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London Luton Airport Expansion

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5.02 Appendix 12.2 GHG Methodology and Data

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5.02 ENVIRONMENTAL STATEMENT APPENDIX 12.2 GHG METHODOLOGY AND DATA

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1 INTRODUCTION

1.1.1 This document is an Appendix to the Environmental Statement (ES) submitted as part of the application for development consent for the proposed expansion of London Luton Airport from 18 million passenger per annum (mppa) to 32 mppa (the 'Proposed Development') by Luton Rising (a trading name of London Luton Airport Limited ('the Applicant')).

1.1.2 It provides detailed methodology and technical information used in the assessment of greenhouse gas (GHG) emissions associated with the Proposed Development as reported in **Chapter 12** of the ES **[TR020001/APP/5.01]**.

2 METHODOLOGY AND ASSUMPTIONS

2.1.1 This section outlines the methodology employed for assessing GHG emissions from the construction and operation of the Proposed Development.

2.1 Current Baseline

2.1.1 The Current Baseline provides a snapshot of emissions for the single year of 2019, the last year the airport was operating normally, at near permitted capacity, before the pandemic. This assessment has been heavily influenced by the 2019 Carbon Footprint report developed by London Luton Airport Operations Limited (LLAOL) the current operator of the airport (Ref. 1). In some cases, particularly relating to airport operations, activity data from the Current Baseline assessment inform the later assessments for the Future Baseline and Core Planning Case.

Aviation

2.1.2 The methodology and assumptions for the aviation element of the Current Baseline assessment are set out in **Table 2.1**.

Table 2.1: Aviation – methodology and assumptions for the Current Baseline

Activity	Methodology and Assumptions
Aviation	Emissions calculations for the Current Baseline, Future Baseline and Core Planning Case have been carried out using the same overall methodology. Aircraft movement data is included in the **Need Case [TR020001/APP/7.04]** as follows: a. Annual numbers of flights for different makes and models of aircraft (fleet mix) were provided, broken down by world region split (Central and Eastern Europe; Domestic; Middle East; North America; Turkey, Near East and North Africa; Western Europe) and by aviation type (commercial aircraft, freight aircraft, business and general aircraft). b. For each world region split, an average flight distance was provided in km; this was converted to nautical miles for the purposes of the emissions calculator. The European Monitoring and Evaluation Programme (EMEP)/ European Environment Agency (EEA) Aviation Emissions Calculator (Ref. 2) was

Activity	Methodology and Assumptions
	used to estimate the fuel consumption and carbon dioxide (CO_2) emissions for each model of aircraft and world region distance; this data was broken down between Landing and Take Off cycle (LTO) and Climb-Cruise-Descend (CCD) phases. Emissions were converted from CO_2 to CO_2e using the appropriate uplift factor for aviation fuel taken from the UK Government conversion factors. Based on the 2019 dataset (Ref.3), a factor 1.01 was applied. The Jet Zero Strategy (Ref. 4) published by the UK Government in July 2022 sets out UK policy around the decarbonisation of the aviation sector. Within this strategy, the so-called High Ambition scenario now effectively represents UK aviation policy. It includes assumptions around carbon pricing, the future use of Sustainable Aviation Fuels (SAFs), improvements to fuel efficiency and the future rollout of Zero Emission Aircraft. Of relevance to the 2019 Baseline assessment are assumptions around carbon pricing and fuel efficiency improvements. The aircraft movement data provided assumes carbon pricing from the UK Emissions Trading Scheme (ETS) and Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) as applied to the Jet Zero High Ambition scenario (Ref. 4) (all data in 2020 prices): a. Department for Transport (DfT) Mid ETS price series (£150/t in 2030, £378/t in 2050) b. Mid CORSIA price series (£6/t in 2030, £378/t in 2050) Jet Zero also assumes that fuel efficiency improves at 2% per year from 2017, i.e. emissions in any given year are 98% of those of the previous year.

Airport Operations

2.1.3 The methodology and assumptions for the Airport Operations element of the 2019 Baseline assessment are set out in **Table 2.2**.

Table 2.2: Airport operations – methodology and assumptions for 2019 Baseline

Activity	Methodology and Assumptions
Airport operations	Energy-related activity data (consumption of natural gas and other fuels, consumption of grid electricity, use of airport vehicles) were taken directly from the Energy Statement, provided as **Appendix 4.3** to the ES **[TR020001/APP/5.02]**. Relevant emissions factors for the consumption of energy were taken from the Department for Business, Energy & Industrial Strategy (BEIS) conversion factors for company reporting (Ref.3) Other operational activity data and consequent emissions (fugitive release of refrigerants, fire training, waste management, water supply and treatment, aircraft engine testing and business travel) were taken from the LLAOL 2019 Carbon Footprint (Ref.1)

2.1.4 The 2019 Baseline GHG emissions arising from activities are based on the Greenhouse gas reporting: conversion factors 2019 published by BEIS (Ref.3). These factors allow for the conversion of activity data into emissions of either CO_2 and/or CO_2e. Conversion factors used to develop the 2019 baseline are presented in **Table 2.3.**

Table 2.3: Airport operations – Emissions factors used for 2019 Baseline assessment

Activity/material	Units	Conversion factor (kg CO_2e/unit)
Natural gas	kWh	0.18387
Gas oil	kWh	0.27319
Grid electricity (generation)	kWh	0.2556
Grid electricity (T&D losses)	kWh	0.0217
Water supply	m^3	0.149
Water treatment	m^3	0.272

Surface access

2.1.5 The methodology and assumptions for the surface access element of the 2019 Baseline assessment are set out in **Table 2.4** below.

Table 2.4: Surface Access – methodology and assumptions for 2019 Baseline

Activity	Methodology and Assumptions
Surface Access	Surface access modelling inputs have been developed by the Applicant's transport planners and modellers: a. The passenger and staff catchment distribution (calculated by CBLTM[1] zone) was converted to the CBLTM-LTN zoning system using suitable disaggregation factors (as defined in the **Transport Assessment [TR020001/APP/7.02]**). b. Total annual demand by mode for each CBLTM-LTN zone was calculated using the distribution for 2016, updated for 2019 data and taking account of the change in mode share as reported in Luton London Airport's Annual Monitoring Report (Ref. 5). For car journeys, the vehicle split between petrol, diesel and electric vehicles was taken from the Department for Transport's (DfT) Transport Analysis Guidance (TAG) Databook (Ref. 6) for the baseline year and suitable emissions factors from UK Government data applied. For taxi, bus and rail journeys, suitable emissions factors from UK Government data were applied.

2.1.6 Passenger and staff travel data for 2019 are shown in **Table 2.5** below.

[1] Central Bedfordshire and Luton Strategic Transport Model

Table 2.5: Passenger and staff travel data for 2019 Baseline

Transport mode	Passenger travel (passenger.km)	Staff travel (passenger.km)
Car	618,320,113	85,354,400
Taxi	143,466,975	n/a
Bus	312,275,777	7,329,119
Rail	287,127,400	10,846,606

2.1.7 Light Goods Vehicle (LGV) and Heavy Goods Vehicle (HGV) transport data for 2019 are shown in **Table 2.6** below.

Table 2.6: Freight transport data for 2019 Baseline

Type of vehicle	Freight transport (vehicle.km)
LGV	36,656,000
HGV	8,743,184

2.1.8 The proportions of cars and LGVs using petrol, diesel and electricity (by vehicle kilometres) in the baseline year of 2019 are shown in **Table 2.7** below.

Table 2.7: Proportion of car and LGV use by fuel type in baseline year of 2019

Fuel type	Proportion of car use (vehicle.km)	Proportion of LGV use (vehicle.km)
Petrol	49.4%	n/a
Diesel	49.9%	99.7%
Electric	0.8%	0.3%

2.1.9 Emissions factors used to convert surface access activity data into emissions are shown in **Table 2.8** below.

Table 2.8: Surface access – Emissions factors used for 2019 Baseline assessment

Activity	Units	Conversion factor (kg CO_2e/unit)
Petrol cars	Vehicle.km	0.18084
Diesel cars	Vehicle.km	0.17336
Electric cars	Vehicle.km	0.04720
Taxi travel	Vehicle.km	0.21024

Activity	Units	Conversion factor (kg CO_2e/unit)
Bus travel	Passenger.km	0.12076
Rail travel	Passenger.km	0.04115
LGV freight transport (ICE[2])	Vehicle.km	0.23156
LGV freight transport (EV[3])	Vehicle.km	0.08738
HGV freight transport	Vehicle.km	0.89061

Construction

2.1.10 There are no emissions from construction activity within the 2019 Baseline GHG assessment.

2.2 Future Baseline and Core Planning Case Methodology

2.2.1 The Future Baseline is a scenario within which the Proposed Development is not built, and the airport continues to operate at the current consented capacity of 18 mppa. The Core Planning Case is a scenario within which the Proposed Development is built, and the airport expands in line with projections for aircraft movement and passenger numbers as described in the **Need Case [TR020001/APP/7.04]** submitted as part of the application for development consent.

2.2.2 External factors, such as the emissions reduction measures described within the UK Government's Jet Zero Strategy (Ref.4) and Transport Decarbonisation Plan (Ref. 7), and the ongoing decarbonisation of the UK electricity grid, are taken into account in both the Future Baseline and Core Planning Case.

Aviation

2.2.3 An explanation of the methodology and assumptions for the aviation element of the Future Baseline and Core Planning Case assessments is set out in **Table 2.9** below.

Table 2.9: Aviation – methodology and assumptions for Future Baseline and Core Planning Case

Activity	Methodology
Aviation	Emissions calculations for the Future Baseline and Core Planning Case scenarios have been carried out using the same methodology as for the 2019 Baseline described above, using aircraft movement data provided by aviation planners. The aircraft movement data provided assumes carbon pricing from ETS / CORSIA as follows (all data in 2020 prices):

[2] ICE = Internal Combustion Engine
[3] EV = Electric Vehicle

Activity	Methodology
	a. DfT Mid ETS price series (£150/t in 2030, £378/t in 2050) b. Mid CORSIA price series (£6/t in 2030, £378/t in 2050) Assumptions applied to the Jet Zero High Ambition scenario (Ref. 8) have been incorporated to the GHG assessment for Aviation as follows: a. Fuel efficiency improves at 2% per year from 2017, i.e. emissions in any given year are 98% of those of the previous year; b. Sustainable Aviation Fuels (SAFs) are blended into the fuel supply chain at the following rates: 0% in 2024; 10% in 2030; 22% in 2040 and 50% in 2050 with the rate increasing in a linear fashion between these milestones; c. The use of SAFs reduces emissions by 67% relative to conventional kerosene aviation fuel; d. Zero Emission Aircraft are introduced at the following rate: none in 2030; 5% of aircraft movements in 2040; 27% of aircraft movements by 2050. The Applicant's aviation consultants have provided aircraft movement data for specific Zero Emission Aircraft, including the DHC-8 Q400 from 2037 onwards and the A320neo, A321neo, 737 Max 8, 9 & 10, and E190-E2 from 2040 onwards. These aircraft are assumed to operate on the same routes as conventionally-fuelled aircraft of the same make and model.

Airport operations

2.2.4 An explanation of the methodology and assumptions for the airport operations element of the Future Baseline and Core Planning Case assessments is set out in **Table 2.10**.

Table 2.10: Airport operations – methodology and assumptions for Future Baseline and Core Planning Case

Activity	Methodology
Airport operations	Energy-related operational emissions for the Future Baseline and Core Planning Case are calculated as follows: a. Natural gas: activity data in MWh/yr are taken directly from the Energy Statement (**Appendix 4.3** of the ES **[TR020001/APP/5.02]** ; emission factors are taken from the 2022 BEIS dataset (Ref. 9); these are assumed to remain constant at this rate for the lifetime of the Proposed Development. b. Gas oil (used in generators and for some heating): activity data in MWh/yr are taken directly from the Energy Statement ; emission factors are taken from the 2022

Activity	Methodology
	BEIS dataset; these are assumed to remain constant at this rate for the lifetime of the Proposed Development. c. Fuel consumption in airport and Third Party operational vehicles (ICE): activity data in MWh/yr are taken directly from the Energy Statement. Emission factors are taken from the 2022 BEIS dataset; these are assumed to remain constant at this rate for the lifetime of the Proposed Development. d. Electricity consumption for airport and Third Party operations, including vehicles: activity data in MWh/yr are taken directly from the Energy Statement. Emission factors (generation and transmission & distribution losses) for the relevant year are taken from the annual projections published by BEIS (Ref. 9). Well to tank factors are assumed to add the same percentage to generation and transmission and distribution (T&D) losses as in 2022. Other operational emissions are extrapolated from the 2019 Carbon Footprint report published by LLAOL as follows: a. Release of refrigerants (fugitive emissions) are assumed to be proportionate to passenger numbers. b. Aircraft engine tests activity data are assumed to remain proportionate to aircraft movement numbers, and are multiplied by a factor to take account of future SAF uptake as per the Jet Zero Strategy High Ambition scenario. c. Waste disposal is assumed to remain proportionate to passenger numbers. LLAOL's methodology for estimating emissions from waste disposal changed in 2020; the approach taken for the Future Baseline and Core Planning Case uses 2020 as a baseline and pro-rates emissions using passenger numbers. d. Water supply and disposal activity data are assumed to remain proportionate to passenger numbers, and are multiplied by projections of future grid carbon intensity on the assumption that electricity consumption makes up a large majority of operational water industry emissions. e. Business travel activity data are assumed to remain proportionate to staff numbers, and are multiplied by a factor (see Surface Access below) to reflect the ongoing transition from ICE to EVs and projections of future grid carbon intensity. f. Emissions from the use of deicer on aprons and runways were not included in the 2019 footprint; LLAOL has provided emissions data for 2021, and emissions in later years are pro-rated from this figure on the basis of passenger numbers.

2.2.5 Carbon emissions factors vary over time and are published annually by UK Government (Ref. 9) for use in relation to corporate reporting of that specific year's emissions. Future emissions factors will differ from these, and in many cases will reduce in line with wider national trends towards decarbonisation, and through improved efficiency of vehicles. The expected future effects of grid decarbonisation are covered in **paragraphs 2.2.6** to **2.2.8** and **Table 2.12** below. Emissions factors that are applied over the entire lifespan of the Proposed Development are shown in **Table 2.11** below.

Table 2.11: Future Baseline and Core Planning Case fuel emissions factors for airport operations

Activity/material	Units	Emissions factor (kg CO_2e/unit)
Natural gas	kWh	0.18254
Gas oil	kWh	2.75857

Grid decarbonisation assumptions

2.2.6 The future decarbonisation of the national grid will influence future emissions from the airport. The source of information used for this is the UK Government Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal (Ref. 10) which provides forecasts for the carbon intensity of grid electricity in the future. This was most recently updated in 2021 from which **Table 2.12** provides carbon intensities for grid electricity.

2.2.7 The projected carbon intensity figures published by the UK Government (Ref. 9) aggregate the emissions from generation (Scope 2) and from transmission & distribution (T&D) losses (Scope 3) into a single figure. These have been disaggregated in **Table 2.12** on the assumption that emissions from generation account for 91.5% of the total, with T&D losses making up the remaining 8.5%. This ratio is based on an analysis of historic grid carbon data.

2.2.8 **Table 2.12** shows projected electricity emissions factors per kWh for generation and transmission & distribution losses for each year from 2025 to 2050.

Table 2.12 Projected grid carbon emissions factors

Year	Emissions Factor (kg CO_2e/kWh)	
	Generation	T&D losses
2025	0.12422	0.01154
2026	0.13554	0.01259
2027	0.11464	0.01065
2028	0.08451	0.00785
2029	0.06994	0.00650

Year	Emissions Factor (kg CO_2e/kWh)	
	Generation	T&D losses
2030	0.06467	0.00601
2031	0.06055	0.00562
2032	0.04806	0.00446
2033	0.03806	0.00354
2034	0.03289	0.00306
2035	0.02857	0.00265
2036	0.02593	0.00241
2037	0.02313	0.00215
2038	0.01914	0.00178
2039	0.01702	0.00158
2040	0.01663	0.00154
2041	0.01574	0.00146
2042	0.01427	0.00133
2043	0.01184	0.00110
2044	0.01124	0.00104
2045	0.01101	0.00102
2046	0.01035	0.00096
2047	0.00879	0.00082
2048	0.00798	0.00074
2049	0.00736	0.00068
2050	0.00698	0.00065

Surface access

2.2.9 An explanation of the methodology and assumptions for the surface access element of the Future Baseline and Core Planning Case assessments is set out in **Table 2.13** below.

Table 2.13: Surface Access – methodology and assumptions for Future Baseline and Core Planning Case

Activity	Methodology
Surface access	Surface access modelling inputs are provided in the **Transport Assessment [TR020001/APP/7.02]**: a. Annual passenger.km data was provided for 2027, 2039 and 2043. Passenger.km data provided was constant for

Activity	Methodology
	each year, so these figures were applied to each year from 2023 to 2050. b. Emissions factors for different modes of transport are aligned with the policy measures and target dates contained within the UK Government's Transport Decarbonisation Plan. (Ref. 7). c. For car travel, it is assumed that cars transition from conventional (ICE) to EV in line with DfT TAG Databook projections until 2030, after which the proportion of petrol and diesel cars on the road decline in a linear fashion, to reach 0% by 2050. The proportion of EV cars increases alongside this decline. Emissions from EVs are assumed to be proportionate to future projections of grid carbon intensity. d. For LGVs, it is assumed that the DfT TAG Databook projections apply to 2035, after which petrol and diesel LGV numbers decline to 0% by 2050 with electric LGVs making up the remainder. Emissions from EVs are assumed to be proportionate to future projections of grid carbon intensity. e. For HGVs, it is assumed that the emissions factor in kg CO2e/veh.km remains flat at 2022 levels until 2035, then reduces linearly to zero from 2036 to 2050. f. The emissions factor for rail and bus travel falls linearly from 2024 onwards, reaching zero by 2050. These declines are consistent with the trend in emissions reductions over the period 2016 – 2022 g. Annual electricity consumption for the Luton DART is taken from the Energy Statement provided as **Appendix 4.3** of the ES **[TR020001/APP/5.02].** Future grid carbon intensity figures are taken from UK Government projections (Ref. 10).

2.2.10 Emissions from surface access travel are derived from information provided by the Applicant's transport planners. **Table 2.14** shows annual passenger travel distances by mode.

Table 2.14: Passenger Travel Data (Annual)

Scenario	Car (Pass.km)	Taxi (Pass.km)	Bus (Pass.km)	Rail (Pass.km)
2019 BY	618,320,113	143,466,975	312,275,777	287,127,400
2027 DM 2039 DM	593,598,156	136,257,708	309,801,640	312,649,470

Scenario	Car (Pass.km)	Taxi (Pass.km)	Bus (Pass.km)	Rail (Pass.km)
2043 DM				
2027 DS	709,020,020	162,752,263	370,040,848	373,442,423
2039 DS	811,660,444	184,735,871	491,097,510	544,201,675
2043 DS	961,967,933	218,946,217	582,041,494	644,979,763

2.2.11 **Table 2.15** shows annual staff travel distances by mode.

Table 2.15: Staff Travel Data (Annual)

Scenario	Car (Staff.km)	Taxi (Staff.km)	Bus (Staff.km)	Rail (Staff.km)
2019 BY	85,354,400	77,594,909	7,329,119	10,846,606
2027 DM 2039 DM 2043 DM	85,354,400	77,594,909	7,329,119	10,846,606
2027 DS	91,458,086	83,143,715	9,134,390	12,693,549
2039 DS	104,468,492	94,971,357	13,289,050	16,184,197
2043 DS	112,222,319	102,020,290	18,719,569	20,036,063

Future vehicle fleet - Cars

2.2.12 Until 2030, the future make-up of the UK car fleet has been taken from the UK Government TAG data book Table A 1.3.9 (Ref. 6) which provides proportions of vehicle kilometres by fuel type for the period to 2050. From 2031 to 2050, the proportion of petrol and diesel cars on the road falls in a linear fashion to reach 0% by 2050. The proportion of electric cars increases over the same period to reach 100% in 2050. The data are represented in **Table 2.16.**

Table 2.16: Proportion of petrol, diesel and electric cars on the road

Year	Proportion of cars using petrol, diesel or electricity		
	Petrol	Diesel	Electric
2025	53.2%	41.4%	5.4%
2026	53.2%	39.4%	7.3%
2027	53.1%	37.5%	9.4%
2028	52.9%	35.7%	11.4%
2029	52.6%	33.9%	13.5%
2030	52.1%	32.3%	15.6%
2031	49.5%	30.7%	17.7%

Year	Proportion of cars using petrol, diesel or electricity		
	Petrol	Diesel	Electric
2032	46.9%	29.1%	24.1%
2033	44.3%	27.4%	28.3%
2034	41.7%	25.8%	32.5%
2035	39.1%	24.2%	36.7%
2036	36.5%	22.6%	40.9%
2037	33.9%	21.0%	45.2%
2038	31.3%	19.4%	49.4%
2039	28.6%	17.8%	53.6%
2040	26.0%	16.1%	57.8%
2041	23.4%	14.5%	62.0%
2042	20.8%	12.9%	66.3%
2043	18.2%	11.3%	70.5%
2044	15.6%	9.7%	74.7%
2045	13.0%	8.1%	78.9%
2046	10.4%	6.5%	83.1%
2047	7.8%	4.8%	87.3%
2048	5.2%	3.2%	91.6%
2049	2.6%	1.6%	95.8%
2050	0.0%	0.0%	100.0%

Emissions factors for passenger vehicles

2.2.13 Petrol and diesel cars on the road in future years are assumed to have the same emissions per km as in 2022. Electric cars are assumed to have the same emissions as in 2022, corrected to take account of grid decarbonisation as per UK Government projections (Ref. 10).

2.2.14 Emissions per vehicle.km for taxis are assumed to reduce at the same rate as for cars as a whole, to reflect the transition from petrol and diesel cars to EVs and the ongoing decarbonisation of the UK electricity grid.

2.2.15 Emissions per passenger.km for buses and trains are assumed to fall in a linear fashion from 2023 onwards, reaching zero emissions by 2050.

2.2.16 Emissions factors in kg CO_2e per vehicle.km for all types of cars and for taxis, and in kgCO2e per passenger.km for buses and trains, are shown in **Table 2.17** below.

Table 2.17: Emissions factors for travel by car, taxi, bus and train

Year	kgCO_2e/vehicle.km				kg CO_2e/pass.km	
	Car (petrol)	Car (diesel)	Car (electric)	Taxi	Bus	Rail
2025	0.174	0.168	0.027	0.203	0.109	0.033
2026	0.174	0.168	0.020	0.199	0.105	0.032
2027	0.174	0.168	0.017	0.195	0.100	0.030
2028	0.174	0.168	0.015	0.191	0.096	0.029
2029	0.174	0.168	0.014	0.187	0.092	0.028
2030	0.174	0.168	0.011	0.182	0.087	0.026
2031	0.174	0.168	0.009	0.177	0.083	0.025
2032	0.174	0.168	0.008	0.164	0.079	0.024
2033	0.174	0.168	0.007	0.155	0.074	0.023
2034	0.174	0.168	0.006	0.147	0.070	0.021
2035	0.174	0.168	0.006	0.138	0.065	0.020
2036	0.174	0.168	0.005	0.128	0.061	0.019
2037	0.174	0.168	0.004	0.119	0.057	0.017
2038	0.174	0.168	0.004	0.110	0.052	0.016
2039	0.174	0.168	0.004	0.102	0.048	0.015
2040	0.174	0.168	0.003	0.092	0.044	0.014
2041	0.174	0.168	0.003	0.083	0.039	0.012
2042	0.174	0.168	0.003	0.074	0.035	0.011
2043	0.174	0.168	0.003	0.065	0.031	0.010
2044	0.174	0.168	0.002	0.056	0.026	0.008
2045	0.174	0.168	0.002	0.047	0.022	0.007
2046	0.174	0.168	0.002	0.038	0.017	0.006
2047	0.174	0.168	0.002	0.029	0.013	0.005
2048	0.174	0.168	0.002	0.020	0.009	0.003
2049	0.174	0.168	0.002	0.011	0.004	0.002
2050	0.174	0.168	0.002	0.002	0.000	0.001

Future vehicle fleet – LGVs

2.2.17 Until 2035, the future make-up of the UK LGV fleet has been taken from the UK Government TAG data book Table A 1.3.9 (Ref. 6) which provides proportions of vehicle kilometres by fuel type (ICE or electric) for the period to 2050. From 2036 to 2050, the proportion of ICE LGVs on the road falls in a linear fashion to reach 0% by 2050. The proportion of electric LGVs increases over the same period to reach 100% in 2050. The data are represented in **Table 2.18.**

Table 2.18: Proportion of diesel and electric LGVs on the road

Year	Proportion of LGVs using diesel or electricity	
	ICE (Diesel)	Electric
2025	99.0%	1.0%
2026	98.6%	1.4%
2027	98.2%	1.8%
2028	97.7%	2.3%
2029	97.0%	3.0%
2030	96.3%	3.7%
2031	95.5%	4.5%
2032	94.7%	5.3%
2033	93.9%	6.1%
2034	93.0%	7.0%
2035	92.2%	7.8%
2036	86.0%	14.0%
2037	79.9%	20.1%
2038	73.7%	26.3%
2039	67.6%	32.4%
2040	61.4%	38.6%
2041	55.3%	44.7%
2042	49.1%	50.9%
2043	43.0%	57.0%
2044	36.9%	63.1%
2045	30.7%	69.3%
2046	24.6%	75.4%
2047	18.4%	81.6%
2048	12.3%	87.7%
2049	6.1%	93.9%
2050	0.0%	100.0%

Emissions factors for freight transport

2.2.18 Diesel LGVs on the road in future years are assumed to have the same emissions per km as in 2022. Electric LGVs are assumed to have the same emissions as in 2022, corrected to take account of grid decarbonisation as per UK Government projections.

2.2.19 The emissions factor for HGVs is assumed to fall in a linear fashion from 2036 onwards, reaching zero in 2050.

2.2.20 Emissions factors for LGVs (diesel and electric) and HGVs are shown in **Table 2.19** below.

Table 2.19: Emissions factors for LGVs and HGVs

Year	kg CO_2e/vehicle.km		
	LGV (diesel)	LGV (electric)	HGV
2025	0.232	0.050	0.891
2026	0.232	0.037	0.891
2027	0.232	0.031	0.891
2028	0.232	0.028	0.891
2029	0.232	0.027	0.891
2030	0.232	0.021	0.891
2031	0.232	0.017	0.891
2032	0.232	0.014	0.891
2033	0.232	0.013	0.891
2034	0.232	0.011	0.891
2035	0.232	0.010	0.891
2036	0.232	0.008	0.831
2037	0.232	0.007	0.772
2038	0.232	0.007	0.713
2039	0.232	0.007	0.653
2040	0.232	0.006	0.594
2041	0.232	0.005	0.535
2042	0.232	0.005	0.476
2043	0.232	0.005	0.416
2044	0.232	0.005	0.357
2045	0.232	0.004	0.298
2046	0.232	0.004	0.238
2047	0.232	0.003	0.179
2048	0.232	0.003	0.120
2049	0.232	0.003	0.060
2050	0.232	0.003	0.001

Construction

2.2.21 An explanation of the methodology and assumptions for construction of the Proposed Development is set out in **Table 2.20**. There is no construction in the Future Baseline scenario.

Table 2.20: Construction – methodology and assumptions for Core Planning Case

Activity	Methodology
Construction materials	Emissions for construction materials were calculated off a dataset of construction materials quantities from Applicants design engineers. This dataset contains the total values for the following materials; concrete, asphalt, steel including both structural and rebar, aggregates and earthworks. The quantities were multiplied by the emissions factors (see **Table** 2.21) that were sourced from the Inventory of Carbon and Energy (ICE) database (Ref. 11). For earthworks the emission factor was assumed to be the same for aggregate. The density for concrete was assumed to be 2.4 tonnes per m^3.
Construction plant use estimates	Non-Road Mobile Machinery (NRMM) includes access platforms, dumpers, excavators, bulldozers, forklift, compressors, generators, mobile cranes, telehandlers and rollers. Total power required for each year was calculated based on the following information provided for each NRMM: a. assigned total number of machine days on site per each stage; b. number of hours of operation per day; c. type of fuel; and d. power output. Based on the power output per stage provided and number of working days, average annual power was calculated for each NRMM. This was then multiplied by BEIS conversion factors (see **Table 2.21**) to develop an estimate of CO_2e emissions. A representative engine efficiency of 40% was applied, requiring output energy to be multiplied by a factor of 2.5 to estimate fuel input energy.
Energy demand	Energy demand was estimated for equipment and facilities used during the construction based on the following information: a. energy usage for each equipment; and

Activity	Methodology
	b. ten working hours per day and 5.5 working days per week were assumed for all equipment. Estimated energy for each piece of equipment was calculated for each year which was then multiplied by BEIS conversion factors (Ref. 3) to develop an estimate of CO_2e emissions.
Waste estimates	The GHG calculations for waste disposal was sourced from the BEIS conversion factors for the year 2022 (see **Table 2.23**). The following scenarios were used: construction waste - a scenario of closed loop waste disposal; demolition waste - a scenario of sending all material to landfill; hazardous waste - a scenario of sending all material to landfill. Transportation of waste from site to disposal was assumed to be 50 km and the transport Emission Factor of 0.12158 (kg CO_2e/tonne.km) was used to account for the vehicles used.
Land use change data	The GHG emissions impact from land use change were estimated using data taken from the Biodiversity Net Gain Report, **Appendix 8.5** of the ES **[TR020001/APP/5.02]**. For each assumed assessment phase of construction, areas of different land cover lost and created were provided. For the purposes of the GHG assessment, each area was categorised as either arable, grassland, scrubland, cleared or forest. Factors for soil and vegetation carbon per hectare for each category were taken from European Commission guidelines for the calculation of land carbon stocks (Ref. 12). Soil and vegetation carbon was converted to carbon dioxide by multiplying by 44/12, the ratio of the mass of CO_2:C.
Water consumption and waste	Estimated water demand data was provided for following locations and operations: a. offices and compounds; b. concrete batching; c. bulk earthworks; and d. internal roads and landscaping mitigation. Annual water usage was estimated based on the quantity of water used per day and number of working days per month. Then % of water discharged was assigned to calculate the amount of water discharged.

Activity	Methodology
	Annual water consumed and discharged were then multiplied by the relevant conversion factors from the 2019 BEIS dataset (Ref. 3) combined with projected grid carbon intensities (see **Table 2.24**) on the assumption that operational water industry emissions are dominated by the consumption of grid electricity.
Construction worker transport	GHG emissions from construction worker transport were calculated using total amount of kilometres travelled per day in each year multiplied by the emissions factor for different type of vehicles (see **Table 2.25**). Following assumptions were used: a. 65 working days per quarter, with peak number of workers on site in each year of the construction; b. 60% of journeys to the site are made by car of which: 80% <40 miles; 15% between 40-80miles; and 5% 80-100 miles; c. 40% of journeys to the site are made by public transport, all assumed to be below 40miles (as above conservative scenario used with max value and return journey); d. a conservative approach has been taken assuming the maximum value for each type of mode and distance is a return journey; and e. for car journeys the vehicle type share data was used from TAG data book to account for changes in the road vehicle fleet.

Construction emissions factors

2.2.22 GHG emissions from construction have been calculated by applying GHG emissions conversion factors for 2022 published by BEIS (Ref. 9) to the estimated quantities of energy, water used, and waste generated during construction.

2.2.23 Embodied carbon in construction materials has been calculated by applying embodied carbon conversion factors from ICE database (Ref. 11)

2.2.24 The emissions factors used for the GHG emissions arising from construction activities are presented in **Table 2.21** to **Table 2.25** below**.**

Table 2.21 Emissions factors for construction materials

Material	Units of activity data	Emission factor kg CO_2e/unit
Concrete	Cubic metres	249.6
Asphalt	Cubic metres	142

Material	Units of activity data	Emission factor kg CO_2e/unit
Steel – Structural	Tonnes	1,550
Steel – Rebar	Tonnes	1,990
Aggregate	Cubic metres	17.928
Earthworks materials – site won	Cubic metres	0
Earthwork material – imported	Cubic metres	17.928

Table 2.22: Emissions factors for plant usage

Assessment Phase	Year	Emission factor by type of fuel kg CO_2e/unit		
		Petrol (average biofuel blend) kWh (Net Calorific Value (CV))	Gas oil kWh (Net CV)	Electricity (kWh)
Assessment Phase 1	2025	0.24227	0.27318	0.125
	2026	0.24227	0.27318	0.092
	2027	0.24227	0.27318	0.076
Assessment Phase 2a	2033	0.24227	0.27318	0.031
	2034	0.24227	0.27318	0.028
	2035	0.24227	0.27318	0.025
	2036	0.24227	0.27318	0.021
Assessment Phase 2b	2037	0.24227	0.27318	0.019
	2038	0.24227	0.27318	0.018
	2039	0.24227	0.27318	0.017
	2040	0.24227	0.27318	0.016

Table 2.23: Emissions factor for waste during construction

Waste type	Emission factor (kg CO_2e/tonne)
Construction waste	0.989
Demolition waste	21.294

Hazardous waste	467.046

Table 2.24: Emissions factors for water supply and treatment (kg CO_2e/m^3)

Assessment Phase	Year	Water supply	Water treatment
Assessment Phase 1	2025	0.077	0.141
	2026	0.084	0.154
	2027	0.071	0.130
Assessment Phase 2a	2033	0.024	0.043
	2034	0.020	0.037
	2035	0.018	0.032
	2036	0.016	0.029
Assessment Phase 2b	2037	0.014	0.026
	2038	0.012	0.022
	2039	0.011	0.019
	2040	0.010	0.019

Table 2.25: Emissions factors for worker transport during construction

Assessment Phase	Year	Emission Factor by type (kg CO_2e/veh.km)		
		Petrol	Diesel	Electric
Assessment Phase 1	2025	0.17431	0.16843	0.027272
	2026	0.17431	0.16843	0.020104
	2027	0.17431	0.16843	0.016638
Assessment Phase 2a	2033	0.17431	0.16843	0.006796
	2034	0.17431	0.16843	0.006169
	2035	0.17431	0.16843	0.005504
	2036	0.17431	0.16843	0.004553
Assessment Phase 2b	2037	0.17431	0.16843	0.00405
	2038	0.17431	0.16843	0.003956
	2039	0.17431	0.16843	0.003745
	2040	0.17431	0.16843	0.003394

3 EMISSIONS SUMMARY

3.1.1 This section provides a breakdown of emissions for each emissions source (aviation, airport Operations, surface access, and construction) for the 2019 Baseline and for the Future Baseline and the Core Planning Case for each year from 2025 to 2050.

2019 Baseline

3.1.2 GHG emissions from the Proposed Development during the 2019 Baseline year are shown in **Table 3.1**.

Table 3.1: GHG emissions in the 2019 Baseline year (tCO_2e)

	Reporting category		
Year	**Aviation**	**Airport Operations**	**Surface Access**
2019	1,123,074	17,149	201,012

Future Baseline

3.1.3 GHG emissions arising estimated for the Future Baseline scenario are presented in **Table 3.2** below**.** This scenario does not contain any construction activity or emissions.

Table 3.2: GHG emissions in the Future Baseline scenario (tCO_2e)

	Reporting category		
Year	**Aviation**	**Airport Operations**	**Surface Access**
2025	956,738	12,669	183,145
2026	920,714	12,741	178,657
2027	885,838	11,560	174,264
2028	856,821	10,031	169,967
2029	829,311	9,111	165,619
2030	802,782	8,551	160,872
2031	777,680	8,039	153,857
2032	755,490	7,213	146,393
2033	733,860	6,485	139,169
2034	712,811	5,500	131,990
2035	692,316	4,548	124,756
2036	672,227	3,775	116,435
2037	650,870	2,996	108,217
2038	630,159	2,776	100,134
2039	610,027	2,689	91,992
2040	588,961	2,710	83,766
2041	542,723	2,659	75,398
2042	500,775	2,585	67,231
2043	460,150	2,478	59,106

	Reporting category		
Year	Aviation	Airport Operations	Surface Access
2044	421,590	2,440	50,912
2045	384,020	2,417	42,566
2046	363,655	2,378	34,319
2047	345,250	2,305	26,091
2048	326,128	2,261	17,897
2049	309,763	2,224	9,676
2050	293,989	2,197	1,522

Core Planning Case

3.1.4 GHG emissions arising from the Proposed Development in the Core Planning Case are presented in **Table 3.3** for each year.

Table 3.3: GHG emissions in the Core Planning Case scenario (tCO_2e)

	Reporting category			
Year	Aviation	Airport Operations	Surface Access	Construction
2025	1,014,704	12,982	201,870	49,270
2026	1,007,461	12,862	204,036	44,867
2027	1,010,984	12,169	206,787	32,776
2028	983,837	10,467	200,983	
2029	951,095	9,509	195,132	
2030	918,708	8,981	188,832	
2031	887,964	8,522	179,958	
2032	859,714	7,632	170,627	
2033	832,059	6,832	161,640	113,531
2034	804,982	5,843	152,770	129,853
2035	778,851	4,890	143,903	124,213
2036	753,309	3,961	133,819	111,187
2037	831,059	3,436	137,177	58,915
2038	874,338	3,175	133,367	71,149
2039	930,022	3,119	131,330	72,732
2040	942,832	3,108	123,772	74,147
2041	925,986	3,127	116,764	
2042	912,665	3,102	109,627	

	Reporting category			
Year	**Aviation**	**Airport Operations**	**Surface Access**	**Construction**
2043	881,398	2,978	99,514	
2044	813,121	2,878	85,720	
2045	746,626	2,836	71,676	
2046	708,135	2,764	57,795	
2047	672,988	2,631	43,945	
2048	636,848	2,552	30,153	
2049	605,329	2,486	16,316	
2050	574,926	2,438	2,588	

Additional data tables required by ANPS

3.1.5 The Airports National Policy Statement (ANPS) (Ref. 13) includes certain additional data reporting requirements. **Table 3.4** to **Table 3.6** below show emissions broken down between traded and non-traded, including and excluding international air transport, and by GHG reporting scope.

3.1.6 Aviation emissions from domestic flights, flights departing between the UK and Gibraltar, and flights from the UK to EEA destinations are covered by the UK ETS. Emissions from flights to other destinations are classed as non-traded. **Table 3.4** below shows traded and non-traded aviation emissions for the Future Baseline and Core planning Case for each year between 2025 and 2050. Values for these emissions are in tonnes of CO_2.

Table 3.4: Future Baseline and Core Planning Case – Aviation emissions split between Traded and Non-Traded (tonnes CO_2)

	Future Baseline		Core Planning Case	
Year	**Traded emissions**	**Non-traded emissions**	**Traded emissions**	**Non-traded emissions**
2025	800,806	146,380	864,483	140,091
2026	769,148	142,375	862,193	135,210
2027	738,412	138,582	852,534	148,357
2028	713,474	134,793	820,827	153,188
2029	690,431	130,601	792,617	148,983
2030	668,225	126,543	765,617	143,920
2031	646,809	123,108	739,912	139,187
2032	628,354	119,594	717,263	133,869

	Future Baseline		Core Planning Case	
Year	Traded emissions	Non-traded emissions	Traded emissions	Non-traded emissions
2033	610,363	116,171	695,275	128,478
2034	592,854	112,841	673,936	123,010
2035	575,807	109,597	653,359	117,717
2036	559,279	106,237	633,341	112,447
2037	543,096	101,276	660,445	162,317
2038	527,268	96,600	659,669	205,940
2039	511,929	92,008	671,658	249,079
2040	493,880	89,202	661,866	271,554
2041	452,696	84,609	625,941	290,801
2042	415,512	80,264	594,616	308,938
2043	379,494	76,062	551,904	320,694
2044	345,371	72,010	500,918	304,085
2045	312,111	68,075	451,215	287,957
2046	295,100	64,924	426,348	274,718
2047	279,877	61,926	404,184	262,086
2048	263,905	58,968	380,836	249,655
2049	250,479	56,191	361,353	237,933
2050	237,549	53,505	342,595	226,591

3.1.7 Total emissions for the Future Baseline and Core Planning Case are presented both including and excluding international air transport. These data are shown in **Table 3.5** below.

Table 3.5: Future Baseline and Core Planning case emissions, including and excluding international air transport (tonnes CO_2e)

	Future Baseline		Core Planning Case	
Year	Including international air transport	Excluding international air transport	Including international air transport	Excluding international air transport
2025	1,152,552	232,164	1,278,825	303,819
2026	1,112,112	224,740	1,269,226	298,184
2027	1,071,661	216,292	1,262,716	283,419
2028	1,036,818	209,285	1,195,287	238,953

	Future Baseline		Core Planning Case	
Year	Including international air transport	Excluding international air transport	Including international air transport	Excluding international air transport
2029	1,004,041	203,045	1,155,736	231,153
2030	972,206	196,809	1,116,521	223,663
2031	939,577	188,460	1,076,444	213,749
2032	909,096	179,407	1,037,973	203,246
2033	879,514	170,717	1,114,061	306,768
2034	850,300	161,835	1,093,447	313,063
2035	821,620	152,946	1,051,858	297,471
2036	792,437	143,177	1,002,276	273,303
2037	762,084	133,513	1,030,587	225,019
2038	733,069	124,560	1,082,029	233,353
2039	704,708	115,698	1,137,202	233,700
2040	675,437	106,748	1,143,859	227,341
2041	620,780	96,543	1,045,876	144,771
2042	570,591	86,687	1,025,394	136,303
2043	521,733	76,923	983,890	124,220
2044	474,943	67,214	901,720	108,055
2045	429,004	57,404	821,138	91,754
2046	400,352	48,421	768,695	76,797
2047	373,646	39,502	719,565	61,936
2048	346,286	30,610	669,553	47,122
2049	321,663	21,813	624,131	32,461
2050	297,708	13,112	579,952	17,955

3.1.8 Overall emissions for the Future Baseline and Core Planning Case are broken down between Scopes 1, 2 and 3, as defined by the GHG Protocol (Ref. 14). These are shown in **Table 3.6** below.

Table 3.6: Future Baseline and Core Planning case emissions by scope (tonnes CO_2e)

	Future Baseline			Core Planning Case		
Year	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3
2025	2,990	2,349	1,147,212	3,828	2,595	1,272,402
2026	2,877	2,550	1,106,685	3,718	2,446	1,263,062
2027	2,763	2,146	1,066,752	3,609	2,191	1,256,917
2028	2,649	1,574	1,032,595	2,665	1,599	1,191,023
2029	2,536	1,296	1,000,209	2,551	1,310	1,151,875
2030	2,422	1,193	968,591	2,437	1,199	1,112,885
2031	2,308	1,111	936,158	2,324	1,112	1,073,009
2032	2,195	877	906,024	2,210	873	1,034,889
2033	2,081	691	876,742	3,997	685	1,109,380
2034	1,526	595	848,180	3,441	609	1,089,397
2035	971	514	820,136	2,886	544	1,048,427
2036	529	464	791,443	2,445	345	999,486
2037	88	412	761,584	2,014	374	1,028,199
2038	88	339	732,642	2,019	331	1,079,679
2039	88	300	704,320	2,028	108	1,135,066
2040	88	334	675,015	2,032	120	1,141,706
2041	88	315	620,377	138	133	1,045,605
2042	88	284	570,219	145	141	1,025,108
2043	88	235	521,411	150	130	983,610
2044	88	222	474,633	150	122	901,448
2045	88	216	428,700	150	118	820,870
2046	88	203	400,062	150	110	768,435
2047	88	171	373,387	150	92	719,323
2048	88	155	346,044	150	83	669,320
2049	88	142	321,433	150	76	623,906
2050	88	134	297,486	150	71	579,731

GLOSSARY AND ABBREVIATIONS

Term	Definition
ANPS	Airport National Policy Statement
BEIS	Department for Business, Energy & Industrial Strategy
CCD	Climb-Cruise-Descend
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DCO	Development Consent Order
DM	Do-Minimum Scenario
DfT	Department for Transport
EEA	European Environment Agency
EMEP	European Monitoring and Evaluation Programme
ETS	Emissions Trading Scheme
GHG	Greenhouse Gas
LLAOL	London Luton Airport Operations Limited (the current operator of the airport)
LTO	Landing Take-off cycle
MPPA	Million Passengers Per Annum
NRMM	Non-Road Mobile Machinery
TAG	Transport Analysis Guidance
T&D	Transmission and Distribution

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