FIVE ESTUARIES OFFSHORE WIND FARM

ENVIRONMENTAL STATEMENT

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DEFINITION OF ACRONYMS

Term	Definition
AR6	Sixth Assessment Report by the Intergovernmental Panel on Climate Change
AR5	Fifth Assessment Report by the Intergovernmental Panel on Climate Change
BNG	Biodiversity Net Gain
CCGT	Combined Cycle Gas Turbine
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DUKES	Digest of United Kingdom Energy Statistics
EIA	Environmental Impact Assessment
g CO_2e/kWh	Grams of Carbon Dioxide Equivalent per Kilowatt-hour of electricity generated
GHG	Greenhouse gas
GJ	Gigajoule
GWP	Global warming potential
GWP100	Global warming potential impact over a 100-year period
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
LCA	Life Cycle Assessment
Mt	Million tonnes
MWh	Megawatt hour
NCV	Net Calorific Value
OP	Onshore platform
ORCP	Offshore reactive compensation platform
OSP	Offshore substation platforms
SF6	Sulphur hexafluoride
TJ	Terajoule
VE	Five Estuaries Offshore Windfarm
WTG	Wind turbine generator

1 GREENHOUSE GAS IMPACT ASSESSMENT

1.1 INTRODUCTION

1.1.1 Since the industrial revolution, humans have accelerated the release of previously stored carbon (in the form of carbon dioxide) and other gases into the atmosphere, where they act to trap heat and cause global warming. Climate change is the term for this long-term rise in average temperatures, which is also associated with changes to global weather patterns.

1.1.2 The climate change impacts of a product, process, service or installation can be determined using a technique known as Life Cycle Assessment (LCA). The International Standards Organisation (ISO), in its series ISO 14040-44, defines LCA to be the "compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle", and outlines the four-step method adopted for this analysis. The sections that follow cover each of these steps in turn, explaining:

- Setting the system boundary to define the scope of work;
- Collecting the necessary data for the modelling;
- Bringing together the flow data and characterisation factors; and
- Interpreting and reporting the results.

1.1.3 The relative contributions that different so-called greenhouse gases (GHGs) make towards climate change are denoted by the global warming potential (GWP) of each gas, relative to the chosen reference gas, carbon dioxide. Because the gases dissipate at different rates in the atmosphere, the GWP of gases varies according to the timeframe of the analysis. Whilst datasets exist for GWP over 20-year and 500-year timeframes, the usual basis for international analysis and reporting is 100-years (GWP100).

1.1.4 Within this timeframe, the United Nations Intergovernmental Panel on Climate Change (IPCC) has published a series of Assessment Reports to provide the latest scientific opinion on the GWP factors that should be used. The most recently issued preliminary GWP results are from the sixth edition report (AR6), however, the latest UK government carbon reporting factors for 2023 are currently based on AR5 (UN IPCC, 2013), and so the GWP factors used in this report are based on that report and are presented below. The table lists all of the gases that make a contribution to the total reported, and no significant emissions are thought to be excluded from the calculations.

Table 1.1: GWP100 factors (from AR5) used in this analysis

Greenhouse gas	GWP100 factor (in kg CO_2e per kg)
Carbon dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous Oxide (N_2O)	265
Sulphur Hexafluoride (SF_6)	23,500

1.2 SETTING THE GOAL AND SCOPE FOR ANALYSIS

1.2.1 The first step was to agree the goal and scope for the analysis, defining what would be within the scope of study and what would not. The topics and the decisions agreed are summarised in Table 1.2.

Table 1.2: Scope of Analysis

Topic	Decision
Study goal:	To identify the life cycle climate change impacts of the proposed Five Estuaries Offshore Windfarm (VE), in comparison with how its electricity might otherwise be generated.
Scenarios:	Two scenarios are presented for VE as there are alternatives for the choice of foundations and the number of wind turbine generators (as well as the VE lifetime). The two scenarios represent the best and worst scenarios of the total life cycle impacts of the VE. The configuration of these two scenarios is explained in more detail in the relevant sections below. The modelling considered the construction, operation and decommissioning of the VE. A Load Factor of 49% has been assumed for both scenarios, sensitivities are carried out in this chapter to assess potential impacts should this be lower or higher.
Time:	The VE is expected to operate for between 24 and 40 years. This means that impacts arising from its decommissioning, as well as those from the later years of its operation, are subject to some level of uncertainty. The approach taken to deal with this uncertainty has generally been to assume the worst case. This is explained in more detail in the relevant sections below.
Geography:	The VE will be located off the coast of Suffolk, England. Accordingly, the study was founded on operations in the UK, and included freight impacts to get materials and components to that region from their points of origin, around the globe. As The VE has not concluded any procurement of major components, it is unable to confirm origins of main suppliers at this stage, indicative source locations for components and materials have been assumed based on similar UK offshore wind farm projects and initial engagement with potential suppliers.
Functional unit:	This is the basis for the reporting of the results. Initial calculations sought to estimate the lifetime impacts of the VE. For the purposes of comparing these to the alternative means of electricity generation, impacts are reduced to an average carbon intensity of generation, in grams of Carbon Dioxide equivalent per kWh of electricity generated (g CO_2e/kWh).
Impact criteria:	A full LCA would examine a wide range of environmental impacts. However, for this GHG impact assessment, it is sufficient to focus solely on global warming potential impacts, over a 100-year period (GWP100).
Data sources:	The data sources used in this study are discussed in the next section.
Life-cycle stages:	An **attributional approach** was deemed appropriate for this study, looking at the VE's complete impacts across its lifetime.

Topic	Decision
	A **systems expansion** approach was adopted to account for the benefits of the electricity generated over its lifetime. This was expected to displace UK marginal electricity, expected to continue to be generated by Gas for years to come. A sensitivity was also performed against the Government's "all non-renewables" technology mix. The **"cut-off" approach** was adopted to account for the benefits of recycled content and recyclability at the end of life. Simply put, this means that the VE could be credited with the benefits of using secondary rather than virgin raw materials in its inputs but could not take credit for sending materials to be recycled at end of life (to avoid double-counting).
Platform:	Calculations were performed in a project specific model developed in MS Excel®.

1.3 DATA COLLECTION

1.3.1 Data collection is the most challenging aspect of an LCA study. Looking to model the entire burdens of an offshore windfarm before, during and after an assumed 24 to 40 years of operation is a challenge, and involves collecting data from the across six key stages of the life cycle:

- Raw Materials;
- Manufacturing;
- Installation;
- Operation;
- Freight; and
- End of Life.

1.3.2 The rest of this section provides more detail on the data collected for each of the six stages. The primary source of data for the VE was information regarding the planning design and construction of the windfarm that has also been used to inform the EIA process to date for the VE.

RAW MATERIALS

1.3.3 'Raw Materials' refers to the environmental impacts embedded in the materials of construction of the windfarm (but not their fabrication or installation, which are covered in later stages). The VE provided details of the materials that are expected to be needed for, for example, the wind turbine generators (WTGs). Details of the materials involved in the construction of the windfarm can be found in Volume 6, Part 2, Chapter 1: Offshore Project Description and Volume 6, Part 3, Chapter 1: Onshore Project Description. This information was supported with data provided in a bespoke template, on the amounts of materials expected to be used in the construction. The main components and weights are listed in Table 1.3. For the purposes of undertaking a robust, conservative analysis, it was assumed that none of these materials would contain recycled content, instead being from newly extracted materials.

1.3.4 Two potential scenarios are presented for the VE, both in terms of the wind turbine generation (WTG) count and the foundation construction, representing the range of potential life cycle impacts. The 'Best Case' scenario consists of 79 smaller WTGs and a gravity based foundation system, operating for 40 years. The 'Worst Case' scenario consists of 41 larger WTGs , monopile foundations and a 24-year lifespan.

Table 1.3 Main materials in the VE components, and their amounts (indicative values)

Description	Detail	Best Case	Worst Case	Units
WTG Foundations	Concrete	355,500	n/a	m3
	Steel	79,000	143,500	t
	Rock Armour	5,622,809	1,056,510	t
Array Cable	Aluminium	1,641		t
	Copper	285		t
	Steel	3,695		t
	Plastic	2,446		t
Export Cable	Copper	10,874		t
	Steel	5,794		t
	Plastic	6,166		t
Offshore Platform	Transformer	923		t
	Shunt Reactor	600		t
	Steel	5,917		t
	Insulation	35		t
	Cables	110		t
	Oil	327		t
	Diesel	100		t
	SF6	10		t
	Coolant	99		t
	Battery	350		t
	Water	8		t
Onshore Substation	Concrete	7,958		m3
	Engineered Fill	220,306		t
	Steel	1,239		t
	Aggregate	14,321		t
	Plastic Pipe	1		t
	Wood	5,700		m^2
	Bitumen	7,187		m^3

Description	Detail	Best Case	Worst Case	Units
	Transformer	500		t
Wind Turbine Generators	Fibreglass	13,983	16,851	t
	Carbon Fibre	1,343	1,681	t
	Cast Iron	11,771	19,311	t
	Steel	92,825	121,032	t
	Copper	8,532	10,988	t
	Polymer	395	410	t
	Neodymium	395	820	t
	Oil	2,273	1,526	t
	Grease	67	68	t
	Nitrogen	6,940	6,964	t
	Diesel	66	39	t
	SF6	14	7	t
	Coolant	2,040	2,047	t
	Battery	213	168	t
Onshore Cable	Aggregate	387,789		t
	Asphalt	12,861		t
	Fencing	170		t
	Concrete	1,979		m^3
	Drainage Stone	33,538		t
	Pipe	39		t
	Geogrid	3,768		t
	Geotextiles	698		t
	Plastic	7,292		t
	Sand	66,406		t
	Steel	248		t
	Aluminium	1,287		t
Road Works	Asphalt	1,058		t
	Aggregate	3,360		t
	Granular Fill	7,676		t

MANUFACTURING

1.3.5 Some of the values in the above section simply cover the production of, for example, a tonne of steel. Further emissions are embedded during the manufacturing of the windfarm components from those materials. From SLR's experience, it is not practical to gather actual manufacturing data for all components, and many would make a negligible contribution to the final impacts, but it was deemed appropriate to estimate the manufacturing burdens for some of the materials, as detailed in Table 1.4. The quoted weights were deduced from all of the data described above and are presented for the two scenarios described in the Raw Materials section.

Table 1.4: Materials weights separately assigned manufacturing burdens

Description	Detail	Best Case	Worst Case	Units
Metal working	Aluminium	2,928		t
	Copper	19,691	22,147	t
	Steel	188,887	281,594	t
	Mischmetal	395	820	t
Geogrid, Drainage & Cable Protection production	Plastic	10,692		t
Geotextile production	Nylon	698		t

INSTALLATION

1.3.6 Installation covers the extensive effort associated with constructing the VE. For the different aspects of the installation, the typical expected consumption and use figures are presented in Table 1.5 below.

Table 1.5: Installation stages separately assigned burdens

Description	Detail	Best Case	Worst Case	Units
Vessel Movements	Gas Oil	93,535		m^3
Construction Crew Transfer Vessels	Diesel	2,423		t
Helicopter access to site	Aviation Fuel	324		hr
Monopiling fuel consumption per Monopile(*)	Diesel	n/a	107	t

(*) An estimate of the piling work (energy per blow, strikes per pile, piles per turbine and total number of turbines) that would be necessary to construct the windfarm (for the worst case scenario), led to an estimation of 0.11 Terajoule (TJ) of energy per wind turbine. This is assumed to be delivered by diesel (with a Net Calorific Value (NCV) of 43 Gigajoules per tonne (GJ/t).

OPERATION

1.3.7 During the operation of the VE, many trips will again be needed to keep the installation in good working order as described in Volume 6, Part 2, Chapter 9: Shipping and Navigation. The anticipated transportation movements across the operational phase of the VE are summarised in Table 1.6.

Table 1.6: Vessel activities during operation and maintenance (Across Lifetime)

Description	Detail	Best Case	Worst Case	Units
Helicopter Site Access	Aviation Fuel	3,060	1,836	hr
Vessel Movements	Diesel	19,917	11,950	t
Vessel Movements	Gas Oil	249,600	149,760	m^3

1.3.8 It is anticipated the maintenance work will include regular replacement of various materials. Since no detailed maintenance data was available, an additional 2% of all raw materials and manufacturing processes to construct the VE are assumed to be required for maintenance/replacement across the lifetime of the VE.

1.3.9 It is also anticipated that the VE will consume a relatively low level of grid electricity itself, in order to enable its efficient operation. There is some uncertainty about the level involved, however the estimate used in these calculations is 4,315 Megawatt-hours per year (MWh/year) for the Best Case and Worst Case informed by consumption figures from other offshore wind farms in the UK.

FREIGHT

1.3.10 In addition to the vessel movements already described, the calculations consider the freight that will bring the construction and maintenance materials to the local area, and (at end of life) remove the materials for recycling or disposal. As mentioned in Table 1.2, at this stage these distances are based on indicative distances and locations. The estimated total additional amounts of freight movements required, in thousands of tonne-kilometres (ktkm) by road and by sea, are presented in Table 1.7, for the two scenarios described in paragraph 1.3.4.

Table 1.7: Additional anticipated freight requirements

	Road ktkm		Ship ktkm	
	Best Case	Worst Case	Best Case	Worst Case
Raw Materials	223,603	132,350	6,278,154	3,572,458
End of Life	385,853	140,964	0	0
Total	**609,456**	**273,314**	**6,278,154**	**3,572,458**

DECOMMISSION (END OF LIFE)

1.3.11 It is difficult to be certain what will happen to the VE's materials at end of life, simply because this will not occur for another 24-40 years, by which time, the state of available technology may be very different. To a large extent, however, the choice of the "cut-off" approach for accounting for recycled content and recycling means this is less critical.

1.3.12 In that accounting framework, the VE could be given credit for any recycled materials used in its lifetime, as these (typically) contain less embedded carbon than the virgin materials they replace. As described in the Raw Materials section above however, it has been assumed that all materials are virgin to perform a robust assessment. At end of life, the materials are charged with the further burdens of their management, until they reach their final resting place, or are ready to become new materials.

1.3.13 For wind turbine infrastructure, this means that the transport elements at end of life must be included, but once the materials reach the point where they are ready to be recycled, they exit the analysis boundary and are not considered further. Moreover, for the materials that are landfilled, associated emissions should be included, however it is anticipated that there should be little if any emissions from the inert materials whilst in landfill, due to low/no decomposition of organic material, so the burden is reduced to the freight impacts mentioned above.

1.4 LIFE CYCLE IMPACT ASSESSMENT

1.4.1 By bringing together all the above information, and applying appropriate characterisation factors, an initial estimation was calculated for the GHG emissions of the VE.

CHARACTERISATION FACTORS

1.4.2 Three sources were used to estimate the unit impacts of the different flows required across the lifetime model of the windfarm, as follows:

- The UK Government's "conversion factors for company reporting of greenhouse gas emissions" was used for marine gas oil (as well as some energy unit conversions and waste management processes). These are themselves based on the Fifth Assessment Report (AR5) from the International Panel on Climate Change (IPCC);
- The University of Bath's Inventory of Carbon and Energy (2019) dataset was used for a characterisation factor for asphalt; and
- All the remaining characterisation factors were taken from the ecoinvent database (2023). To ensure consistency with the UK Government's data, the method used was the same IPCC2013 data from the AR5 report.

1.4.3 This selection of sources for the characterisation factors means that all impacts are reported as emissions of greenhouse gases that contribute to climate change, considered over a 100-year period, relative to the impact of carbon dioxide i.e.in units of weight of carbon dioxide equivalents.

CLIMATE CHANGE RESULTS

1.4.4 Applying the chosen characterisation factors to the inventory of flows generated during the data collection, and summing by life cycle stage, led to the compilation of the initial results presented in Table 1.8 below.

Table 1.8: Climate change impact (in t CO2e) contributions from each life cycle stage

Life Cycle Stage	Best Case	Worst Case
Raw Materials	2,254,000	2,565,000
Manufacturing	478,000	679,000
Transport	157,000	78,000
Installation	261,000	261,000
Operation	800,000	512,000
End of Life	0	0
Total	**3,950,000**	**4,095,000**

1.4.5 The results show that the VE's materials (and their manufacture) make the largest contribution (c. 69% and 79% respectively) to the overall impacts. In contrast, despite the large quantum of fuel consumption from vessel movements throughout the lifetime, the impacts from transport are relatively insignificant accounting for only c. 4% and 2% of the respective overall impacts.

1.4.6 Table 1-8 also shows that a greater number of smaller gravity based foundation WTGs (Best Case scenario) has a lesser carbon impact compared to a smaller number of larger monopile based foundation WTGs (Worst Case scenario). The results from the worst case compared to the best case scenario only see a c. 4% increase in the overall carbon impact.

CARBON INTENSITY CALCULATION

1.4.7 3.95 Million tonnes (Mt) CO_2e is a significant amount of carbon emissions for the VE over its lifetime, but this should be assessed in the context of the electricity it will generate. There are uncertainties about how much electricity will be generated (these are explored later in Section 1.4.15), however it is estimated that its annual production levels might be of the order of 5,086 GWh/yr. This is estimated based on the wind turbine sizes and numbers for which the emissions have been calculated. Ultimately the actual number of turbines could be lower, which would reduce the annual production levels, although embedded carbon emissions would also reduce in this scenario. Running at this rate for 40 years, the VE will generate 203,460 GWh of electricity over its lifetime. Dividing the aforementioned 3.95Mt CO_2e of carbon emissions (for the Best Case Scenario) across this electricity generated yields the average carbon intensity of the electricity over the VE's lifetime:

$$\text{VE carbon intensity} = \frac{\text{Lifetime carbon emissions}}{\text{Lifetime electricity generated}} = \frac{3{,}950{,}000}{203{,}460} = 18.6\text{t/GWh (or g/kWh)}$$

1.4.8 The equivalent value for the Worst Case scenario across a 24-year lifespan is 32.8g CO2e/kWh. This significant difference arises because the emissions associated with the VE's construction are shared across many fewer years.

PAY BACK PERIOD

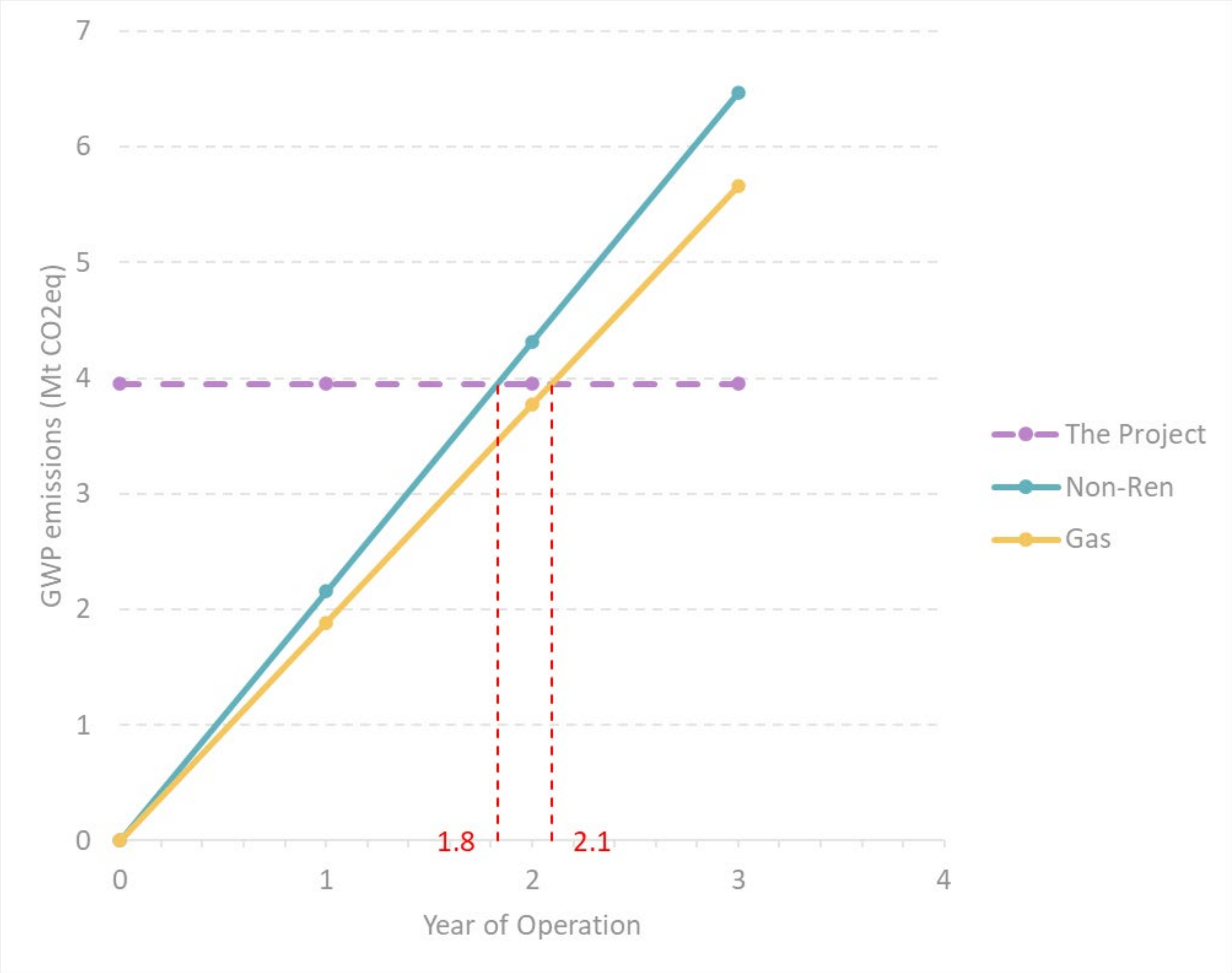
1.4.9 It is common practice to determine the VE's "pay-back" period – that is, how long into the lifetime of the windfarm before the carbon emissions associated with its construction are counter-acted by the lower carbon emissions of the electricity it generates. In order to perform this calculation, it is necessary to determine how the electricity would otherwise be generated. It is accepted that, when the windfarm comes online, its additional electricity will not replace nuclear or other renewable generating technologies. Rather, it will displace whatever generation technology would have been "the last to be turned on" – not the grid mix, therefore, the so-called "marginal mix". In the UK, for the foreseeable future, the marginal mix technology is gas, namely Combined Cycle Gas Turbine (CCGT) which has a carbon intensity of about 371g/kWh[1]. Alternatively, RenewableUK recommends[2] using the DUKES "all non-renewable fuels" (coal, oil, gas and other solid fuels including non renewable waste) emission factor of 424g/kWh[1].

1.4.10 Multiplying these intensities by the 5,086 GWh of electricity generated each year (Best Case scenario) reveals that the counterfactual-sourced electricity would be responsible for 1.9Mt CO_2e (gas CCGT or 2.2Mt CO_2e (all non-renewables) each year. The cumulative effect of this over the first three years of operation is compared in Figure 1.1 with the total lifetime emissions for the VE. As the annotation shows, under the assumptions outlined above, the VE would be expected to achieve payback in about two years (and then deliver annual savings for each of the following years of operation).

[1] Taken from DUKES 2023 data, Table 5.14: https://assets.publishing.service.gov.uk/media/64c1292090b545000d3e8396/DUKES_5.14.xlsx

[2] See https://www.renewableuk.com/page/UKWEDExplained

Figure 1.1: Cumulative GWP emissions from the VE (Best Case scenario) versus counterfactuals

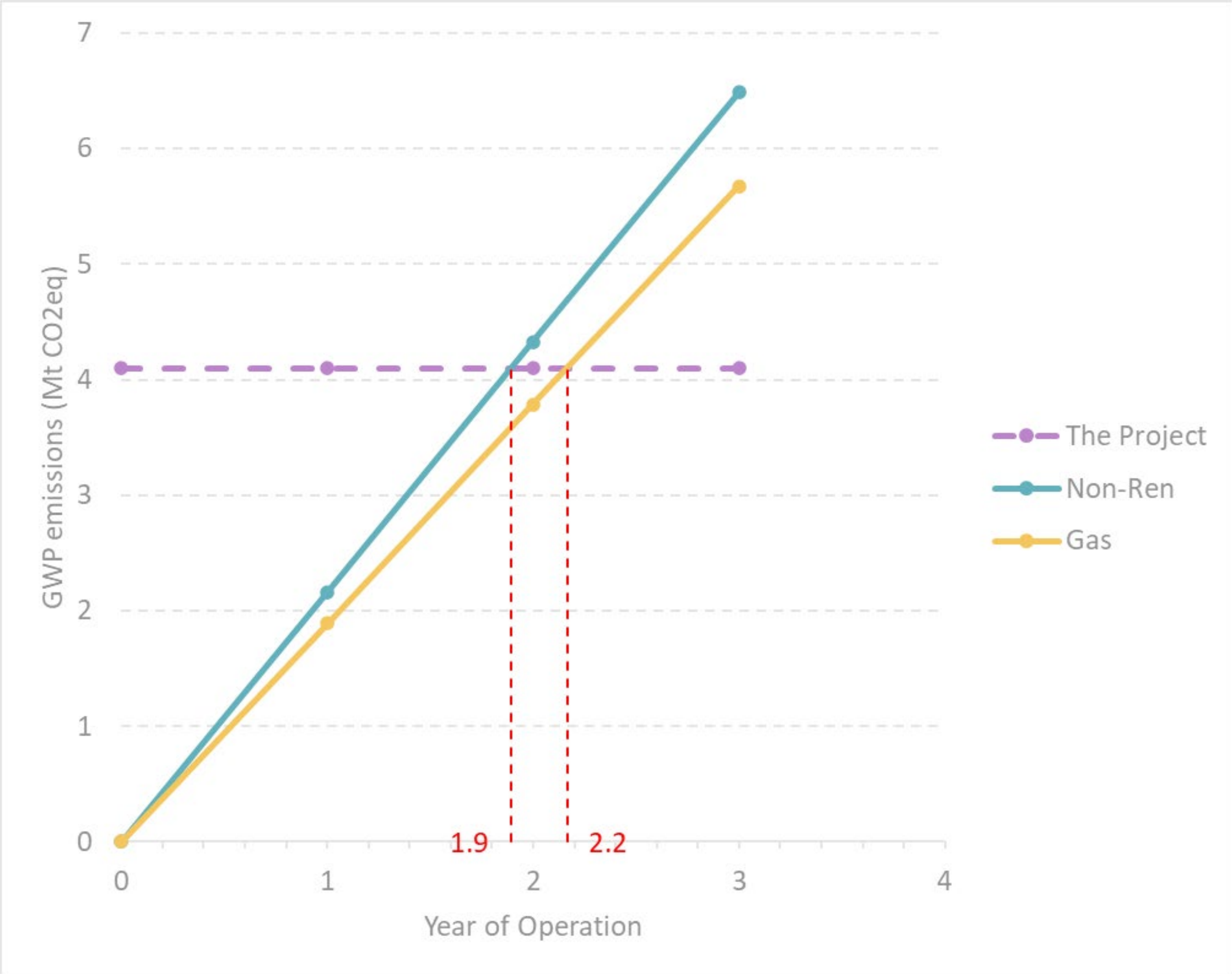


1.4.11 Another way of looking at this is to determine the cumulative impacts of 40 years of the alternative electricity sources. These turn out to be 75Mt CO_2e (gas CCGT) or 86Mt CO_2e (all non-renewables), between 19 and 22 times the lifetime carbon emissions of the VE, depending on the alternative electricity source.

1.4.12 Overall, VE Best Case scenario is deemed to have a net benefit regarding lifetime emission reduction compared to the project baseline scenarios, with a net benefit of 71MTCO_2e assuming Gas CCGT and 82MTCO_2e assuming all non-renewables derived electricity.

1.4.13 Turning to the Worst Case scenario, the slightly higher impact of producing the 41 monopile WTGs is plotted against comparable annual emissions for gas (CCGT) and all non-renewable in Figure 1.2. The changes are small, and the VE would again be expected to achieve payback in about two-years (and then deliver annual savings for each of the following years of operation).

Figure 1.2: Cumulative GWP emissions from VE (Worst Case scenario) versus counterfactuals



1.4.14 Operating for 24 years, the cumulative emissions of the alternative electricity sources would be 45Mt CO_2e (gas CCGT) or 52Mt CO_2e (all non-renewables), between 11 and 13 times the lifetime carbon impacts of the VE, depending on the alternative electricity source.

1.4.15 Overall, VE Worst Case scenario is deemed to have a net benefit regarding lifetime emission reduction compared to the project baseline scenarios, with a net benefit of 41MTCO_2e assuming Gas CCGT and 48MTCO_2e assuming all non-renewables derived electricity.

SENSITIVITY TESTING

1.4.16 As demonstrated in Figure 1.1 and Figure 1.2 above, it is good practice to explore how the results might depend on important uncertainties or assumptions in the underlying data. In this instance, the results are quite conclusive that the VE (Best and Worst Case) is (11-22 times) better than the likely counterfactual electricity alternatives. However, it is still instructive to explore how much the values might change, based on changes in the underlying data. In this section, two further checks are performed below.

ANNUAL ELECTRICITY PRODUCTION

1.4.17 It was stated above in Section 1.4.7 that there is some uncertainty about the amount of electricity that the VE might annually produce, with the initial value used being 5,086 GWh/yr. Underpinning this value is an inherent assumption about the possible load factor of the VE; what if that were unduly optimistic?

1.4.18 To explore this, several scenarios were proposed, in which the electricity generated might differ from the initial assumption. A Load Factor range of 45% - 53% was selected by making references to RenewableUK and Department for Energy Security and Net Zero on average load factors for onshore and offshore wind.

1.4.19 Reducing the assumed Load Factor from 49% to 45% increases the payback time (for the Best Case scenario) to 3.6-4.1 years, so has little effect on the results. To explore a much more extreme possibility, the annual electricity production was halved, to 2,543 GWh/yr. Even under these circumstances, the VE still achieved carbon payback after 3.7-4.2-years of operation.

1.4.20 Comparatively, the abovementioned scenarios of reduced Load Factor and electricity production were also applied to the Worst Case scenario. Reducing the Load Factor to 45%increases the payback time (for the Worst Case scenario) to 2.1-2.4 years, so has little effect on the results. A halving of the annual electricity production to 2,552 GWh/yr, would still see the VE achieve carbon payback after 3.8-4.3 years of operation.

1.4.21 Conversely, a higher Load Factor for VE of 53% for both scenarios was also evaluated. Under these circumstances, VE would achieve carbon payback in 1.7-1.9 years (for the Best Case scenario) and 1.8-2.0 years (for the Worst Case scenario).

1.4.22 The VE GHG results are seen to be relatively robust to uncertainties around the exact amount of electricity that will be generated across both the Best and Worst case scenarios, in each case achieving carbon payback in under 5 years of operation.

CONSTRUCTION BURDENS

1.4.23 As there are some uncertainties about the exact details surrounding the materials to be used for the VE, it was decided to explore how the results would change if the material burdens were **double** the originally estimated values (as were their manufacturing, transport and installation values). In this scenario, the VE (Best Case scenario) would take 3.3-3.7 years to payback its carbon burden. For the Worst Case scenario, the VE would take 3.5-4.0 years to payback its carbon burden. Overall, these results demonstrate the strong carbon benefit of the VE.

BIODIVERSITY NET GAIN

1.4.24 Biodiversity Net Gain (BNG) proposals and landscape mitigation proposals have been developed in parallel to ensure a holistic approach that delivers increased biodiversity and increased tree cover around the OnSS and replacement planting of trees and hedgerows along the length of the onshore ECC. Consideration has also been given to the role mitigation planting has to play in terms of carbon sequestration. The extensive use of trenchless techniques in the installation of the onshore ECC will notably reduce the amount of soil disturbance that will occur and in so doing, reduce the amount of carbon released. Proposals for extensive tree planting, hedgerow planting and the establishment of grasslands will help protect underlying soils from the regular disturbance that arable farmland is typically subject to, and the trees and plants will help to sequester carbon from the atmosphere through the process of photosynthesis. These measures are set out in Volume 9, Report 22: Outline Landscape and Ecological Management Plan (OLEMP). While the level of carbon reduction associated with measures set out in the OLEMP will be fractional compared to the carbon reductions associated with the production of renewable energy, it is important to note the local contribution the planting will provide in tackling the nature crisis.

1.5 SUMMARY

1.5.1 This study has performed a LCA of the VE. The scope considered impacts across the whole life cycle, from the production of the raw materials used to construct the facility, all the way through to the recycling or disposal of those same materials after decommissioning at the end of its lifetime.

1.5.2 The greenhouse gas emissions across an assumed 40-year lifetime operation with 79 WTGs and gravity based foundation system are estimated to be 3.95Mt CO2e (Best Case scenario). The VE is expected to produce 5,086 GWh of electricity each year, meaning the carbon intensity of the electricity generated will be about 18.6g CO2e/kWh.

1.5.3 The greenhouse gas emissions across an assumed 24-year lifetime operation with 41 WTGs and monopile foundations are estimated to be 4.1Mt CO2e (Worst Case scenario). The VE is expected to produce 5,104 Wh of electricity each year, meaning the carbon intensity of the electricity generated will be about 32.8g CO2e/kWh.

1.5.4 When compared with the alternative of generating the electricity by gas (CCGT) (with a carbon intensity of 371g CO2e/kWh) or “all non-renewables” (424g CO2e/kWh), the VE will pay-back the embedded emissions in its construction in about two years for both the Best and Worst case scenarios.

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