation of the reduction in risk of major industrial accidents due to the implementation of the directive, as well as an estimation of the avoided damage costs for potential accidents in the absence of the directive. However, we could not identify any relevant research in this area and further research is recommended for analysing potential implementation gaps and associated costs.

8. Horizontal instruments

8.1 EU environmental policy and law

Horizontal instruments do not focus on specific environmental policy areas but cut across them. The horizontal instruments identified are more procedural in nature and do not set specific quantifiable environmental targets. Rather, they aim to contribute widely to improving environmental conditions in the EU and so they may indirectly contribute to achieving the environmental targets set within the specific policy areas. They provide mechanisms to improve implementation of specific policies, decision-making, and legislative development and so they even contribute to setting appropriate environmental targets. Further, in addition to enabling environmental remediation their effect is often of a preventive nature, while they also allow for the creation of efficiency gains.

Horizontal instruments were not covered by the 2011 study, which hence did not provide an assessment of implementation gaps and costs for these instruments. Similarly, for this study we make no attempt to estimate an implementation gap cost for these instruments. Their procedural and process-oriented nature, as well as the lack of quantifiable environmental targets would not allow for precise assessment. Also, the implementation gap cost for horizontal instruments is captured to a large extent in the costs of not achieving targets in the other 6 specific policy areas.

Nonetheless, in this chapter we discuss the implementation and effects of horizontal instruments separately and mainly in qualitative terms. We do so for a sub-set of the three Directives referred to as key horizontal instruments relevant to EU environmental rules by the Commission SWD(2018) 10 final[36], namely:

[36] EC (2018g), Commission Staff Working Document, Environmental Compliance Assurance — scope, concept and need for EU actions Accompanying the document EU actions to improve environmental compliance and governance, COM(2018) 10 final

- Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage (ELD)
- Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE Directive)
- Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment, and as amended by Directive 2014/52/EU (EIA Directive)

This sub-set of instruments is covered in more detail in the remainder of this chapter. Additional horizontal instruments not covered in detail notably include the SEA Directive (Directive 2001/42/EC), legislation on access to environmental information and public participation, as well as instruments not directly addressed at Member States (for more details see Annex 2: EU environmental law).

8.2 Environmental target

As previously noted, the horizontal instruments identified do not set specific quantifiable environmental targets, in the sense of specifying an environmental status to be achieved that can then be compared to the actual status reached – and thereby to derive an estimate of the implementation gap. We, thus, in the remainder of this section describe qualitatively the rationale and requirements of the three key Directives – the Environmental Liability Directive (ELD), the INSPIRE Directive and the EIA Directive and where relevant how these link to the other six policy areas.

Environmental Liability Directive

The ELD (Directive 2004/35/EC) requires that economic operators causing certain types of environmental damage take preventative and remedial actions and bear all the related costs. Overall, the ELD reinforces the 'polluter pays' principle, however it does not set quantifiable environmental targets. By establishing a framework of environmental liability, the ELD may indirectly contribute to achieving the environmental targets set within the other six policy areas.

The ELD defines three types of environmental damage:

- *"damage to protected species and natural habitats"* with significant adverse effects on the conservation status of such habitats or species as defined in the Birds Directive and the Habitats Directive
- *"water damage",* which is any damage that significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential, as defined in the Water Framework Directive 2000/60, of the waters concerned
- *"land damage",* which is any land contamination resulting from the introduction, in, on or under land, of substances, preparations, organisms or micro-organisms that creates a significant risk to human health

Based on the above definitions, there may be stronger and more direct interdependencies with some of the specific policy areas. This goes in particular for *nature and biodiversity* as well as the *water* areas. Damage to air is not an environmental damage type, in its own right, under the above ELD definitions. However, air is indirectly covered to some extent by the ELD, which specifies that "*environmental damage also includes damage caused by airborne elements as far as they cause damage to water, land or protected species or natural habitats*" (Directive 2004/35/EC, preamble paragraph 4). This means an indirect interlinkage of the ELD to the *air and noise* area.

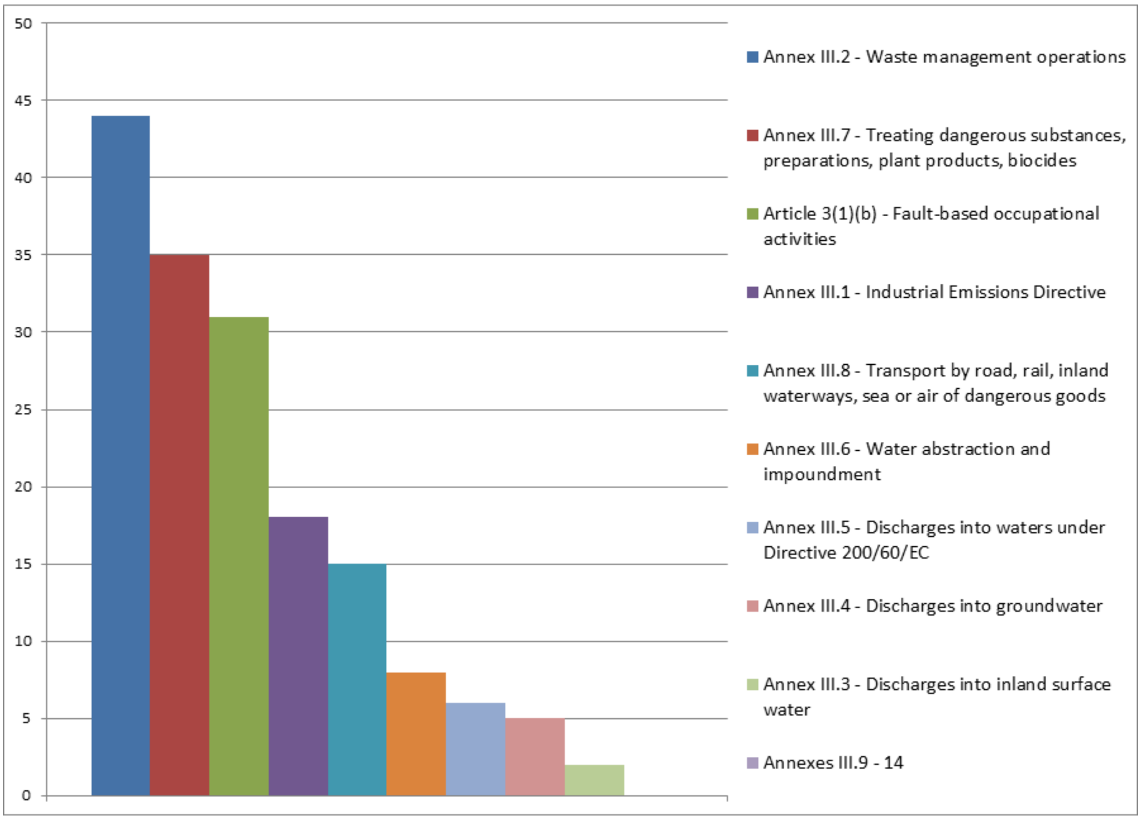
Similarly, the degree of interdependencies of the ELD to the other policy areas may be connected to the scope of the liability regimes provided by the ELD. The types of activities listed in Annex III of the Directive (linked to strict liability) further reinforce the linkage to the *water* area and also suggest linkages of this horizontal instrument to the specific areas of *industrial emissions and major accident hazards*, *waste,* and *chemicals*.

Looking at implementation of the ELD between April 2007 and April 2013 (period for which there is information available[37]), gives an indication of such actual linkages. According to the second implementation report of the ELD, Member States reported In in this period about 1,245 cases of environmental damage which triggered the application of the ELD, of which around 50% concerned damage to land, 30% damage to water accounts, and 20% damage to biodiversity (EC 2016g, p. 3). The occupational activities causing environmental damage in the same period were mostly related to the areas of (EC 2016g, p. 3-4):

- *Waste*: Waste management activities
- *Chemicals*: Treatment of dangerous substances, preparations, plant protection products or biocidal products
- *Nature* and *biodiversity* damage from other occupational activities linked to fault-based liability
- *Water*: when abstraction and impoundment, as well as discharges into ground and surface water are considered as a group
- *Industrial emissions / Air*: Activities under the Industrial Emissions Directive

[37] Moreover, the Commission is soon publishing country fiches on the ELD on its website (expected in the first half of 2019): http://ec.europa.eu/environment/legal/liability/index.htm. The report has taken into account draft country fiches from July 2018 which were temporarily available through the ELD Expert Group.

Figure 8-1 ELD cases by number of cases according to the type of damaging activity



Source: COM/2016/0204 final, p. 4

Besides the ELD, the European legal framework for environmental liabilities is further set out and reinforced through relevant provisions included in the EU Directives concerning the specific policy areas.

For example, Article 7 of the Industrial Emissions Directive (2010/75/EU) includes provisions without prejudice to the ELD in the event of any incident or accident significantly affecting the environment. The provisions concern measures to be taken by operators and competent authorities in case of such event to limit the environmental consequences and to prevent further possible incidents or accidents.

The Waste Framework Directive (2008/98/EC) specifies that without prejudice to the ELD, Member States may take action to recover the costs of non-compliance and remedial measures from persons responsible for waste management. The Landfill Directive (1999/31/EC) and the Mining Waste Directive (2006/21/EC) also set out that operators shall bear the costs of any measures to be undertaken to correct for significant adverse environmental effects revealed by the control and monitoring procedures of the facilities.

INSPIRE Directive

The INSPIRE Directive (2007/2/EC) aims to create a spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment. It is based on the spatial data infrastructures established by Member States and addresses 34 spatial data themes needed for environmental applications.

The Directive sets requirements with respect to the interoperable sharing and exchange of spatial data across Europe, which can help Member States to monitor and report, on the environment more effectively and efficiently as well as implement and enforce environmental law and carry out complex tasks that depend on the use of spatial information. INSPIRE, which is being implemented in incremental stages and needs to be fully implemented by 2021, does not set quantifiable environmental targets but requires compliance with the conditions for interoperable sharing and exchange of spatial data across Europe. What is more, as pointed out in the 2016 INSPIRE implementation report (EC 2016i, p. 4), there has not been an identified upper limit or total number of datasets falling within scope of the Directive, which makes it difficult to define a target in terms of number of datasets and the implementation gap in that regard.

The Directive supports the application of knowledge-based policies and monitoring of activities that have an environmental impact, through setting out actions to remove obstacles to the sharing of spatial data between all levels of government within and across Member States. This means that public authorities and the organisations working on their behalf should have obstacle-free access and the right to use the spatial data owned by other public authorities.

In addition, non-public authorities including the private sector, academia, NGOs, and private citizens should also have access to INSPIRE spatial data, according to applicable conditions for the re-use of data by third parties set by another Directive, namely the Re-use of Public Sector Information (PSI) Directive (Directive 2003/98/EC).

EIA Directive

The EIA Directive 2011/92/EU as amended by Directive 2014/52/EU aims to ensure that public and private projects which are likely to have a significant effect on the environment are adequately assessed before they are approved. The possible impacts that a project may have on the environment are identified and assessed before development consent is provided to allow such a project to proceed. Developers can adjust projects accordingly to avoid or minimise negative environmental impacts before they occur, and competent authorities can incorporate measures into the project approval to avoid, reduce or compensate for negative impacts. Moreover, the Directive also ensures early public participation in the environmental decision-making procedures, by providing public concerned with the possibility to comment before a development consent decision is taken, and by requiring competent authorities to inform the public inter alia on the envisaged measures to avoid, reduce or compensate environmental impacts when approving projects.

The EIA Directive does not set quantifiable environmental targets/standards, but procedural requirements to ensure that significant impacts of a project on the following factors are responded to: (a) population and human health; (b) biodiversity, with particular attention to species and habitats protected under Birds and Habitats Directives (c) land, soil, water, air and climate; (d) material assets, cultural heritage and the landscape. The EIA process enables public authorities and project developers make well-informed decisions with respect to permitting (development consent) and project design based on objective information and the results of consultation with the public/stakeholders.

8.3 Implementation gap

The horizontal instruments identified for the purposes of this study do not set specific quantifiable environmental targets. Rather, they aim to contribute widely to improving environmental conditions in the EU and so they may indirectly contribute to achieving the environmental targets set within the specific policy areas. This also implies that any non-implementation of the horizontal instruments may be measured in part via (higher) implementation gaps for the specific policy areas.

The 2017 Environmental Implementation Review, as well as other available reports identified several challenges in the implementation of the various horizontal instruments, thereby suggesting the existence of implementation gaps. However, as the instruments falling within this category are more 'procedural' in their nature, i.e. they do not set specific environmental targets, but rather provide mechanisms to improve decision-making, legislative development and implementation, the size of the implementation gap is difficult to assess in quantitative terms.

Below, we describe the status of the implementation of the three Directives in qualitative terms based on available implementation reports and studies.

Environmental Liability Directive

The 2017 Environmental Implementation Review Communication found that 22 EU Member States would need to *"step up efforts in the implementation of the Environmental Liability Directive (ELD) with proactive initiatives, such as setting up a national register of ELD incidents and/or drafting national guidance."*[38].

The 2016 REFIT evaluation of the ELD showed that the Directive had helped improve the level of environmental protection in the EU to a limited degree, however that it had not yet fulfilled its potential (EC, 2016h). This suggests that there was at the time an implementation gap. The evaluation found that implementation varied significantly from one Member State to another in terms of the number of ELD cases and the way the Directive was implemented, partly explained by the framework character of the Directive. "*A few Member States appear to make use of the ELD relatively frequently for environmental damage incidents, using it as a mainstream enforcement tool in circumstances where EU law might in any case require action (e.g. biodiversity damage). Other Member States appear to apply national legislation for environmental damage incidents instead of the ELD, by making extensive use of their interpretation of the 'significance threshold'*"[39].

The second implementation report on the ELD published in 2016 presents the experience gained in applying the Directive between 2007 and 2013 (EC, 2016g). It found that the ELD enabled in this period the remediation of environmental damage of a total of EUR 180 million, or EUR 6 million if the five major instances are excluded (EC 2016g, p. 5). Member States reported approximately 1,245 confirmed incidents of environmental damage which triggered the application of the ELD (EC 2016g, p. 2; EC 2016h, p. 22)[40]. About 50% of the reported cases concerned damage to land, 30% damage to water and 20% damage to biodiversity. Two Member States accounted for more than 86% of all reported damage cases and six Member States reported most of the remaining cases, while eleven Member States had reported no ELD damage incidents possibly because they dealt with such cases under other national legislation.

[38] EC (2017), Annex 1 to Commission Communication, The EU Environmental Implementation Review: Common challenges and how to combine efforts to deliver better results, *Guidance to Member States: suggested actions on better environmental implementation,* COM/2017/063 final, p.7

[39] EC (2016), Executive Summary to the REFIT Evaluation of the Environmental Liability Directive, SWD(2016) 122 final, p.3.

[40] In addition, Member States (excluding Italy) voluntarily reported 31 instances of imminent threat of environmental damage. However, this is likely a low estimate, as reporting of incidences of imminent threat is formally outside of the scope of Member State reports to the Commission. Source: SWD(2016) 121 final, p. 22.

The number of annual ELD cases per Member State varied from 95 to 0, a divergence found to be largely explained by different legal frameworks and in particular by whether pre-existing legislation was repealed or not, possible differences in the state of the environment, and different interpretations of key terms and concepts (e.g. the 'significance' threshold). Draft country fiches on the ELD[41] suggest that this divergence in terms of the number of cases treated under the ELD in different Member States continues to be observed today.

The information available through the REFIT evaluation and the ELD second implementation report suggests that there is likely to be an implementation gap and that the application of the ELD can be strengthened and streamlined. The number of reported incidents provides an indication as of which countries have made considerable efforts to implement the Directive.

[41] The Commission is soon publishing country fiches on the ELD on its website (expected in the first half of 2019): http://ec.europa.eu/environment/legal/liability/index.htm. The report has been based on draft country fiches from July 2018 which were temporarily available through the ELD Expert Group page.

Table 8-1 Number of confirmed ELD environmental damage cases, April 2007 – April 2013

Number of confirmed ELD environmental damage cases	Member States
Zero (0)	Reported that no ELD incidence occurred: • Czech Republic • Denmark • France • Luxembourg • the Netherlands • Slovenia • Slovakia Initiated proceedings but the cases were either pending or concerned only incidents of imminent threat: • Austria • Bulgaria • Ireland • Malta
1 - 60	• Belgium • Cyprus • Estonia • Finland • Germany • Greece • Italy • Latvia • Lithuania • Portugal • Romania • Spain • Sweden • United Kingdom
> 500	• Hungary • Poland

Source: Based on EC (2016h), REFIT Evaluation of the ELD, SWD(2016) 121 final, p. 22

However, it is difficult to make a judgement on the size of the implementation gap (nationally and EU wide), due to both data availability gaps and also conceptual difficulties in defining the gap (stemming largely from the absence of an environmental target), not least because a high number of reported incident cases in a Member State does not necessarily indicate that the Member State in question applies the ELD more strictly or a low implementation gap, and vice versa:

- A low (high) number of ELD reported cases of occurred environmental damage could either indicate good (poor) environmental status/low (high) number of environmental damage instances, or that damage instances are dealt with under environmental liability clauses in national law e.g. national water or waste legislation (or that there was no pre-existing national environmental liability law or if there was that it has been repealed), or a high (low) implementation gap. It could also be linked to the Member State interpretation of the 'significance threshold' for environmental damage.

- Data availability: Non-obligatory reporting of instances of imminent threat of environmental damage, means that the number of cases of prevented damage due to immediate action is largely unknown.

INSPIRE Directive

As already mentioned, the INSPIRE Directive, which needs to be fully implemented by 2021 does not set environmental targets, while it covers an enormous number of potential spatial datasets and, from the outset, no upper limit or total number could be identified (EC 2016i, p. 4).

The 2017 Environmental Implementation Review Communication noted that "*in most Member States, data-sharing has not progressed as much as the INSPIRE Directive intended, and Member States need to step up efforts if they are to derive the full benefits of the Directive's potential*" (COM/2017/063 final, p.11).

The Commission 2016 report presenting the implementation progress of the Directive as well as results of its REFIT evaluation, showed that although progress had been made in implementing the Directive by 2014, none of the deadlines with respect to the Directive's major milestones had been met by all Member States (EC 2016i, p.4). This suggested an implementation gap at the time. The requirements and timetable defined by the Directive did not pose fundamental problems for eight Member States, however, for many others progress did not meet expectations (EC 2016i, p.7). The 2016 report presented key reasons for the implementation gaps, including delays in transposing and setting up effective administrative structures due to political, legal and economic challenges at national level (EC 2016i, p.7-8). The principle reason highlighted for the implementation gaps was the complex and heterogeneous national data policies and the absence of a pan-European data policy hindering the free flow of data. Legal or financial barriers hindered the accessibility of many datasets, a prerequisite for creating added value from these data in the internal market. Here it is worth noting that in the meantime the EU has taken action to unlock the re-use potential of different types of data and facilitate its free flow across borders in the context of its Digital Single Market strategy[42].

A more recent report by the Commission's Joint Research Centre (JRC, 2017) provided the status of implementation of the INSPIRE Directive in EU in 2016[43] and the progress made since the above-mentioned mid-term report and REFIT evaluation which referred to the situation in 2013-14. This covered: i) the state of play with respect to the governance, use and impact of the Directive in Member States on the one hand; and ii) Member State progress with the implementing the four main steps in

[42] For example, on 22 January 2019, negotiators from the European Parliament, the Council of the EU and the Commission reached an agreement on a revised directive that will facilitate the availability and re-use of public sector data, http://europa.eu/rapid/press-release_IP-19-525_en.htm

[43] The 'Summary Report on Status of implementation of the INSPIRE Directive in EU' draws inter alia on Member States 2016 tri-annual INSPIRE implementation reports. INSPIRE Article 21(d) requires Member States to prepare and submit every three years, starting in 2010, an implementation report with information on the coordinating structures, on the use of the infrastructure for spatial information, on data-sharing agreements and on the costs and benefits of implementing the INSPIRE Directive. Tri-annual implementation reports were submitted by Member States in 2010, 2013 and 2016, while the next one is due in 2019.

relation to management of spatial datasets that fall under the Directive. The findings with respect to both aspects are summarised in the table below.

Table 8-2 State of play with respect to the governance and use of INSPIRE, and progress with implementing provisions on management of spatial datasets in Member States, 2016

Aspect	Requirement	Progress as of 2016
Governance and use of the INSPIRE Directive	Ensuring effective coordination (Article 18[44])	• In 19 Member States, the implementation of this provision was well advanced or (nearly) completed while any outstanding issues were minor / could be addressed easily. • In 9 Member States, implementation of this provision had started and made some progress but was still far from being complete. Outstanding issues were significant and needed to be addressed. The outlook for 8 of these Member States was assessed to be positive, with clear and targeted actions having been identified which would allow reaching the objectives of the legislation in an effective way. • In no (0) MS was the implementation of this provision found to be falling significantly behind or to have not started, such that serious efforts would be necessary to close the implementation gap.
	Data sharing without obstacles (Article 17[45])	• In 15 Member States, the implementation of this provision was well advanced or (nearly) completed while any outstanding issues were minor / could be addressed easily. • In 13 Member States, implementation of this provision had started and made some progress but was still far from being complete. Outstanding issues were significant and needed to be addressed. The outlook for 8 of these Member States was assessed to be positive, with clear and targeted actions having been identified which would allow reaching the objectives of the legislation in an effective way. • In no (0) MS was the implementation of this provision found to be falling significantly behind or to have not started, such that serious efforts would be necessary to close the implementation gap.
	Usage of the infrastructure for spatial information	<u>Usage at MS level:</u> • The documentation of spatial data sets and services has raised awareness about their availability in the public administration, and has improved spatial data sharing and use. • The use of the spatial infrastructure stays limited, without having specific tailored guidelines and an application layer that satisfies existing use cases • The availability of view and download services that can be reused by targeted applications is essential in order to build such an abstraction layer that satisfies existing use cases • Usage of discovery services was limited mostly to professional users (and not available to the wider user community)

[44] Article 18 of the INSPIRE Directive stipulates that "*Member States shall ensure that appropriate structures and mechanisms are designated for coordinating, across the different levels of government, the contributions of all those with an interest in their infrastructures for spatial information. These structures shall coordinate the contributions of, inter alia, users, producers, added-value service providers and coordinating bodies, concerning the identification of relevant data sets, user needs, the provision of information on existing practices and the provision of feedback on the implementation of this Directive*".
[45] Article 17 of the INSPIRE Directive foresees that "*Each Member State shall adopt measures for the sharing of spatial data sets and services between its public authorities [and that these measures] shall preclude any restrictions likely to create practical obstacles, occurring at the point of use, to the sharing of spatial data sets and services*".

Aspect	Requirement	Progress as of 2016
		• In Member States with limited or low quality service offering, usage of the infrastructure tends to be limited. • In Member States where the Open Data initiative is higher on the political agenda, and Open Data and INSPIRE ambitions were implemented in a complementary way the use of spatial data and the INSPIRE infrastructure is boosted. In Member States where the legal obligation is the only driver for the INSPIRE implementation and where no use cases were being developed or where implementation was done in isolation, the use of the infrastructure was limited. Usage at EU level: • The lack in availability of interoperable pan-European information products within the INSPIRE infrastructure that support and facilitate EU-level use cases limits the use of the infrastructure at EU-level. • There are still many isolated and non-interoperable data sets that cannot be used in cross-border and EU applications. The Commission has selected monitoring and reporting under the environmental acquis as a priority use case for the development of a first set of pan-European information products. A rolling priority list of eReporting data sets related to environmental reporting obligations has been prepared.
Management of spatial datasets	Step 1: Identify spatial datasets	By mid-2016, Member States had identified more than 90,000 spatial data sets in relation to themes listed in the INSPIRE annexes, demonstrating a lot of progress from 2013 onwards. Many spatial data sets have been identified in this period, mainly under Annex III data themes. Trends and outlook are in most cases positive. A lot of relevant spatial data sets have already been identified for the different data themes. The identification could further improve by identifying and documenting spatial data sets required under the existing reporting and monitoring regulations of EU environmental law. In 8 Member States, the implementation of this provision was well advanced or (nearly) completed. In 20 Member States, implementation of this provision had started and made some progress but was still far from being complete; of these 20, the outlook was positive for 14 Member States.
	Step 2: Document the identified spatial datasets (metadata);	Documentation on data and services in EU is constantly improving. Overall, 87% of the metadata (data sets and services) conforms to the INSPIRE metadata specifications. In 18 Member States, the implementation of this provision was well advanced or (nearly) completed. In 10 Member States, implementation of this provision had started and made some progress but was still far from being complete; of these 10, the outlook was positive for 8 Member States.
	Step 3: Provide services for identified spatial datasets (discovery, view, download)	The number of digital spatial data services across EU is evolving slowly. More than 40,000 view services and more than 30,000 download services are available. However, many of identified spatial data sets are still not accessible through the services and there is space for improvement. The overall technical conformity of the existing services is more than 50%, which is low and should be also further improved. • In 3 Member States, the implementation of this provision was well advanced or (nearly) completed. • In 20 Member States, implementation of this provision had started and made some progress but was still far from being complete. Outstanding issues were significant and needed to be addressed. The outlook for 12 of these Member States was assessed to be positive, with clear and targeted actions having been identified which would allow reaching the objectives of the legislation in an effective way. • In 5 MS the implementation of this provision was found to be falling significantly behind or to have not started, such that serious efforts would be necessary to close the implementation gap. The outlook for 4 of these Member States was assessed to be positive, with clear and targeted actions

Aspect	Requirement	Progress as of 2016
		having been identified
	Step 4: Make spatial datasets interoperable by aligning them with the common data models.	Almost 14,000 data sets in EU reported to be conformant to the INSPIRE interoperability specifications. It shows that Member States had started preparations to meet 2017 and 2020 data interoperability deadlines. However, significant efforts need to be made by all Member States in order to meet these obligations. The outlook for 21 of these Member States was assessed to be positive, with clear and targeted actions having been identified which would allow reaching the objectives of the legislation in an effective way. For another 5 Member States, the outlook was assessed to be neutral (neither positive nor negative), as no real progress had been made in the recent past or the identified actions were not clear and targeted enough to predict a more positive outlook.

Source: Based on JRC (2017)

With respect to the usage of INSPIRE infrastructure at EU level, a priority list of datasets has been identified that relate to environmental reporting (e-Reporting) obligations under the EU environmental acquis. They have been defined in the framework of INSPIRE Maintenance and Implementation Work Plan (MIWP) 2016-2020. Among the main objectives of the Commission for establishing the priority list of data sets for e-Reporting has been to communicate to Member States information priorities and expectations through clearly identifying the spatial data sets relevant for environmental reporting. The list is a "living" inventory of environmental information needs and as such provides an instrument to incrementally build comparable INSPIRE maturity across Member States, as well as an instrument to monitor progress on INSPIRE implementation in general and for the reporting use case specifically[46]. Thus, it gives some insights into the status of implementation of the Directive by Member States.

The recently launched *INSPIRE Geoportal*[47] provides statistical overviews by environmental domain and by country of the availability of the priority data sets, including the number of datasets with metadata, download and view services. The priority datasets concern key e-Reporting legislation and fall under 6 environmental domains, namely Air & Noise, industry, Waste, Nature & Biodiversity, Water, and Marine (see table below). *Water* is clearly the domain at the forefront in terms of number of INSPIRE conforming datasets for e-Reporting purposes (see table below).

46 MIWP action 2016.5 "Priority list of datasets for e-Reporting". https://ies-svn.jrc.ec.europa.eu/projects/2016-5/wiki/
47 The INSPIRE Geoportal was launched in September 2018, http://inspire-geoportal.ec.europa.eu/pdv_home.html

*Table 8-3 Number of e-Reporting datasets with metadata, download and view services, by environmental domain, February 2019 (all countries)**

Domain	Description	Metadata	Download	View
Air & Noise	Covers ambient air quality and cleaner air for Europe, industrial emissions…	268	129	160
Industry	Covers industrial emissions and industrial accidents…	70	32	38
Waste	Covers the landfill of waste, waste from extractive industries, soil…	88	40	60
Nature & Biodiversity	Covers conservation of natural habitats and wild fauna and flora, wild birds…	233	120	130
Water	Covers the Water Framework Directives, Urban waste water, bathing water…	576	228	309
Marine	Covers the Marine Strategy Framework Directive, marine environmental policy…	57	37	34

Source: INSPIRE Geoportal (accessed 08/02/2019

Notes*:* Total figures include the EU-28, Norway, Switzerland, Liechtenstein and Iceland

The typology of environmental domains used on the *INSPIRE Geoportal* is slightly different compared to the environmental policy areas of this study: C*hemicals* is not included as a category, while *water* forms two distinct categories*.* The *INSPIRE Geoportal* also provides an overview of the number of Member States' priority data sets with metadata, download and view services, grouped by e-Reporting legislation:

Table 8-4 e-Reporting legislation of priority data sets

e-Reporting legislation covered by priority data sets	Number of datasets with Metadata | downloadable | viewable (all Member States)	Relevant environmental areas of the present study
Landfill of Waste Directive (Directive 1999/31/EC)	2 | 1 | 1	Waste
Water Framework Directive (Directive 2000/60/EC)	312 | 122 | 147	Water
Noise Directive (Directive 2002/49/EC)	149 | 88 | 101	Air and noise
Extractive Waste Directive (Directive 2006/21/EC)	1 | 0 | 0	Waste / Industrial emissions and major accident hazards
Bathing Water Directive (Directive 2006/7/EC)	13 | 10 | 7	Water
Floods Directive (Directive 2007/60/EC)	184 | 68 | 107	Water
Air Quality Directive (Directive 2008/50/EC)	65 | 17 | 27	Air and noise
Marine Strategy Framework Directive (Directive 2008/56/EC)	23 | 14 | 14	Water
Birds Directive (Directive	56 | 35 | 37	Nature and biodiversity

2009/147/EC)		
Industrial Emissions Directive (Directive 2010/75/EU)	14 | 4 | 4	Industrial emissions and major accident hazards
SEVESO III Directive (Directive 2012/18/EU)	8 | 4 | 6	Industrial emissions and major accident hazards
Sewage Sludge Directive (Directive 86/278/EEC)	1 | 0 | 0	Water
Urban Waste Water Treatment Directive (Directive 91/271/EEC)	55 | 24 | 39	Water / Industrial emissions and major accident hazards
Nitrates Directive (Directive 91/676/EEC)	26 | 14 | 19	Chemicals / Water
Habitats Directive (Directive 92/43/EEC)	91 | 54 | 57	Nature and biodiversity
Drinking Water Directive (Directive 98/83/EC)	6 | 3 | 6	Water
Recommendation on hydraulic fracturing (Recommendation 2014/70/EU)	3 | 1 | 1	Industrial emissions and major accident hazards / Water / Air and noise
European Pollutant Release and Transfer Register (Regulation (EC) 166/2006)	20 | 9 | 9	Air and noise
Invasive Alien Species Directive (Regulation (EU) 1143/2014)	6 | 1 | 2	Nature and biodiversity
Mercury Regulation (Regulation (EU) 2017/852)	0 | 0 | 0	Chemicals / Waste / Industrial emissions and major accident hazards
Nationally designated areas – CDDA (EEA Annual Work Programme)	59 | 25 | 25	Nature and biodiversity
National biogeographical regions (National legislation)	13 | 6 | 6	Nature and biodiversity

Source: INSPIRE Geoportal (accessed on 8 February 2019)

The situation per Member State as of February 2019 is presented in the following table. A total of 1,016 e-reporting datasets with metadata were available as of February 2019 in the different Member States, and about half as many with download (452 e-reporting datasets) or view services (557 e-reporting datasets).

Table 8-5 Number of e-Reporting datasets with metadata, download and view services, by Member State, February 2019 (all environmental domains)

Country	Metadata	Download services	View services
Austria	74	63	68
Belgium	101	28	57
Bulgaria	0	0	0
Croatia	14	1	3
Cyprus	5	5	1
Czech Republic	39	5	37
Denmark	39	5	5
Estonia	21	1	1
Finland	20	15	13
France	117	0	0
Germany	65	29	15
Greece	38	31	31
Hungary	13	0	0
Ireland	9	0	0
Italy	16	0	1
Latvia	0	0	0
Lithuania	0	0	0
Luxembourg	66	66	56
Malta	54	52	54
Netherlands	42	25	26
Poland	1	0	0
Portugal	134	27	79
Romania	21	10	1
Slovakia	12	2	5
Slovenia	4	1	0
Spain	81	80	81
Sweden	30	6	23
United Kingdom	0	0	0
Total	**1016**	**452**	**557**

Source: Based on INSPIRE Geoportal information (accessed 08/02/2019)

A mixed picture of the situation can be drawn from the above table, ranging from some Member States with zero availability of priority data sets with metadata, download or view services (BG, LV, LT, UK), to Member States with a high number of INSPIRE conforming priority datasets (e.g. AT, BE, PT, ES, LU). Also, some countries demonstrate a more balanced attention to metadata, download and view services (e.g. AT, EL, MT, LU, ES), while others have prioritised the availability of metadata (e.g. FR, BE, DE, EE, HU, IE), download services relative to view services (e.g. DE, RO) or view services relative to download services (e.g. BE, CZ, PT, SE).

EIA Directive

According to the impact assessment of the proposal amending the EIA Directive in 2012, the implementation gaps of the EIA Directive concerning the screening process, insufficient quality of the EIA documentation and public participation represented 12% of the infringements related to EU environmental law (EC 2012, p. 44). Implementation gaps were often observed in Member States where a high number of infrastructure projects were carried out and which had less experience in applying the Directive, and in Member States where its application is decentralised.

We note the caveat that infringement cases do not provide a complete or representative picture of the implementation status, but rather indicate areas of implementation deficiencies of strategic or political importance[48]. While keeping this in mind, a similar exercise shows that the EIA Directive represented close to 10% (or 28 out of 290) of the active infringement cases related to EU environmental law as of 1 November 2018[49]. Eleven (11) of the 28 active cases concerned cases of late transposition (known as "non-communication cases") of the 2014 amendments to the Directive. From the remaining 17 active cases, at least 5 concerned the transposition into national law of access to justice in environmental matters provisions of the EIA Directive, 4 concerned poor quality EIAs, 4 insufficient coverage. Six (6) of the 9 cases pertaining to specific projects, concern impacts on nature & biodiversity.

8.4 Implementation gap cost

As already noted we do not estimate an implementation gap cost for horizontal instruments. However, we describe the foregone benefits from the non-implementation of horizontal instruments in qualitative terms. These concern environmental and health impacts within the specific policy areas but also wider socio-economic benefits.

Environmental Liability Directive

The ELD's fundamental principle is prevention of environmental damage incentivised by exposing operators to potential legal and financial liability for the damage caused and the subsequent remediation. This exposure induces operators to assess and manage environmental risks with a view to preventing environmental damage from occurring in the first place. Furthermore, the Directive requires operators to initiate preventative measures where there is an imminent threat of environmental damage occurring. In the event that environmental damage does occur, the ELD focuses on its remediation. Overall, the ELD reinforces the 'polluter pays' principle.

The impact of non-implementation would translate into reduced levels of environmental risk assessment and risk management by operators and hence a reduced prevention of environmental damage – resulting from higher occurrence of incidents or accidents. It would also mean that imminent environmental damage would be more likely to materialise, and that occurred damage would not be remedied. The incentivising effect of the Directive, materialising in enhanced precautionary measures and better financial security, and the prevented damage due

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[48] This is in particular the case since the 2016 Commission Communication 'EU law: Better results through better application', whereby the Commission has taken a more strategic approach to its enforcement actions when it comes handling of infringements, focusing on cases of incorrect application raising issues of wider principle, cases where there is sufficient evidence of a general practice, of a problem of compliance of national legislation with EU law or of a systematic failure to comply with EU law.

[49] COWI/Eunomia estimate based on the list of active infringements as of 1 November 2018, http://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/infringement_decisions

to immediate action in case of imminent damage, is largely unknown due to yet non-existing data EC (2016g, p.5). The amount of remedied environmental damage under the ELD between 2007 and 2013 amounted to around EUR 180 million in total, or around EUR 6 million if the five major instances are excluded (2016g, p.5).

There are some reports of environmental damage costs in particular for major incidents or accidents in the EU, which illustrate the magnitude of environmental liabilities that can be incurred in case of such major incidents. Costs related to prevention and remediation of environmental harm can be in the tens to hundreds of millions of euro, before even taking into account additional costs pertaining to property damage, personal injury claims, legal costs, fines etc (Irish EPA, 2014, Appendix C, p. 77 and Table C3).

Table 8-6 Environmental liability cost estimates for major past incidents/accidents in the EU

Operator/ location	Description of operation and incident	Environmental liability costs
Buncefield, UK	Oil-products storage depot Seveso site Vapour cloud explosion and fire Major losses of fuel, foam and fire water to environment	Competent authority and government response EUR 18 million* Emergency response EUR 8.4 million * Environmental impact (drinking water) EUR 2.4 million * Costs do not include those associated with storage and treatment of fire water
Chemie-Pack, Netherlands	Storage, blending, filling and packaging of chemicals 50 employees Seveso site Fire	Estimated total costs of EUR 65.4m: Land damage EUR 38.2 million Waterbed pollution of ditches EUR 13.5 million Cleaning up above the ground EUR 9.6 million Management of fire water EUR 2.5 million Waterbed pollution port EUR 1.6 million
Boliden Apirsa mine, Aznalcóllar, Spain	Large-scale losses from mine tailings dam	Remedial and restoration measures cost local and national authorities around EUR 101 million. Protective measures cost the authorities a further EUR 70 million.
AZF chemical plant, France	Explosion resulting in the release of nitric acid and ammonia into river, leading to large-scale destruction of aquatic fauna	The clean-up pollution operation and the rehabilitation of the site cost an estimated EUR 250 million.

Sources: Irish EPA (2014). Guidance on assessing and costing environmental liabilities, Appendix C, p. 77 and Table C3; BIO Intelligence Service et al. (2012). Study to explore the feasibility of creating a fund to cover environmental liability and losses occurring from industrial accidents; Nicolette Bouman (Ministry of Infrastructure and the Environment, The Netherlands) (2012). Fire at Chemie-Pack; Mike Jenkins (Environment Agency Technical Adviser) (2013) Calculating the cost of pollution incidents; NL (2013), Report under Article 18(1) of Directive 2004/35/EC.
Notes: figures marked with an * were converted to euro on basis of £1.00 = EUR 1.20.

The following table provides more details on the Chemie-Pack fire incident in the Netherlands, which resulted in environmental damage cost of about EUR 65.4 million.

Table 8-7 Environmental liability costs – the case of Chemie-Pack fire incident

Incident description

In January 2011 there was a major fire at Chemie-Pack, a storage, blending, filling and packaging facility of chemicals in Moerdijk, the Netherlands. The incident resulted in damage to the soil because of pollution of the water used to put out the fire.

Damage assessment

The area affected was determined by the experts from the Regional Environmental Service. The area affected was assessed at approximately 8 hectares. The starting point for determining the area was that a mix of chemicals (incl. pesticides, volatile aromatics, chlorobenzenes, dioxins, VOCls, PAHs and PCBs) stored at Chemie-Pack were flushed away with the water used to put out the fire. The chemicals subsequently penetrated the soil. This water also polluted the water beds of the surrounding ditches and those of De Roode Vaart and the Northern Dock.

Trigger of environmental liability provisions

The occupational activity at Chemie-Pack is covered by Annex III.7.(a) of the ELD. The ELD is implemented in the Netherlands through title 17.2 of the Dutch Environmental Management Act (Wet milieubeheer).

Although the incident would fall under the Dutch ELD-transposing provisions, these were not formally triggered, and the case was not reported by the competent authorities to the Dutch ELD reporting point. Nonetheless, the various competent bodies acted immediately in order to ensure that the pollution would remain as limited as possible and would be removed by the firm, and that the firm would be made liable for the costs. In doing so the competent authority took as its legal basis the regulations implementing the Seveso Directive, national water legislation and national soil regulations, the latter being stricter than the Dutch law implementing ELD in the sense that they stipulate that all soil pollution must be cleared up (rather than pollution above a significant damage threshold). By doing, this the competent authority considered that the objective of the ELD was achieved.

Remediation measures

To remediate the damage and restore water and land at their status before the incident, the measures taken included: 1. Removal of the water used to put out the fire (restrict: remove the source of spreading and contact possibilities); 2. Removal of the slurry (restrict: remove source of spreading and contact possibilities); 3. Removal of pollution (rectify: examination and decontamination) for both the topsoil and the surface water. For soil decontamination the source was removed as much as possible and the risks of further spreading were controlled while limiting the costs as much as possible. A groundwater protection system was put in place to ensure that the pollution did not spread to the deeper groundwater and.

Remediation costs and recovery

The costs involved in the remediation action regarding water and land damage were estimated at EUR 65.4 million (excluding the costs for the acute phase and project organisation). The amount concerns direct costs for treating the water used to put out the fire, above-ground clearance and waterbed and soil decontamination:

Remediation measure	Cost
Soil decontamination	EUR 38.2 million
Ditch waterbed decontamination	EUR 13.5 million
Above-ground clearance	EUR 9.6 million
Treating the water used	EUR 2.5 million
Port waterbed decontamination	EUR 1.6 million
Total	**EUR 65.4 million**

The costs were initially borne by the municipality, the province, Water Board Brabantse Delta, Rijkswaterstaat and the Moerdijk Port Authority, who then started proceedings for their recovery. Chemie-Pack went bankrupt after the fire, but the real estate company of Chemie-Pack and its director were condemned in several cases to many millions of damages. Insurers refused to pay compensation because the company violated the rules. Legal proceedings came to an end in 2014 with a settlement of EUR 4.2 million for all claims for damages, an amount considered the maximum feasible, after it became clear that further legal proceedings would be costly without leading to a higher yield.

Sources: Irish EPA (2014). *Guidance on assessing and costing environmental liabilities*, Appendix C, p. 77 and Table C3; Nicolette Bouman (Ministry of Infrastructure and the Environment, The Netherlands) (2012) *Fire at Chemie-Pack*; NL (2013), Report under Article 18(1) of Directive 2004/35/EC (environmental liability); Omroep Brabant (2014), *Chemie-Pack pays 4.2 million euros for damage after chemical fire in 2011 (Chemie-Pack betaalt 4,2 miljoen euro voor schade na chemiebrand in 2011),* news article of 10 October 2014.

The implementation gap cost is in part captured in the costs of not achieving environmental targets in the 6 specific environmental areas because of inadequate prevention/precautionary measures and inadequate remediation action by the liable entities.

Also, the overall low number of cases giving rise to the ELD means low demand for/availability of financial security products, so increased cost of environmental damage for operators.

The implementation gap also means increased costs for authorities / society at large for remediation action to restore environmental damage on a secondary basis rather than cost being internalised or borne by the liable person, in line with the polluter-pays principle.

INSPIRE Directive

The INSPIRE Directive (2007/2/EC) sets requirements to comply with the conditions for interoperable sharing and exchange of spatial data across Europe. Interoperable sharing and exchange between public authorities can help Member States to report on the environment more efficiently, better target compliance checks and inspections, and facilitate implementation of complex tasks such as flood prevention, which depend on the use of topographical, meteorological and other information. The cost of non-implementation would be the foregone benefits associated with poorly informed decisions due to insufficient access to environmental information, as well as foregone efficiency gains. More in detail this includes foregone benefits in relation to (EC 2016i, p. 9):

- More efficient access to information leading to better and cheaper eGovernment services for citizens and businesses, thus improving transparency and creating business opportunities using environmental data. This boosts research and innovation potential.
- An improved evidence base for policy development, decision-making and implementation, reducing costs and improving the quality of assessments e.g. in the area of environmental (impact) assessments and (risk) management.
- Better cooperation between public authorities and between different sectors (e.g. spatial planning, transport, agriculture and environment), and administrative cost savings (through less duplication of work) while improving accessibility and data quality.
- Building up technological skills, competences and capacity building in public administrations.

The benefits of INSPIRE in terms of innovation and business opportunities are amplified thanks to existing and ongoing initiatives enabling the re-use of different types of data and its flow across borders in the context of the EU Digital Single Market strategy. The provisions of the Public Sector Information Directive enable access to INSPIRE data by third parties (private sector, academia, NGOs etc) and hence the creation of innovative digital products and services. INSPIRE thus plays a contributing role in strengthening the data economy in the EU. An assessment of the socio-economic impact of the emerging data market in Europe showed a positive trend in recent years in terms of the value of the EU data market (i.e. the market of digital products and services), as well as the value of the overall EU data economy. The EU data market reached EUR 59.5 bn in 2016, with the overall value of the data economy reaching EUR 300 bn in the same year, i.e. nearly 2% of the European GDP (IDC and Open Evidence 2017, p. 9-10). Under a high growth scenario characterised by favourable framework conditions, higher ICT investment and a stronger role of digital innovation, the positive trends are expected to continue: the data market is expected to reach EUR 106.8 bn by 2020 at a compound annual growth rate of 15.7% since 2016, and the overall value of the data economy is expected to increase to EUR 739 bn by 2020 (IDC and Open Evidence 2017, p. 17-20).

Member States' triannual implementation reports include a section on the (costs and) benefits of implementing the INSPIRE Directive. Drawing inter alia on the latest available triannual reports (2016), the *'Summary Report on Status of implementation of the INSPIRE Directive in EU'* summarised the findings with respect to (costs and) benefits as follows (JRC 2017, p 11):

- The quantification and management of (costs and) benefits are considered difficult because of the federated and technical nature of the INSPIRE implementation in many Member States (across administrative levels and cross-domain).
- Benefits for citizens, businesses, and administrations lack quantification.
- In general, the qualitative and strategic benefits are considered significant. There are many examples of increased data sharing through the development of new services and geoportals making public spatial data electronically available. Many projects and new applications are already making use of INSPIRE data "as-is".
- Some Member States expect to be able to make a more reliable evaluation of the cost-benefit ratio when INSPIRE-conformant data and services are more widely available and used.

Despite underscoring the general lack of quantitative estimates of the benefits of the Directive, the same report also points out a few examples of their quantification in some countries. Examples cover the quantification of the benefits at the overall Member State level, as well as the quantification of benefits stemming from specific use cases (see table below).

Table 8-8 INSPIRE benefits - quantification examples

Country	Estimated benefits of INSPIRE
Lithuania	Lithuania has provided a concrete assessment of economic and social benefits generated at the national level as a result of the functioning of the infrastructure for spatial information. The assessment identified public service savings of around EUR 1.2 million in working days from the implementation of the Directive and the socio-economic benefits have been assessed from EUR 0.9 million in the year 2014 to an average of EUR 1.8 million annually the following years.
Spain	The geoportal for hydrocarbons allows for citizens savings of up to EUR 60 million /year
Denmark	A business case underlying the release of (all) spatial data was estimated an annual net gain to be averaging about 100 million kr. (about EUR 13 million) until 2020.

Source: JRC 2017, p. 11

EIA Directive

The EIA Directive (2014/52/EU) sets requirements to ensure that significant environmental impacts are prevented or responded to. If the requirements in the EIA Directive with respect to assessing the environmental impacts of private and public projects are not complied with and the necessary adjustments to them in terms of prevention, mitigation and compensation measures are not identified and made, this may lead to projects and programmes with (unnecessary) negative environmental impacts and foregone socio-economic benefits.

The benefits attributable to the EIA Directive are to some extent process related and of a preventative nature and thus difficult to delineate. This means that the quantification of the foregone benefits in relation to non-implementation of the EIA Directive is also difficult. Studies on the EIA Directive have not quantified or monetised the environmental benefits and the wider economic and social benefits that can be attributed to the EIA Directive (EC 2012, p. 95). Moreover, projects are site specific and quantification would require a project by project assessment, and as such there has been no attempt in the academic literature to capture the benefits from the Directive in aggregate in a monetary sense (Milieu/COWI 2016, p.15).

The difficulty to quantifying benefits largely stems from the variety of projects and environmental issues covered by the EIA Directive, as well as the diversity of approaches to the EIA process (EC 2012, p. 7). Evaluating the environmental benefits once the project has been developed has also proven difficult due to lack of monitoring data (EC 2012, p. 7), however this might change to a certain extent in the future as ex-post project monitoring requirements have been introduced with the 2014 amendments to the Directive, and applicable for projects for which the EIA procedure or screening was initiated after 16 May 2017.

Nonetheless, the Directive's benefits can be qualitatively described. The cost of non-implementation would be the foregone benefits in relation to (Milieu/COWI 2016, p.73):

- Improved decision making on projects;
- Improved design of projects
- Clarity on screening and scoping of EIA projects
- Better public acceptance

The first three of the above aspects largely accrue as **environmental benefits**, through the mainstreaming of environmental considerations as early as possible in decision-making process and enhancing environmental sustainability of projects through preventing, mitigating or compensating environmental damages. Since its coming into force, the Directive has provided significant environmental benefits (EC 2012, p. 6-7).

In addition, the EIA Directive brings about the following wider **socio-economic benefits (**EC 2012, p. 7-8):

- **Avoided costs of reparation**. Avoiding potentially high costs of unanticipated environmental damage or liabilities which may arise at a later stage.
- **Avoided public costs for health damages**, while likely to be significant, are difficult to estimate and no data is available at present.
- Other social benefits include the preservation of **quality of life** (e.g. preservation of ecosystems and the landscape), where again no quantifiable data is available.
- The EIA Directive has harmonised the principles and practices of environmental assessments in the EU and has introduced minimum requirements that have improved the **functioning of the internal market**.
- By obliging developers to assess environmental impacts, the EIA Directive, contributes to improving the **environmental profile and reputation** of the project initiator and significantly enhances the developer’s environmental credibility.
- In addition, through the obligation to anticipate environmental impacts of their projects and identify measures to prevent and mitigate them, the EIA Directive

provides incentives for developers to apply innovative design and pollution abatement processes. **Increased innovation** is in turn likely to translate into higher competitiveness for companies.

- Expertise is required to comply with the requirements of the EIA Directive (mainly the preparation of EIA reports). This has led to the **creation or to the preservation of jobs** (mostly high-skilled ones) in public authorities and in environmental consultancy companies; specific jobs dedicated to EIAs may also have been created internally in large companies.
- The alignment of the EIA with the Aarhus Convention (through Directive 2003/35/EC), resulted in wider social (**governance**) benefits, such as increased **public participation** in decision-making procedures relating to projects (e.g. changes in the design of projects and increased social acceptability), development of '**civil society**' and increased possibilities for the public to **challenge the legality of final decisions**.

8.5 Lessons learnt and recommendations

The underlying horizontal instruments do not specify environmental targets, yet contribute indirectly to achieving the environmental targets set within the specific policy areas. This implies that it is difficult to define, let alone measure the implementation gap for horizontal instruments. Any non-implementation of the horizontal instruments is largely measured in the form of higher implementation gap costs for the specific policy areas. Measuring and adding the implementation gap costs for the horizontal instruments to the total cost estimate as a result comes at the risk of double-counting.

The risk of double-counting as well as not being able to derive a cost estimate for these instruments were acknowledged already from the outset of the study. Nonetheless, horizontal instruments provide important mechanisms to improve decision-making, legislative development and implementation, and the study would be incomplete without this policy area. The underlying chapter has consequently a somewhat different nature compared to the chapters on the other policy areas. First, it discusses the overall objectives of the instruments rather than their environmental targets. Secondly, it discusses the implementation status and challenges, rather than measuring a concrete implementation gap. Third, it discusses qualitatively the type of foregone benefits associated with non-implementing these instruments. It does so for a sub-set of horizontal instruments, and in the future additional instruments can be added, for example the SEA Directive.

The work carried out in this area confirmed the anticipated limitations with respect to quantifiability of gaps or costs and the risk of double-counting. We expect these limitations to remain largely applicable, and therefore future work can seek added value by concentrating on the qualitative dimension of the status of implementation. For example, when discussing the status of implementation, we make use of indicators (e.g. number of reported ELD incidents; number of INSPIRE datasets concerning key EU e-Reporting legislation; number of EIA-related infringement cases), which provide a qualitative indication as of which countries have made considerable efforts to implement the Directives. However, it is difficult to make a precise judgement on the size of the implementation gap based on these indicators, due to both data availability gaps and conceptual difficulties in defining the gap (stemming largely from the absence of environmental targets). Future work can build on such indicators, while making use of new and more comprehensive evidence as it becomes available (ongoing work under the Directives covered means that up to date information on their implementation is soon to become available). Similarly, the foregone benefits associated with not implementing the horizontal instruments are primarily discussed qualitatively, with some quantification examples provided where possible. Future work can concentrate on identifying and drawing on additional quantification examples from specific Member States or specific cases.

9. Conclusion

9.1 Environmental targets and implementation gaps

Looking across the findings for the seven policy areas presented in the previous chapters, it is evident that the policy areas differ in the way the respective Directives and Regulations intervene to improve the environment. In the context of this study, it is – as summarised in Table 9-1 – particularly important that the policy areas differ with respect to the concreteness of the environmental targets they aim to achieve. In itself, this implies that the implementation gaps we estimate for the different policy areas differ with respect to their concreteness and quality.

The table shows that the EU environmental legislations on air, water and waste provide for specific environmental targets. Hence, implementation gaps for air can be estimated by comparing air pollution monitoring information gathered in the Member States with the targets. There are for both the water and waste policy areas different target types within different pieces of the EU legislation. Measurability is also here high as each environmental target type is of quantitative nature.

Measurability of environmental targets is also high for the policy area: industrial emissions and major accident hazards as the EU legislation provides for specific source emission targets. The achievement of most of these source emission targets will, however, already be accounted for by the analysis of implementation gaps for the air policy area. Hence, the focus in our analysis is on achieving the additional targets for heavy metals and organic substances.

In contrast, measurability of the environmental targets is particularly low for the policy area: nature and biodiversity. Reasons for this are the broad definition of the target and the fact that the assessment of whether the target has been achieved or not is limited by the fact that there is no clear baseline against which to estimate how the status of flora and fauna might have developed in the absence of EU action.

Measurability of the environmental targets for chemicals and for horizontal instruments are also low. The reason is here that the requirements of the respective EU legislations do not concern specific targets but merely focus on actions to be taken to avoid environmental damage.

Finally, for noise – which is part of the first policy area – the EU legislation does not provide for specific noise pollution limits. Although it can be argued that the requirements to assess noise levels by producing environmental noise maps etc. may look at the noise exposure limits recommended by the WHO, we have not found it appropriate to fully consider the non-achievement of the recommendations as an implementation gap.

Table 9-1 Comparison of environmental targets across policy areas

Policy area	Type	Measurability
Air and noise	*Air*: specific limits for air pollution concentration values and for overall national emission ceilings *Noise*: WHO guidelines may be used as 'policy targets'	*Air*: High – concrete, quantitative target values are specified *Noise*: High – but new WHO guidelines provide target values not yet included in many monitoring activities
Nature and biodiversity	Target to halt the loss of biodiversity and ecosystem services, and to ensure that species and habitats recover sufficiently to enable them to flourish over the long term	Low – as the assessment of whether this target has been achieved or not is limited by the fact that there is no clear baseline against which to estimate how the status of flora and fauna might have developed in the absence of EU action
Water	Different target types within different pieces of EU water legislation – e.g. targets for ecological status, bathing water quality, nitrate concentration, and requirements to waste water discharges	High – each target type is measurable in quantitative terms
Waste	Different target types within different pieces of EU waste legislation – e.g. targets for collection, reuse, recovery, recycling, and landfill	High – each target type is measurable in quantitative terms
Chemicals	No specific targets – but requirements to controlling in connection with using and placing chemicals on the market	Low – no quantitative target values
Industrial emissions and major accident hazards	Specific source emission targets – where most are set to contribute to the above air pollution targets, apart from the targets for heavy metals and organic substances	High – concrete, quantitative target values are specified
Horizontal instruments	No targets but requirements to take actions to avoid environmental damage	Low - no specific targets

Source: COWI/Eunomia.

The above differences in types and measurability – as well as differences in the units of measurement – of the environmental targets for the policy areas imply that the measurements of implementation gaps differ.

For air and noise, the implementation gap is measured via the number of people exposed above the environmental targets. Hence for air, it is the people who are exposed to air pollution above the concentration values. For noise, it is those living in locations where there is too much noise – e.g. close to major roads.

For nature and biodiversity, the ideal measure would be the increased level of biodiversity and ecosystem services if all provisions of the Habitats and Birds Directives had been fully implemented. However, as just mentioned above, the assessment of whether this target has been achieved or not is limited by the fact that there is no clear baseline to measure against.

For both water and waste, the implementation gaps are measure as the distance from specific environmental statues – e.g. the distance from having the required bathing water quality, or the distance to fulfilling the waste recycling targets.

For chemicals, the lack of quantitative targets limits the possibility to measure implementation gaps. However, in any case we find the Directives REACH and CLP have been fully implemented in the Member States, and so we conclude that there are no implementation gaps.

For industrial emissions and major accident hazards, focus is on the individual requirements of the IED and discuss the potential implementations gaps that could arise therein.

Similarly, for the horizontal instruments the lack of specific targets limits the possibility to measure implementation gaps. Here, we merely conclude that any insufficiencies in making use of the horizontal instruments may have impeded the achievement of the environmental targets specified for the other policy areas.

9.2 Costs of not implementing EU environmental law

Policy areas differ with respect to the units of measurement of the implementation gap estimates. This implies that they are difficult to compare – and to add together.

To enable this, we have in this study gone a step further and estimated the *costs* of the implementation gaps – i.e. to measure them in EUR. The result of this exercise is provided in Table 9-2 which shows that the estimated costs and foregone benefits at EU level amount to **around EUR 55 bn per year (in 2018).** In other words, the cost of not achieving the EU environmental targets is around EUR 55 bn per year for EU as a whole. A similar estimate of EUR 50 bn per year for 2011 was provided by the COWI (2011) study.

This implementation gap cost estimate is connected with much uncertainty. Therefore, we have in this report provided estimates in the form of ranges for each of the policy areas, i.e. ranges within which we believe that the estimates lie with a reasonable level certainty. This results in a total **range estimate of EUR 29.7-79.6 bn per year** – i.e. the costs of not delivering on the EU environmental targets amount to between EUR 29.7 bn and EUR 79.6 bn per year.

Table 9-2 Costs of not implementing EU environmental law, EUR bn per year, 2018

Policy area	Range estimate	Central estimate
Air	8.7 - 40.4	24.6
Nature and biodiversity	10.5 - 15.7	13.1
Water	4.3 - 14.3	9.3
Waste	3.2 - 4.8	4.0
Chemicals	0 – 0	0
Industrial emissions and major accident hazards	3.0 - 4.4	3.7
Horizontal instruments	-	-
Total	**29.7-79.6**	**54.7**

Source: COWI/Eunomia.

The total estimate does not consider the implementation gap costs for noise. The reason is that the EU legislation on noise does not provide for specific noise limits. However, there are still significant health costs from excessive noise pollution, and we provide a related cost estimate of around EUR 30.7 bn per year assuming that the WHO (1999) recommended noise exposure limits represent the 'policy targets'.

The implementation gap cost estimate for air focuses on the health costs to the EU urban population exposed above the environmental limits. Hence, the estimation is based on the data on the number of people living in urban areas where air pollution too often exceeds concentration values, on assumptions about how much the air pollution exceeds the concentration values, and on assumptions (modelling) about how this impacts health conditions.

For nature and biodiversity, the lack of a good implementation gap measure implies a loaf of a good implementation gap cost measure. Hence, the estimate included in Table 9-2 should be considered as a very rough estimate. It is based on the estimates by ten Brink et al (2008) that the Natura 2000 network provides EUR 200-300 bn per year in benefits, and that around 5% could be seen as the annual rate of loss, i.e. the costs of deterioration of ecosystem from not fully implementing the EU legislation.

For water, the implementation gap costs are estimated as the foregone benefits from water not being of a 'good' ecological status, and as the economic value of damages to water resources e.g. from nitrogen discharges.

For waste, the implementation gap cost estimate is based on a number of different cost types for the different waste issues. There are, for example, health and environmental costs associated with illegal landfills and illegal waste export activities. There will be missed benefits from non-realised circular economy market developments. Furthermore, there may be spill-over effects from potentially increased use of more polluting power sources where non-recycled waste is landfilled rather than undergoing energy recovery.

For chemicals, the conclusion is that there are no implementation gaps, and this obviously implies that there are no implementation gap costs either.

For emissions and major accident hazards the non-achievement of most of these source emission targets are already accounted for when estimating the implementation gap costs for the air policy area. Hence, the implementation gap cost estimates in this case only relate to the non-achievement of the additional targets for heavy metals and organic substances.

Finally, for lack of implementation gaps measures for the horizontal instruments does not allow us to make an implementation gap cost estimate.

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Unequal exposure and unequal impacts: social vulnerability to air pollution, noise and extreme temperatures in Europe

Executive summary

Europe's environmental quality has been steadily improving over recent decades. Nonetheless, air pollution and noise continue to contribute to serious illnesses and premature deaths, especially in urban areas. In addition, recent years in Europe have been marked by extreme temperatures with severe implications for human health.

Exposure to air pollution, noise and extreme temperatures does not affect everyone in the same way. On the contrary, the uneven distribution of the impacts of air pollution, noise and extreme temperatures on the health of Europeans closely reflects the socio-demographic differences within our society. Personal characteristics, such as age or health, determine how sensitive people are to these environmental health hazards, i.e. how badly their health may be affected if they are exposed to them. In addition, people's ability to avoid, or cope with, these environmental health hazards is influenced by their socio-economic status (i.e. income, employment status or level of education). Older people, children, those experiencing material disadvantage and those in bad health are typically more vulnerable to air pollution, noise and extreme temperatures than the general population. They are also the ones who tend to have the least say in how and where they live, work or go to school, which, in turn, affects their exposure to these environmental health hazards. As a result, their health tends to suffer the most from the impacts of air pollution, noise and extreme temperatures (see Figure ES.1 on page 9).

The aim of this report is to assess inequalities in the exposure to and impacts of selected environmental health hazards (air pollution, noise, and extreme temperatures) on European society and to discuss how these are reflected in current policy and practice.

The assessment described in this report looks at the overlap between socio-demographic characteristics and the levels of exposure to environmental health hazards within sub-national regions. In many European countries, the disproportionate exposure of lower socio-economic groups to air pollution, noise and high temperatures occurs in urban areas, so the report also addresses cities.

The assessment shows that across Europe there are pronounced large-scale regional differences in the levels of social vulnerability and exposure to environmental health hazards. For example, high temperatures and ozone pollution tend to affect the south of Europe to a greater extent than the north, while particulate matter pollution tends to be most concentrated in central and eastern Europe. Lower household incomes and higher unemployment are more prevalent in southern, central and eastern Europe, and both western and southern parts of Europe have a high proportion of the elderly in the population. Some regions with the lowest incomes and the highest unemployment rates are affected by extreme temperatures, which may affect the ability of the population to afford keeping homes adequately cool or warm. Consequently, in many regions, the population's high social vulnerability overlaps with high levels of environmental health hazards, resulting in negative health outcomes.

Within individual sub-national regions and cities, there are also stark inequalities in the impacts of environmental health hazards, which are linked to the varying vulnerability and exposure of different groups. In cities in particular, the neighbourhoods where residents' lives are shortened by air pollution and noise can be found next to areas of much better environmental quality, usually inhabited by more affluent communities.

The ongoing and projected changes in European society – for example, the rapid ageing in many western and southern countries or the continuing economical differences between the East and the West – mean that the inequalities in social vulnerability with regard to environmental health hazards are likely to persist or even increase. Furthermore, the changing climate has brought more extreme weather and climate events, which, especially when combined with persistent air pollution and noise, will continue to pose health risks. Consequently, the necessity of specific policies and actions aimed at protecting vulnerable groups from environmental health hazards should be explored further.

Currently, inequalities in the exposure to and impacts of environmental health hazards on European society are only somewhat addressed in policy and practice. The international strategies and agreements (e.g. the United Nations' Sustainable Development Goals, the Paris Agreement or the World Health Organization's strategies) tend to recognise the need for policy and action to focus on the protection of the most vulnerable groups against environmental health hazards. Also, key EU environmental policies, such as the Seventh Environment Action Programme, the air quality and noise directives and the EU strategy on adaptation to climate change, highlight the need to protect vulnerable groups from pollution and extreme temperatures. However, EU policies tend not to explicitly include actions targeting vulnerable groups.

This report also presents some examples of practical interventions targeting vulnerable groups. Road traffic management, promoting walking and cycling, nature-based solutions (e.g. tree planting) and good-quality housing are identified as effective responses to the combination of air pollution, noise and extreme temperatures that particularly benefit vulnerable groups. The impacts of extreme temperatures can be reduced by identifying the location of vulnerable individuals and areas, thus enabling a quick and targeted response; including specific groups in heat and cold action plans; and supporting bottom-up initiatives providing help to vulnerable people during extreme weather events. Fewer examples of actions targeting specifically vulnerable communities have been found in relation to air pollution and noise, as mitigating measures usually target entire populations or places exceeding the acceptable concentration values. The difficulties

encountered when identifying examples of actions specifically aimed at vulnerable people emphasise the need for enhanced sharing of effective measures, especially at a local level.

Furthermore, a supportive policy framework is necessary to encourage actions targeting or considering the impacts of environmental health hazards on vulnerable groups. Enhancing coherence between policy areas is one of the ways to ensure more focus on vulnerable groups in the environmental context. In particular, increasing coherence between health, poverty, climate change and air pollution policies could bring measurable benefits to public health. At a local level, a multi-pronged approach in policy areas from welfare to urban design, that addresses locally specific hazards and vulnerabilities, can help to reduce inequalities in the health impacts of air pollution, noise and extreme temperatures.