

The Lighthouse Green Fuels Order

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Glossary

Acronym	In Full / Term
CHP	Combined Heat and Power
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero
ES	Environmental Statement
GHG	Greenhouse gas
HGV	Heavy Goods Vehicle
ICE	Inventory of Carbon and Energy
LGV	Large Goods Vehicle
RICS	Royal Institution of Chartered Surveyors
RTFO	Renewable Transport Fuel Obligation
SAF	Sustainable Aviation Fuel

1 Introduction

1.1 Overview

- 1.1.1 This appendix sets out the data, assumptions and limitations of the assessment undertaken to evaluate the likely significant effects of greenhouse gas (GHG) emissions that would arise from the construction, operation and decommissioning of the Proposed Development.
- 1.1.2 This appendix is intended to be read alongside **Chapter 14: Greenhouse Gas Emissions (Environmental Statement (ES) Volume I, Application Document Ref. 6.1)**.
- 1.1.3 The methodology used for the GHG assessment is detailed in Section 3 of **Chapter 14: Greenhouse Gas Emissions (ES Volume I, Application Document Ref. 6.1)** and is not duplicated here.
- 1.1.4 The future baseline is assumed to be zero. Therefore, this appendix only elaborates on the data and assumptions made for the Proposed Development.
- 1.1.5 Section 2 of this appendix sets out the assessment data, assumptions and limitations associated with the GHG assessment of the construction, operation and decommissioning of the Proposed Development.
- 1.1.6 Section 3 of this appendix contains all supporting data tables supplementary to the information set out in Section 2.
- 1.1.7 Section 4 of this appendix sets out the data sources and assumptions used to compare the impact of Sustainable Aviation Fuel (SAF) to traditional jet fuel, as presented in Section 14.6 of **Chapter 14: Greenhouse Gas Emissions (ES Volume I, Application Document Ref. 6.1)**.

2 Assessment data, assumptions and limitations

Table 2.1 Assessment data, assumptions and limitations for the GHG assessment of the Proposed Development

Emissions module	Emission source	Assessment data	Limitations	Assumptions
A1-3 Product stage	Extraction, transportation and manufacture of construction materials	Construction material quantities are based on an early design stage bill of quantities provided by the Applicant. The quantity of imported soil is based on Table 16.6 in Chapter 16: Materials and Waste (ES Volume I, Application Document Ref. 6.1). For the quay walls, material quantities have been provided by the Arup Marine Engineering team and represent Rochdale upper limit values. An overview of the key construction materials is provided in Table 3.1.	Materials for which the quantities are provided in 'number' could not be converted into 'm³' or 'tonnes'. They are considered in the calculations through a 15% uplift factor applied to Module A1-3. If the materials of which an element is made were not defined, one main material is assumed. E.g., Main equipment items = steel; Pipework = steel	The quantity of imported soil is determined by subtracting the volume of excavated material reused on-site from the total backfill volume requirement. GHG emission factors have been sourced from: - Department for Energy Security and Net Zero (DESNZ) GHG Conversion Factors [Ref 1] - ICE database v4.0 [Ref 2] - National Highways Carbon Tool [Ref 3] An overview of the used GHG emission factors can be found in Table 3.1. 15% uplift factor added to calculations not based on detailed design data as per Royal Institution of Chartered Surveyors (RICS) [Ref 4].
A4 Transport to site	Transport of construction	Default transport scenarios defined by the RICS	Project-specific transport distances and modes for	Transport by road is assumed to take place by Heavy Goods Vehicle (HGV)

Emissions module	Emission source	Assessment data	Limitations	Assumptions
	materials to site	Professional Standard [Ref 4] are used.	transporting the construction materials to the site were not available at the time of this assessment.	and transport by sea by container ships as per RICS [Ref 4]. The GHG emission factors were sourced from the DESNZ GHG Conversion Factors [Ref 1]. An overview of the used GHG emission factors can be found in Table 3.2. A 15% uplift factor added to calculations not based on detailed design data as per RICS [Ref 4].
A5 Construction and installation	Construction and installation activities	Fuel use of construction equipment is estimated based on the types of plant and machinery used and their operating durations, as provided by the Applicant.		Fuel consumption (L/hr) for different equipment types is based on The Reference Manual for Construction Plant [Ref 5], published by the Inventory of Carbon and Energy (ICE). Where this source did not provide data for specific equipment, BS 5228-1:2009 (<i>Code of practice for noise and vibration control on construction and open sites – Part 1: Noise</i>) [Ref 6] was used to determine the equipment's power rating (kW). This was then converted to fuel consumption using the following formula: Fuel consumption (L/hr) = Engine rated power (kW) × Operating load factor (%) × Specific fuel consumption (L/kWh) Assumptions: Operating load factor: 70% (medium load)

Emissions module	Emission source	Assessment data	Limitations	Assumptions
				Specific fuel consumption: 0.25 L/kWh An overview of the equipment types considered and their fuel consumption or engine power can be found in Table 3.3. A 15% uplift factor added to calculations to cover any equipment for which appropriate fuel usage could not be identified, as per RICS [Ref 4].
	Construction waste and waste management	Construction waste materials and quantities are based on the information presented in Chapter 16: Materials and Waste (ES Volume I, Application Document Ref. 6.1) . Table 16.28 provides information on excavation waste and Table 16.29 provides details on other construction waste streams.		Appropriate GHG emission factors have been taken from DESNZ GHG Conversion Factors [Ref 1]. An overview of the used GHG emission factors can be found in Table 3.4. 15% uplift factor added to calculations not based on detailed design data as per RICS [Ref 4].
	Construction workforce travel	Data on the construction workforce travel by car (km/year) and by minibus (km/passenger/year) has been informed by the Transport assessment in Appendix 18A: Transport Assessment (ES Volume III, Application Document Ref. 6.3) .		Transport emissions factors (kgCO ₂ e/km) were sourced from the DESNZ GHG Conversion Factors [Ref 1], as shown in Table 3.5. Fleet mix projections have been sourced from the DfT TAG Data Book [Ref 7] for cars and Large Goods Vehicle (LGVs) (as a proxy for the minibus). Emission factors for EVs are assumed to decarbonise over time aligned with the

Emissions module	Emission source	Assessment data	Limitations	Assumptions
		Census “travel to work” data has been used to develop a gravity model to distribute worker trips across origin locations, the methodology for which is set out in the Transport Assessment in Appendix 18A: Transport Assessment (ES Volume III, Application Document Ref. 6.3) , along with vehicle occupancy rates and workforce distribution assumptions.		grid average industrial emissions factors in the DESNZ Green Book [Ref 8]. A 15% uplift factor added to calculations not based on detailed design data as per RICS [Ref 4].
B2 Maintenance	Maintenance activities	The assumptions consider a fixed fraction of module A1-A5 Production and Construction stage emissions.	No project-specific information on maintenance activities was available at this phase.	Maintenance activities have been modelled following the general assumptions outlined in the RICS Professional Standard [Ref 4]. Module B2 has been calculated as 1% of the Module A1–A5 production and construction stage emissions over the assessment period. A 15% uplift factor added to calculations not based on detailed design data as per RICS [Ref 4].
B3 Repair	Repair activities	The assumptions consider a fixed fraction of module B2 Maintenance.	No detailed repair process data available at time of the assessment.	Repair activities have been modelled following the general assumptions outlined in the RICS Professional Standard [Ref 4], with Module B3 assumed to be 25% of Module B2.

Emissions module	Emission source	Assessment data	Limitations	Assumptions
				A 15% uplift factor added to calculations not based on detailed design data as per RICS [Ref 4].
B6 Operational energy use	Energy use associated with the operation of the Proposed Development	Based on indicative figures provided by the Applicant, carried out in line with Renewable Transport Fuel Obligations Order (RTFO) guidance [Ref 9, Ref 10 and Ref 11]. Based on these calculations, the GHG emissions for modules B6, B7 and B8 could be derived for the Proposed Development.	None.	The electricity used by the plant is assumed to be sourced from the waste wood and biomass fuelled combined heat and power (CHP) plant (e.g., lighting, kitchens, electrical equipment/machinery). Therefore, GHG emissions associated with Module B6 are related to the upstream harvesting, processing and transport of the required biomass. White pellets are used for both the waste wood and biomass fuelled CHP plant (module B6) and the SAF production (module B8). Therefore, the impacts related to the white pellet production and transport have been allocated to each module based on the estimated mass required for the CHP plant and for the SAF production: • White pellet for CHP plant (module B6): 36% • White pellet for SAF production: 64% During the start-up phase (i.e. before the CHP plant can meet the full electricity demand for normal operation), grid electricity will be required. At the time of the assessment, no project-specific data was available related to this. However, as

Emissions module	Emission source	Assessment data	Limitations	Assumptions
				these emissions are expected to be relatively limited compared to those associated with CHP-supplied electricity, they are assumed to be covered by the uplift factor applied to module B6 as mentioned below. A 15% uplift factor added to calculations not based on detailed design data as per RICS [Ref 4].
B7 Operational water use	Operational water use	Based on indicative figures provided by the Applicant, carried out in line with RTFO guidance [Ref 9, Ref 10 and Ref 11]. Based on these calculations, the GHG emissions for modules B6, B7 and B8 could be derived for the Proposed Development.	None.	No assumptions made as part of the GHG assessment.
B8 Other activities associated with low-carbon SAF and naphtha production and distribution	Biomass cultivation, collection and transport to pellet production plant	Based on indicative figures provided by the Applicant, carried out in line with RTFO guidance [Ref 9, Ref 10 and Ref 11]. Based on these calculations, the GHG emissions for modules B6, B7 and B8 could be derived for the Proposed Development.	None.	No assumptions made as part of the GHG assessment.
	Pellet production and transport to LGF plant			
	Materials, gases and chemicals utilised during			

Emissions module	Emission source	Assessment data	Limitations	Assumptions
	LGF plant operation			
	Transport, processing and disposal of operational waste from LGF plant			
	Carbon dioxide released from chemical processes during LGF plant operation			
	Transport and distribution of low-carbon SAF produced at the LGF plant			
B8 User activities	Operational workforce travel	Transport distances for operational workforce travel by car (km/year) were informed by the Transport assessment in Appendix 18A: Transport Assessment (ES Volume III, Application Document Ref. 6.3) .		Transport emissions factors (kgCO₂e/km) were sourced from the DESNZ GHG Conversion Factors [Ref 1], as shown in Table 3.5. Fleet mix projections have been sourced from the DfT TAG Data Book [Ref 7] for cars. Emission factors for EVs are assumed to decarbonise over time aligned with the grid average industrial emissions factors in the DESNZ Green Book [Ref 8].

Emissions module	Emission source	Assessment data	Limitations	Assumptions
		Census “travel to work” data has been used to develop a gravity model to distribute worker trips across origin locations, the methodology for which is set out in the Transport Assessment, Appendix 18A: Transport Assessment (ES Volume III, Application Document Ref. 6.3) , along with vehicle occupancy rates and workforce distribution assumptions.		A 15% uplift factor added to calculations not based on detailed design data as per RICS [Ref 4].
C1 Deconstruction and demolition	Deconstruction and demolition	The assumptions consider a fixed fraction of module A5.2 Construction activities.	No project-specific information on deconstruction or demolition activities was available at this phase.	Deconstruction and demolition activities have been modelled following the general assumptions outlined in the RICS Professional Standard [Ref 4]. RICS: 25% of Module A5.2. A 15% uplift factor added to calculations not based on detailed design data as per RICS [Ref 4].
C2 Transport	Transport, waste processing and disposal of construction materials and products	Demolition waste materials and quantities are based on the information presented in Table 16.26 in Chapter 16: Materials and Waste (ES Volume I, Application Document Ref. 6.1) .	The default end-of-life routes provided by the RICS Professional Standard [Ref 4] have been considered for the different materials as project-specific data was too limited.	As the quay walls have a design life exceeding the assumed 30-year operational period, their decommissioning has not been included within the assessment. The GHG emission factors were sourced from the DESNZ GHG Conversion Factors [Ref 1] for the waste processes.
C3 Waste processing for reuse, recycling or recovery				
C4 Disposal				

Emissions module	Emission source	Assessment data	Limitations	Assumptions
				A 15% uplift factor added to calculations not based on detailed design data as per RICS [Ref 4].

3 Data tables

3.1 A1-3 Production

Table 3.1 Construction materials data and assumptions

Construction material	Quantity (tonnes)	Emission factor assumed (description)	Emission factor (kgCO ₂ e/kg)
Structural steel	33,458	Steel, section	1.610
Civils	3,485	Combined carbon factor for retaining concrete reinforced walls	0.145
Piping	30,900	Steel, welded pipe	2.510
Electrical	715	Miscellaneous cable	2.727
Instrumentation	1,680	Steel, hot-dip galvanized steel	2.620
Telecoms	808	Miscellaneous cable	2.727
Equipment	3,240	Steel, hot-dip galvanized steel	2.620
Concrete	1,600,247	Concrete - In-situ - GGBS 25% - RC 32/40 (32/40MPa)	0.113
Imported soil for backfill	726,436	Earthworks - Imported soil - General soil/topsoil	0.024
Steel - piles (2m dia.)	7,600	Steel, section	1.610
Steel - piles (2.2m dia.)	400	Steel, section	1.610
Steel - piles (1.2m dia.)	1,600	Steel, section	1.610
Steel - sheet piles	2,200	Steel, section	1.610
Steel - tie rods	1,200	Steel, section	1.610
Steel - waler beams	200	Steel, section	1.610
Steel - crane rails	1,500	Steel, section	1.610
Reinforced concrete (pile infill)	51,840	Combined carbon factor for reinforced concrete pile	0.133
Reinforced concrete (rock socket)	21,960	Combined carbon factor for reinforced concrete pile	0.133
Reinforced concrete (capping beams and crane beam)	30,000	Combined carbon factor for reinforced concrete capping beam	0.146
Granular fill material	256,000	Aggregates and sand, from virgin land won resources, bulk, loose	0.004

Construction material	Quantity (tonnes)	Emission factor assumed (description)	Emission factor (kgCO ₂ e/kg)
Rock - scour protection	37,590	Granite	0.093
Pavement (blockwork or concrete)	8,400	Concrete - In-situ - GGBS 25% - RC 32/40 (32/40MPa)	0.113

Table 3.2 Transport mode data and assumptions

Transport mode	Emission factor assumed (description)	Emission factor (kgCO ₂ e/tonne.km)
By road - HGV	HGV (all diesel) - All rigids - Average laden	0.198
	WTT - HGV (all diesel) - All rigids - Average laden	0.043
By sea – container ship	Cargo ship - Container ship - Average	0.016
	WTT - Cargo ship - Container ship - Average	0.004

3.2 A5.2 Construction activities

3.2.1 The construction equipment associated with the Proposed Development has been aligned, where practicable, with the equipment types defined in The Reference Manual for Construction Plant [Ref 5] and BS 5228-1:2009 [Ref 6]. These references were used to determine corresponding fuel consumption rates (L/hr) or engine power ratings (kW). In cases where the Applicant's data did not specify equipment size or capacity, reasonable worst-case assumptions have been applied.

Table 3.3 Construction equipment used for the Proposed Development and their estimated fuel use (L/hr) or engine power (kW).

Construction equipment for Proposed Development	Matched equipment in Ref 5 or Ref 6	Fuel use (L/hr) [Ref 5]	Engine power (kW) [Ref 6]
Articulated Dump Truck (25t)	Articulated dump trucks	20	
Cement mixer truck	Concrete mixers	2.4	
Cherry Picker	Access Platforms	8.8	
Coating truck	Small dumpers	7	
Compressor	Compressors	8.2	
Compressor for shot blasting	Compressors	8.2	
Concrete Mixer Trucks	Concrete mixers	2.4	
Concrete pump	Concrete pumping truck		97
Continuous Flight Auger Rig - CFA	Augur piling rig		126
Crane (50–100 t)	Cranes: tracked	40	

Construction equipment for Proposed Development	Matched equipment in Ref 5 or Ref 6	Fuel use (L/hr) [Ref 5]	Engine power (kW) [Ref 6]
Crawler crane (1000t) - LR11000	Cranes: tracked	55	
Crawler Crane (500t) - LR1500	Cranes: tracked	55	
Crawler Crane (800t) - LR1800	Cranes: tracked	55	
Diesel generator	Generating sets	18	
Diesel generator (Optional - if no grid power)	Generating sets	18	
Diesel generator (optional if no power grid)	Generating sets	18	
Diesel water pump	Pumps	2.1	
Directional drill (generator)	Tracked mobile drilling rig		251.5
Dozer (20t)	Crawler dozers	25	
Dozer D6	Crawler dozers	20	
Drill Rig/Rotary Kelly Drill	Tracked mobile drilling rig		186
Dump Truck (25t)	Articulated dump trucks	20	
Dumper (6t)	Small dumpers	7	
Feller Bunchers	Excavation hydraulic backbone	27	
Forklift (3–5t)	Fork lifts	4.5	
Generator for welding	Generating sets	2.5	
Hiab	Cranes lorry mounted	21	
HIAB Lorry (self-loading)	Cranes lorry mounted	21	
Hydraulic Hammer Rig	Augur piling rig		126
Hydraulic vibratory compactor (tracked excavator)	Vibrating plate compactors	1	
Large Hydraulic Excavator (30–50 t class)	Excavation hydraulic backbone	41	
Large Rotary Bored Piling Rig	Augur piling rig		126
Lorry	Flat bed lorry		260
Manlift 25m	Access Platforms	8.8	
Medium Excavator (15–30 t) with Rock Breaker	Excavation hydraulic backbone	27	
Mobile Crane (400t)	Cranes: tracked	40	
Mobile Crane (50–100t)	Cranes: tracked	40	

Construction equipment for Proposed Development	Matched equipment in Ref 5 or Ref 6	Fuel use (L/hr) [Ref 5]	Engine power (kW) [Ref 6]
Mobile telescopic (100t)	Cranes: tracked	33	
Mobile Telescopic Crane (55t)	Cranes: tracked	25	
Mud Pump	Pumps	3.2	
NDT truck and equipment	Small dumpers	7	
Portable generators (Optional - if no grid power)	Generating sets	18	
Roller (18t)	Rollers	14	
Roller (18t)/plate compactor	Rollers	14	
Scissor Lift	Access Platforms	8.8	
Scissor Lifts	Access Platforms	8.8	
Telehandler	Fork lifts	8.8	
Tipper Lorry	Rear dump trucks	40	
Tracked Crusher	Tracked breaker		59
Tracked drilling rig	Tracked mobile drilling rig		251.5
Tracked Excavator (22t - 30t)	Excavation hydraulic backbone	27	
Tracked Excavator (22t)	Excavation hydraulic backbone	27	
Tracked Excavator (25t)	Excavation hydraulic backbone	27	
Tracked excavator (30t)	Excavation hydraulic backbone	32	
Tracked excavator (30t) with vac lift	Excavation hydraulic backbone	32	
Tracked Excavator Fitted with Breaker	Excavation hydraulic backbone	27	
Tracked Mobile Crane (100t)	Cranes: tracked	33	
Tracked mobile crane (110t)	Cranes: tracked	33	
Tracked mobile crane (55t)	Cranes: tracked	25	
Tracked mobile crane (60t)	Cranes: tracked	25	
Truck mounted concrete pump	Pumps	2.1	97
Vibratory Pile Extractor/Hammer	Augur piling rig		126
Vibratory Piling Rig	Augur piling rig		126
Water bowser (dust suppression)	Diesel water pump		10

Construction equipment for Proposed Development	Matched equipment in Ref 5 or Ref 6	Fuel use (L/hr) [Ref 5]	Engine power (kW) [Ref 6]
Wheeled Loader	Wheeled loaders	18.8	

3.3 A5.3 Construction waste

Table 3.4 GHG emission factors used for construction waste

Emission factor assumed for waste process (description)	Emission factor (kgCO ₂ e/tonne)
Construction - Soils - Landfill	19.547
Construction - Soils - Closed-loop	1.008
Construction - Metals - Closed-loop	1.010
Construction - Concrete - Open-loop	1.010
Construction - Concrete - Landfill	1.260

3.4 A5.4 Construction workforce travel and B8 Operational workforce travel

Table 3.5 Workforce travel transport mode data and assumptions

Transport mode	Emission factor assumed (description)	Emission factor (kgCO ₂ e/tonne/km)
Cars	Cars - Average car - Petrol	0.163
	Cars - Average car - Petrol - WTT	0.046
	Cars - Average car - Diesel	0.173
	Cars - Average car - Diesel - WTT	0.041
	Cars - Average car - Plug-in Hybrid EV	0.092
	Cars - Average car - Plug-in Hybrid EV - UK Electricity	<i>Decarbonises over time in line with Ref 8</i>
	Cars - Average car - Plug-in Hybrid EV - UK Electricity T&D	0.001
	Cars - Average car - Plug-in Hybrid EV - WTT	0.029
	Cars - Average car - Battery EV	0
	Cars - Average car - Battery EV - UK Electricity	<i>Decarbonises over time in line with Ref 8</i>
	Cars - Average car - Battery EV - UK Electricity T&D	0.004
	Cars - Average car - Battery EV - WTT	0.010
Minibus	Bus - Coach	0.028
	Bus - Coach - WTT	0.007

3.5 C2-4 Transport, waste processing and disposal of demolition waste

Table 3.6 GHG emission factors used for demolition waste

Emission factor assumed for waste process (description)	Emission factor (kgCO ₂ e/tonne)
Construction - Concrete - Open-loop	1.010
Construction - Concrete - Landfill	1.260
Construction - Metals - Closed-loop	1.010
Plastics - Average Plastics - Incineration	4.686
Construction - Aggregates - Closed loop	1.008
Construction - Aggregates - Landfill	1.263
Construction - Insulation - Closed-loop	1.008
Construction - Insulation - Landfill	1.260
Electrical items - WEEE - small - Open-loop	4.686
Electrical items - WEEE - small - Landfill	8.983

4 Comparison of SAF with traditional jet fuel

- 4.1.1 To contextualize the GHG emissions of the Proposed Development, the emissions from the SAF produced during the 30-year operational life of Proposed Development are compared to an equivalent amount of jet fuel, as presented in section 14.6 of **Chapter 14: Greenhouse Gas Emissions (ES Volume I, Application Document Ref. 6.1)**.
- 4.1.2 The GHG emissions of traditional jet fuel are derived from the DESNZ GHG Conversion Factors [Ref 1], as shown in Table 4.1. While it is recognised that the embodied emissions of jet fuel in 2050 may increase due to factors such as more energy-intensive extraction from depleted reserves or higher transport emissions associated with longer supply chains, a fixed emissions factor has been applied. This approach provides a conservative basis for assessing the potential GHG savings of SAF relative to conventional jet fuel.

Table 4.1 GHG emissions used for traditional jet fuel

Emission factor assumed (description)	Emission factor (kgCO ₂ e/litre)
Aviation turbine fuel	2.54
WTT – Aviation turbine fuel	0.53

References

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