Thurrock Flexible Generation Plant

Preliminary Environmental Information Report
Chapter 14: Climate Change

Date: September 2018

Environmental Impact Assessment

Preliminary Environmental Information Report

Volume 3

Chapter 14

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Summary

This document reports the assessment of greenhouse gas emissions and effect on climate change that would be caused by the proposed development.

Qualifications

This document has been prepared by Tom Dearing, a Chartered Environmentalist and full Member of the Institute of Environmental Management and Assessment, who has eight years' experience of carbon footprint and climate change assessment for developments in the energy, waste, renewables, transport and major infrastructure sectors.

1. Introduction

1.1 Purpose of this chapter

1.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the findings of Environmental Impact Assessment (EIA) work undertaken to date concerning potential impacts of Thurrock Flexible Generation Plant on climate change.

1.1.2 The PEIR is being published to inform pre-application consultation. Following consultation, comments on the PEIR will be reviewed and taken into account in preparation of the Environmental Statement (ES) that will accompany the application to the Planning Inspectorate (PINS) for development consent.

1.1.3 Climate change in the context of EIA can be considered broadly in two domains: the impact of greenhouse gas emissions (GHGs) caused directly or indirectly by the proposed development, which contribute to climate change; and the potential impact of changes in climate to the development, which could affect it directly or could modify its other environmental impacts.

1.1.4 This chapter focuses on the impact of the proposed development on climate change due to its GHG emissions.

1.1.5 As agreed through EIA scoping (see Sections 1.4 and 0), the main potential impact of climate change on the proposed development affects flood risk, which has been assessed in Volume 3, Chapter 15: Hydrology and Flood Risk. In addition, the potential changes in the future baseline due to climate change are discussed in Section 3.2 of each EIA topic chapter in Volume 3.

1.1.6 This chapter summarises information contained within the technical report included at Volume 6, Appendix 14.1: GHG Calculation.

1.1.7 In particular, this PEIR chapter:

- presents the existing environmental baseline established from desk studies, surveys and consultation to date;
- presents the potential environmental effects on climate change arising from Thurrock Flexible Generation Plant, based on the information gathered and the analysis and assessments undertaken to date;
- identifies any assumptions and limitations encountered in compiling the environmental information; and
- highlights any necessary monitoring and/or mitigation measures that could prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process.

1.2 Planning policy context

1.2.1 Planning policy for energy generation Nationally Significant Infrastructure Projects (NSIPs), specifically in relation to climate change, is contained in the Overarching National Policy Statement (NPS) for Energy (EN-1) (DECC, 2011a) and the NPS for Fossil Fuel Electricity Generating Infrastructure (EN-2) (DECC, 2011b).

1.2.2 NPS EN-1 overall describes the national need for transition to a low-carbon electricity supply and notes the continued role of some fossil-fuelled generation to provide energy security, especially where flexibility and fast changes in generation are required (see paragraphs 3.3.10 to 3.3.12 in the NPS).

1.2.3 Although paragraph 3.3.4 of NPS EN-1 is clear that "…*until such time as fossil fuel* [sic] *generation can effectively operate with CCS* [carbon capture and storage]*, such power stations will not be low carbon"*, paragraph 2.2.4 states that:

"Not all aspects of Government energy and climate change policy will be relevant to IPC [Infrastructure Planning Commission, now PINS] *decisions or planning decisions by local authorities, and the planning system is only one of a number of vehicles that helps to deliver Government energy and climate change policy. The role of the planning system is to provide a framework which permits the construction of whatever Government – and players in the market responding to rules, incentives or signals from Government – have identified as the types of infrastructure we need in the places where it is acceptable in planning terms."*

1.2.4 The NPS highlights the importance of the EU Emissions Trading System (ETS) for control of GHG emissions from electricity generation. It also describes the policy reliance placed on deployment of carbon capture and storage (CCS) for fossil-fuelled generation plants and in section 4.7, the requirement for applicants to demonstrate carbon capture readiness (CCR). A CCR Report will be produced by the applicant to support the Development Consent Order (DCO) application. Land for CCR has been set aside within the main development site (zone A) as described in Volume 2, Chapter 2: Project Description.

1.2.5 NPS EN-1 and NPS EN-2 include guidance on what matters are to be considered in the climate change assessment. These are summarised in Table 1.1 below.

Table 1.1: Summary of NPS EN-1 and EN-2 provisions relevant to this chapter.

Summary of NPS EN-1 and NPS EN-2 provision	How and where considered in the PEIR
Greenhouse gas emissions	
Paragraph 5.2.2 in NPS EN-1 states that "*CO_2 emissions are a significant adverse impact from some types of energy infrastructure which cannot be totally avoided…*" and that "*Any ES on air emissions will include an assessment of CO_2 emissions…*".	This chapter provides an assessment of CO_2 emissions and other relevant greenhouse gases.
This is repeated in paragraph 2.5.2 of EN-2.	
Climate change adaptation	
Section 4.8 of NPS EN-1 concerns climate change adaptation. Paragraph 4.8.5 states that applicants must consider the impacts of climate change and that an ES "*…should set out how the proposal will take account of the projected impacts of climate change*."	As agreed through EIA scoping (see Sections 1.4 and 0), the relevant climate change risk requiring adaptation in the case of the proposed development is flooding, assessed in Volume 3, Chapter 15: Hydrology and Flood Risk.
Paragraph 4.8.7 of NPS EN-1 specifies that applicants should apply as a minimum the 10%–90% estimate range for the world's current emission scenario and relevant research based on this. Paragraph 4.8.9 specifies that where the development includes safety-critical elements such as sub-stations, the high emissions scenario should be considered.	For EIA purposes, the specified estimate range (including the high emissions scenario) has been considered in Section 3.2 of each topic chapter in Volume 3. Further details of the climate change allowance included in the flood risk assessment are given in Chapter 15.

1.2.6 NPS EN-1 and NPS EN-2 also highlight a number of factors relating to the determination of an application and in relation to mitigation. These are summarised in Table 1.2 below.

Table 1.2: Summary of NPS EN-1 and NPS EN-2 policy on decision making relevant to this chapter.

Summary of NPS EN-1 and NPS EN-2 policy on decision making (and mitigation)	How and where considered in the PEIR
Greenhouse gas emissions	
Paragraph 5.2.2 in NPS EN-1 states that "*Government has determined that CO_2 emissions are not reasons to prohibit the consenting of projects which use these technologies* [i.e. CCS] *or to impose more restrictions on them in the planning policy framework than are set out in the energy NPSs* [i.e. CCR]". The paragraph goes on to state that "*The IPC* [now PINS] *does not, therefore need to assess individual applications in terms of carbon emissions against carbon budgets…*"	Notwithstanding these earlier policy statements, greenhouse gas emissions have been assessed as required by the EIA Regulations 2017.
This is repeated in paragraph 2.5.2 of EN-2.	
Climate change adaptation	
Paragraphs 4.8.6 and 4.8.8 of NPS EN-1 specify that the IPC (now PINS) should be satisfied that applicants have taken into account climate change impacts using the latest UK projections available when the ES was prepared, that these should cover the infrastructure lifetime, and that there are not critical operational design features that may be affected by more radical climate changes.	The latest climate projections at the time of PEIR drafting (September 2018) have been considered in Section 3.2 of each topic chapter in Volume 3. Further details of the climate change allowance in the flood risk assessment, including risks to critical design features, are given in Volume 3, Chapter 15: Hydrology and Flood Risk.

1.2.7 Other relevant national policy is provided in the National Planning Policy Framework (NPPF) (Ministry of Housing Communities and Local Government (MHCLG), 2018), the Carbon Plan (Department for Energy and Climate Change (DECC), 2011c) and the UK Clean Growth Strategy (Department for Business, Energy and Industrial Strategy (BEIS), 2017a). Although not adopted national policy, the advice of the National Infrastructure Commission (NIC) given in the National Infrastructure Assessment (NIC, 2018) is also considered relevant.

1.2.8 With regard to climate change, the core planning principle of the NPPF is that the planning system should:

"…support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure" (paragraph 148).

1.2.9 Under paragraph 154, applicants for energy development are not required to demonstrate the overall need for low-carbon energy. 'Low-carbon' technologies are defined in the NPPF at page 70 as "*…those that can help reduce emissions (compared to conventional use of fossil fuels)*."

1.2.10 The 2011 Carbon Plan is the UK's national strategy under the Climate Change Act 2008 for delivering emissions reductions through to the Fourth Carbon Budget period (2023-27) and preparing for further reductions to 2050. The Carbon Plan notes at paragraph 2.146 the need for some flexible fossil fuelled electricity generation for security of supply and emphasises throughout the envisaged role of CCS for fossil-fuelled generation.

1.2.11 It was expected to be updated or replaced by a national 'Emissions Reduction Plan' that the former coalition government committed to publish in 2016, but that has been delayed indefinitely. Due to the age of the Carbon Plan, certain policy expectations have been overtaken by subsequent policy decisions: in particular, the expected government funding for deployment of CCS technology has lapsed following the failure of the second CCS competition (National Audit Office (NAO), 2017).

1.2.12 The National Infrastructure Assessment discusses the need for flexible generation and storage (page 39) and does not recommend deployment of CCS for fossil-fuelled power generation as this would not be cost-competitive with other options (page 43).

1.3 Legislation

1.3.1 The Climate Change Act 2008 commits the UK government to reducing greenhouse gas emissions by at least 80% of 1990 levels by 2050, and created a framework for setting a series of interim national carbon budgets and plans for national adaptation to climate risks.

1.3.2 At present the Third, Fourth and Fifth Carbon Budgets, set through The Carbon Budget Orders 2009, 2011 and 2016, are 2.54 $GtCO_2e$ for 2018-2022, 1.95 $GtCO_2e$ for 2023-2037 and 1.73 $GtCO_2e$ for 2028-2032.

1.3.3 The Climate Change Act also created the Committee on Climate Change to give advice on carbon budgets and report on progress. Although not itself setting legislation or government policy, the Committee on Climate Change's statutory role to advise government under the Climate Change Act 2008 means that its recommendations or identification of policy gaps are relevant to consider in this assessment. In its advice on setting the Fifth Carbon Budget (Committee on Climate Change, 2015a) and on sectoral scenarios (Committee on Climate Change, 2015b) for achieving the budget, the Committee considered carbon reduction pathways and actions for the power generation sector.

1.3.4 Chapter 2 of the sectoral scenarios report concerns decarbonising power generation. Decarbonisation of electricity supply, to 50-100 gCO_2/kWh by 2030 from around 450 gCO_2/kWh today[1], is crucial for achieving the UK carbon budget. The importance of CCS deployment for fossil-fuelled power generation in the 2020s onwards is emphasised. Page 88 of the main Fifth Carbon Budget report suggests that flexible gas-fired generation capacity can assist with managing the transition to low-carbon power generation at lowest cost[2].

1.3.5 The Committee's 2018 report to Parliament (Committee on Climate Change, 2018) identifies significant policy gaps for meeting carbon budgets. For the power sector, alongside ongoing renewables deployment, it recommends new flexible generation and storage (Table 2.3 on page 63) and continues to emphasise the need for CCS deployment.

1.3.6 The UK's ratification of the Paris Agreement (FCCC/CP/2015/L.9/Rev.1) will in the advice of the Committee require more ambitious UK carbon emission reductions than legislated for in the Climate Change Act 2008, particularly beyond 2050. However, pending further changes in emissions reduction pledges by other EU member states, the Committee has not recommended that the Fifth Carbon Budget should be altered at present (Committee on Climate Change, 2016a and 2016b).

1.3.7 Concerning the implications of Brexit for UK climate change policy, the Committee notes (Committee on Climate Change, 2016c) that this does not affect the existence of the UK's domestically-legislated climate goals for 2050. In summary, the Committee indicates that domestic policies to achieve the equivalent effects on GHG reductions as lost EU-level policies will be required, and highlights again the existing policy gap for achieving carbon reductions required by the Fifth Carbon Budget.

1.3.8 Greenhouse gas emissions from electricity generation facilities are currently regulated by the EU ETS established by Directive 2003/87/EC as amended by Directive 2009/29/EC and implemented in the UK by the Greenhouse Gas Emissions Trading Scheme Regulations 2012.

[1] At the time of that document's production; subsequently the carbon intensity of electricity generation in the UK has further significantly decreased, which is discussed in the following sections of this chapter.
[2] In full, the Committee states: *"Flexible unabated gas plant. More efficient and flexible generation technologies are available that can operate stably at lower levels of output, provide faster frequency response than at current levels, and consume less fuel when part-loaded to provide system reserve. Greater use of these would require less overall thermal plant to be built to stabilise the system, be less likely to curtail renewables output, and reduce overall emissions."*

1.3.9 The EU ETS allocates national emissions budgets for member states, out of an overall limit on emissions that is reducing by 1.74% each year, intended to achieve at least a 40% reduction of emissions in the relevant sectors by 2030 compared to 1990 levels. Power generators must purchase all emissions allowances at auction, as no free allowances are allocated in the current ETS phase. Each facility is regulated in the UK by a GHG Emissions Permit and must obtain sufficient allowances to cover all of its emissions per annum, whether by allocation or trading: a surplus of allowances can be banked or sold; where there is a deficit, allowances must be purchased.

1.3.10 As set out in NPS EN-1, UK policy for GHG emission reductions therefore distinguishes between the traded and non-traded sectors, taking the overall cap and reductions in emissions over time through the ETS as a committed measure that will be achieved through the cap-and-trade mechanism.

1.3.11 However, at the time of writing (September 2018), the future participation of the UK in the EU ETS following Brexit in 2019 is unclear. The compliance date for 2018 emissions allowances surrender has been brought forward to before Brexit to enable temporary continued functioning of the ETS in the UK during this year. The Brexit White Paper (HM Government, 2018) suggests that the UK may or may not remain part of the EU ETS after Brexit (paragraph 140) but does indicate that the "*high standards*" of the Climate Change Act 2008 would be maintained after Brexit (section 1.6.4).

1.4 Consultation

1.4.1 Key issues raised during scoping and consultation to date specific to climate change are listed in Table 1.3, together with how details of how these issues have been considered in the production of this PEIR and cross-references to where this information may be found.

Table 1.3: Key points raised during scoping and consultation to date.

Date	Consultee and type of response	Points raised	How and where addressed
20 September 2018	PINS Scoping Opinion	Paragraph 3.3.19: the ES should assess likely significant effects from the proposed development on climate change (due to GHG emissions) and its vulnerability to climate change, including where relevant adaptation or resilience measures.	This chapter describes impacts on climate change due to GHG emissions. Flood vulnerability and adaptation with consideration of climate change are assessed in Volume 3, Chapter 15: Hydrology and Flood Risk. Other risks are discussed in the following row.
		PINS ID 4.11.4: updated UK climate projections ('CP18') are expected to be published in November 2018, which may differ from the CP09 projections considered at scoping stage. The proposed development might continue to operate after its design lifetime of 35 years. Climate change risks and adaptation relating to changes in temperature, humidity and wind speed (including resilience) should be assessed with reference to CP18 and the proposed development lifespan.	Section 3.2 refers to the expected future publication of CP18, although does note that CP09 remains the current dataset for planning. Following publication of the PEIR, further work will be undertaken to consider potential climate risks and any necessary adaptation or resilience measures in light of CP18 data (if available prior to completion of the ES) and time periods beyond 2069.
	Marine Management Organisation (MMO) in PINS Scoping Opinion	CP09 and CP18 are an important source of data to bear in mind for a precautionary approach to coastal process and flood risk assessment.	Flood risk with consideration of climate change is assessed in Volume 3, Chapter 15: Hydrology and Flood Risk.
	Natural England in PINS Scoping Opinion	The ES should reflect Defra (Department for Environment, Food and Rural Affairs) principles on biodiversity and climate change. It should identify how the development's effects on the natural environment will be influenced by climate change, and how ecological networks will be maintained.	Climate change influences on the natural environment in the future baseline, affecting the assessment of impacts, have been considered in Section 3.2 of Volume 3, Chapter 9: Ecology.
	PINS Scoping Opinion	PINS ID 4.11.6: the ES should set out the calculation methods used to quantify the GHG emissions relating to the proposed development.	Calculation methods and data sources are detailed in Volume 6, Appendix 14.1: GHG Calculations.
	PINS Scoping Opinion	PINS ID 4.11.7: the ES should state any assumptions made in calculating the predicted GHG emissions, any limitations to the calculations and any uncertainties this presents for the assessment of GHG emissions.	Assumptions and uncertainties are discussed in Section 2.4, with more detail in Volume 6, Appendix 14.1: GHG Calculations.

2. Assessment Approach

2.1 GHG Emissions Calculation – Overview

2.1.1 In overview, GHG emissions have been estimated by applying published emissions factors to activities in the baseline and to those required for the proposed development. The emissions factors relate a given level of activity, or amount of fuel, energy or materials used, to the mass of GHGs released as a consequence.

2.1.2 Further detail of the approach, data inputs, assumptions and boundaries of the calculations are given in Volume 6, Appendix 14.1: GHG Calculations.

2.1.3 The GHGs considered in this assessment are those in the 'Kyoto basket' of global warming gases[3] expressed as their CO_2-equivalent global warming potential (GWP). This is denoted by CO_2e units in emissions factors and calculation results. GWPs used are typically the 100-year factors in the Intergovernmental Panel on Climate Change Fourth Assessment Report (Forster *et al*, 2007) or as otherwise defined for national reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

2.1.4 GHG emissions caused by an activity are often categorised into 'scope 1', 'scope 2' or 'scope 3', following the guidance of the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol suite of guidance documents (WRI and WBSCD, 2004). Scope 1 emissions are those released directly by the entity being assessed, e.g. from combustion of fuel at an installation. Scope 2 emissions are those caused indirectly by consumption of imported energy, e.g. from generating electricity supplied through the national grid to an installation. Scope 3 emissions are those caused indirectly in the wider supply chain, e.g. in the upstream extraction, processing and transport of fuel consumed or the downstream disposal of waste products from an installation.

2.1.5 This assessment has sought to include emissions from all three scopes, to most completely capture the impacts attributable to the proposed development, where this is material and possible from the information and emissions factors available.

2.1.6 Due to the nature of the proposed development, combusting large amounts of natural gas, its gross GHG emissions total is dominated by scope 1 emissions from gas combustion and scope 3 emissions from the gas supply chain. Scope 2 emissions are also relevant where the proposed development scenario compared to the baseline involves the consumption or displacement of electricity generated for the national grid. Other scope 3 emissions, e.g. from the 'embodied carbon' in construction materials used or arising from operational waste generation, are considered to be *de minimis* as set out in the assessment section below.

2.1.7 The assessment has considered (a) the GHG emissions caused by the proposed development, (b) any GHG emissions that it displaces or avoids, compared to the current or future baseline, and hence (c) the net impact on climate change due to these changes in GHG emissions overall.

2.2 Baseline study

Desktop study

2.2.1 Information on current and future baseline GHG emissions associated with electricity generation and other relevant activities for the proposed development has been collected from the published statistics summarised at Table 2.1.

Table 2.1: Summary of key desktop reports.

Title	Year	Author
UK Government GHG Conversion Factors for Company Reporting v1.09	2018	BEIS and Defra (2018)
Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book, and supporting data tables	2017	BEIS (2017b)
Future Energy Scenarios, data tables	2018	National Grid (2018)

Site specific surveys

2.2.2 No site-specific surveys have been required for this assessment.

2.3 Study area

2.3.1 As GHG impacts are global and cumulative with all other sources, no specific geographical study area is defined for this assessment.

[3] carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (SF_6), where relevant

2.4 Uncertainties and/or data limitations

2.4.1 There is uncertainty about future climate and energy policy and market responses, which affect the likely future carbon intensity of energy supplies. Government projections consistent with national carbon budget commitments have been used in the assessment.

2.4.2 The proposed development is a flexible generation plant and its operating times may vary, depending on the needs of National Grid. This affects both the gross GHG emissions and the net effect of other electricity supply sources displaced. The assessment has considered the maximum annual operating hours (defined in Table 2.2) for gross emissions and a range of scenarios, described in Section 3.2 and Volume 6, Appendix 14.1: GHG Calculations, for the net emissions effect.

2.4.3 Due to the early stage of development design and the flexibility sought by the applicant within the design envelope, limited information is available about proposed construction materials and activities or the potential use of gases with high GWP in elements of the development such as substation components. This has been managed through screening and sensitivity testing of the possible impact magnitude against a defined *de minimis* threshold as detailed in Appendix 14.1.

2.5 Impact assessment criteria

2.5.1 The significance of an effect is determined based on the magnitude of an impact and the sensitivity of the receptor affected by the impact of that magnitude. This section describes the criteria applied in this chapter to characterise the magnitude of potential impacts and sensitivity of receptors.

Magnitude of impact

2.5.2 As GHG emissions can be quantified directly and expressed based on their GWP as tonnes of CO_2-equivalent emitted, the magnitude of impact is reported numerically rather than requiring descriptive terms.

Sensitivity of receptor

2.5.3 GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in CO_2-equivalents, has therefore been treated as a single receptor of high sensitivity (given the severe consequences of global climate change).

Significance of effect

2.5.4 Assessment guidance for GHG emissions (Institute of Environmental Management and Assessment (IEMA), 2017) indicates that in principle, any GHG emissions may be considered to be significant, and advocates as good practice that GHG emissions should always be reported at an appropriate, proportionate level of detail in an ES. There are however no clear, generally-agreed thresholds or methods for evaluating the significance of GHG effects in EIA. To aid in considering whether effects are significant, the guidance referenced above recommends contextualising the magnitude of a development's GHG impacts in several possible ways.

2.5.5 Taking the guidance into account, the following factors have been considered in contextualising the proposed development's GHG emissions:

- with reference to the magnitude of gross and net GHG emissions as a percentage of the UK's national carbon budget;
- through comparing the GHG emissions intensity of the proposed development with current baseline emissions intensity for such energy generation and projections or policy goals for future changes in that baseline; and
- with reference to whether the proposed development contributes to and is in line with the UK's national carbon budget and carbon policy sectoral goals for GHG emissions reduction, where these are consistent with science-based commitments to limit global climate change to an internationally-agreed level.

2.5.6 Effects from GHG emissions are described in this chapter as being adverse, neutral/negligible or beneficial based on the following definitions.

2.5.7 **Adverse:** the development's GHG impacts would be greater than the current or future baseline and/or would not meet existing policy goals.

2.5.8 **Neutral** or **negligible**: the development's GHG impacts would be consistent with existing policy goals, or the impact is little or no net environmental change.

2.5.9 **Beneficial**: the development's GHG impacts would be reduced compared to the baseline and/or would include measures that go beyond existing policy goals.

2.5.10 **Adverse** or **beneficial** effects are considered to be significant, taking into account the IEMA guidance and the high sensitivity of the receptor. **Neutral** or **negligible** effects are not considered to be significant.

2.6 Maximum design envelope parameters for assessment

2.6.1 The maximum design envelope parameters identified in Table 2.2 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These parameters have been identified based on the overview description of the development provided in Volume 2, Chapter 2: Project Description, including all potential development options where these are under consideration by the applicant.

2.6.2 Effects of greater adverse significance are not predicted to arise should any other development scenario within the proposed development design envelope be taken forward in the final design scheme.

Table 2.2: Maximum design envelope parameters assessed.

Potential impact	Maximum design scenario	Justification
Construction		
Embodied carbon in construction materials and equipment of flexible generation plant.	These are a *de minimis* element of total lifecycle emissions including operational use.	A reasonable assumption where specific embodied carbon information about manufactured components or estimates of construction material volumes are not available. See further detail in Volume 6, Appendix 14.1: GHG Calculations.
GHG emissions from construction transport.	Maximum design scenario for construction traffic generation as specified in Volume 3, Chapter 10: Traffic and Transport. Major engineered components (e.g. transformers, gas engine blocks) transported from Europe; other materials and staff travelling up to 100 km (one way).	The maximum design scenario parameters for vehicle flows and have been specified for that assessment. Reasonable parameters to estimate contribution of construction transport to total lifecycle emissions.
Operation and maintenance		
GHG emissions from combustion of gas.	Maximum 4,000 annual operating hours. Maximum gross electrical generation capacity 600 MWe; minimum gas engine efficiency 52%.	Maximum gas combustion for the specified electrical generation capacity would generate the highest GHG emissions.
Fugitive GHG emissions.	Gas insulated switchgear (GIS) substation components containing sulphur hexafluoride (SF_6) operated in accordance with current F-gas Regulations and good practice.	Air insulated substation components or use of alternative insulating gas with lower GWP would have lower potential for GHG emission impact.
	No fugitive emission of natural gas.	Reasonable expectation for the safe operation of the flexible generation plant and high-pressure gas transmission.
	Organic Rankine cycle (ORC) system uses hydrofluorocarbon (HFC) gas R245fa operated in accordance with current F-gas Regulations and good practice.	A reasonable assumption based on examples from manufacturers of similar systems.
Displaced GHG emissions due to energy export.	Maximum parasitic load 1.5% of gross electrical generation capacity. No export of heat.	Reasonable minimum energy export would have lowest displaced GHG emissions and hence highest net total GHG emissions attributable to the proposed development.
Decommissioning		
GHG emissions from decommissioning and deconstruction activity.	Less than construction stage, as many materials would be recycled or left in situ and activities such as transport will be increasingly decarbonised.	Reasonable assumption in context of national commitments to decarbonisation.

2.7 Impacts scoped out of the assessment

2.7.1 The impacts listed in Table 2.3 have been scoped out of the assessment for climate change as agreed through the EIA scoping process detailed in Volume 2, Chapter 5: Scoping and Consultation.

Table 2.3: Impacts scoped out of the assessment.

Potential impact	Justification
Construction	
GHG emissions from construction activities (e.g. due to fuel consumption by construction plant).	These are considered to be minimal and not significant. PINS ID 4.11.2 in 20 September Scoping Opinion.

Potential impact	Justification
Operation and maintenance	
Impacts or risks of climatic changes on operation of the development other than flood risk.	Probabilistic projections of change in climatic variables under a high emissions scenario were reviewed at scoping stage and not considered to be of sufficient magnitude to require any specific design response for resilience or to impact on the proposed development's operation. However, as acknowledged in Table 1.3 following receipt of the PINS Scoping Opinion, further work will be undertaken following publication of the PEIR to consider updated climate projections ('CP18') if available and also the time period beyond the flexible generation plant's 35 year design operating lifetime. The influence of climate change on flood risk has been assessed in Volume 2, Chapter 15: Hydrology and Flood Risk.
Decommissioning	
Direct GHG emissions from decommissioning activity.	These are considered to be minimal and not significant. PINS ID 4.11.3 in 20 September Scoping Opinion.

2.8 Measures adopted as part of Thurrock Flexible Generation Plant

2.8.1 A number of measures have been designed in to the flexible generation plant to reduce the potential for impacts on climate change. These are listed in Table 2.4.

Table 2.4: Designed-in measures.

Measures adopted as part of Thurrock Flexible Generation Plant	Justification
Land for carbon capture readiness (CCR) is set aside within the main development site.	This allows for potential addition of carbon capture and storage (CCS) at a later point, which would mitigate CO_2 emissions.
Use of ORC system will improve the overall thermal efficiency of the gas engines.	The improvement in efficiency (increasing useful electricity generated per unit of fuel combusted) reduces the GHG intensity of the proposed development.
Measures to air pollutant emissions from construction plant and activity, detailed in the Code of Construction Practice at Volume 5, Appendix 2.2, will also offer mitigation of construction plant GHG emissions.	Use of efficient and well-maintained plant and using mains electricity rather than less efficient portable generators will reduce direct and indirect GHG emissions from fuel and energy consumption.
Goals to reduce embodied carbon in construction materials required, detailed in the Code of Construction Practice.	The measures detailed would reduce indirect GHG emissions in the construction stage of the lifecycle.

3. Baseline environment

3.1 Current baseline

3.1.1 The current baseline for existing land-use within the application boundary is the GHG emissions from agricultural and Common Land use, i.e. agricultural machinery and minor fluxes in soil and vegetation carbon stocks, which may be a net source or sink depending on the farming or land management regime in each zone.

3.1.2 Existing agricultural land-use is described in Volume 3, Chapter 8: Land Use, Agriculture and Socio-Economics and does not involve intensive livestock farming or horticulture with potentially higher GHG emissions intensity.

3.1.3 The current baseline with regard to grid-average electricity generation, without the proposed development, is 325 $kgCO_2e/MWh$ (including scope 3 but as-generated, i.e. excluding transmission and distribution losses) (BEIS and Defra, 2018).

3.2 Future baseline

3.2.1 The future baseline GHG emissions for existing land-use without the proposed development are expected to remain similar, with a decrease in agriculture-related emissions over time in line with the UK's national climate change policies.

3.2.2 The future baseline for electricity generation that would be displaced by the proposed development depends broadly on future energy and climate policy in the UK, and more specifically (with regard to day-to-day emissions) on the demand for operation of the proposed development compared to other generation sources available, influenced by commercial factors and National Grid's needs.

3.2.3 Several future baseline scenarios have therefore been considered, using both BEIS and National Grid projections of the carbon intensity of long-run marginal and grid-average electricity generation during the proposed development's operating lifetime (BEIS, 2017b; National Grid, 2018) and assumptions about specific generation sources that could be displaced. These are detailed in Volume 6, Appendix 14.1: GHG Calculations.

Climate change

3.2.4 The Met Office UK Carbon Projections ('UKCP09') dataset[4] provides probabilistic projections of change in climatic parameters over time for 25 km grid squares across the UK. Projected changes during low, medium and high future global greenhouse gas emissions scenarios have been reviewed for the period from 2020 up to 2069, encompassing the potential six year construction and 35 year operational periods of the proposed development.

3.2.5 The influence of these potential changes on future baseline for the EIA has been discussed within this chapter section for each of the other topic chapters in Volume 3.

[4] CP09 is presently being updated to CP18, expected to be published in November 2018 (Met Office, 2018). CP09 remains the most up-to-date available data and remains an appropriate tool for adaptation planning (Met Office, 2017).

4. Assessment of Effects

4.1 Construction phase

Magnitude of impact

4.1.1 Construction phase GHG emissions, considering the potential embodied carbon in materials, construction activity and transport requirements, are considered to be *de minimis* as they are estimated to be less than 1% of total operational-phase emissions. Further detail of this estimation is provided in Volume 6, Appendix 14.1: GHG Calculations.

Sensitivity of the receptor

4.1.2 The atmospheric mass of the relevant GHGs and consequent warming potential is considered to be of high vulnerability and limited recoverability. The sensitivity of the receptor is therefore considered to be **high**.

Significance of effect

4.1.3 Overall, it is predicted that the *de minimis* impact on the **high** sensitivity receptor would result in a **negligible** effect, which is not significant in EIA terms.

Further mitigation or enhancement

4.1.4 Construction-stage effects are not considered likely to be material to the total life-cycle effect of the proposed development. Nevertheless, in consideration of IEMA guidance that all GHG emissions are potentially significant, and government policy seeking GHG emissions reductions across all economic sectors including construction, further good-practice mitigation has been recommended through the Code of Construction Practice (CoCP) (Volume 5, Appendix 2.2) to seek a lean design and minimise embodied carbon.

Residual effect

4.1.5 The residual effect following further mitigation is predicted to be **negligible**, which is not significant in EIA terms.

Future monitoring

4.1.6 No future monitoring of construction phase GHG emissions is considered to be required.

4.2 Operational and maintenance phase

Magnitude of impact

4.2.1 The proposed development's total gross direct and indirect GHG emissions over its operating lifetime are estimated to be approximately **38 $MtCO_2e$** (million tonnes of carbon dioxide equivalent).

4.2.2 However, its operation would displace marginal alternative sources of electricity generation and would also play a role in avoiding GHG emissions by enabling greater use of renewable generation. Several scenarios for emissions sources displaced or avoided have been considered, discussed in Appendix 14.1.

4.2.3 Taking into account GHG emissions reductions from displacement of projected typical marginal generation sources, plus the benefits of the battery storage and the benefits of greater enabled renewable generation, the proposed development's net GHG emissions are estimated to be lower, at approximately **20 $MtCO_2e$**.

4.2.4 Considering more specifically displacement of other gas-fired flexible generators (using different technologies, with lower efficiency) as the marginal source, plus battery storage and enabled renewable generation as above, the proposed development is estimated to have net negative GHG emissions (i.e. a net beneficial impact) of between -**11 $MtCO_2e$** and **-22 $MtCO_2e$**.

Sensitivity of the receptor

4.2.5 The atmospheric mass of the relevant GHGs and consequent warming potential is considered to be of high vulnerability and limited recoverability. The sensitivity of the receptor is therefore considered to be **high**.

Significance of effect

4.2.6 In order to evaluate the significance of effect resulting from the impact magnitude, the proposed development's GHG emissions have been contextualised in the three ways discussed in paragraph 2.5.5: as a percentage of the national carbon budgets; compared to emissions intensity for baseline electricity generation; and with reference to the relevant national policies for carbon reduction in the electricity sector. These are discussed in turn.

National carbon budgets

4.2.7 The gross GHG emissions from the proposed development would be 0.28% of the UK's national carbon budget during 2023–2027 and 0.32% of the 2028–2032 budget. Gross GHG emissions would be 3.4% of the national carbon budget in 2050, based on the 80% reduction compared to 1990 baseline emissions required by the Climate Change Act 2008. No national carbon budgets have yet been set for the remaining intervening periods to 2050.

4.2.8 While the proposed development's GHG emissions would fall under the EU ETS as a new entrant, which the national carbon budget is net of (i.e. treating all UK ETS sector emissions as capped to the UK's agreed effort-sharing level), it is not known whether UK participation in the EU ETS will continue following Brexit.

Baseline electricity generation carbon intensity

4.2.9 As a fossil-fuelled flexible generation plant with capacity to meet intermittent, peak demands, the proposed development naturally has higher carbon intensity than the projected grid-average (future baseline) or marginal sources in the future under a national scenario of decarbonisation.

4.2.10 However, as discussed in Appendix 14.1, it is relevant to consider more specifically the baseline of other current and future peaking generation sources that could be displaced, particularly in the nearer-term before renewable or other low/zero-carbon supplies might come to constitute the majority of both the grid-average and marginal generation sources. The proposed development would have higher efficiency and hence lower carbon intensity than a baseline of comparable alternative peaking generation sources.

National policy

4.2.11 National energy and climate policy strongly supports decarbonisation of electricity generation through greater deployment of renewable and other low/zero carbon technologies, and acknowledges that this also creates a greater need for flexible generation and energy storage to balance peaks in supply and demand. A limited continued role of gas-fired generation is expected in policy in the near term, potentially extended with use of CCS in the longer term.

4.2.12 Paragraph 2.4.4 of NPS EN-1 states that the planning system should consent "*whatever* [development] *players in the market responding to rules, incentives or signals from Government*" consider to be necessary, provided that the development location is found to be acceptable in planning terms. With regard to climate change 'rules, incentives or signals', this must be balanced against the acknowledged policy and incentive gaps identified by the Committee on Climate Change, discussed in Section 1.3, but nevertheless the direction of travel is clear.

4.2.13 The proposed development would have lower GHG emissions than alternative gas-fired flexible generation, with net emissions that are a reduction (beneficial impact) overall.

Conclusion

4.2.14 Overall, evaluating the magnitude of GHG emissions impact due to the proposed development in the context of the most probable scenario for comparative baseline emissions (especially during initial years of operation) and its role in supporting energy and climate policy goals (which intimate an urgent need for flexible generation to achieve the overall generation mix required), the net impact is considered to be a reduction in GHG emissions and this is a **beneficial** effect that is significant in EIA terms.

Further mitigation or enhancement

4.2.15 CCS, if feasible for the proposed development in future, could offer substantial further GHG emissions reductions, further enhancing the beneficial effect on climate change from that point in the facility's lifetime onwards. Land for CCS is safeguarded on the main development site as required for carbon capture readiness.

Residual effect

4.2.16 The residual effect following further enhancement is predicted to be **beneficial**, which is significant in EIA terms.

Future monitoring

4.2.17 Future monitoring of GHG emissions is expected to be required by the facility's GHG Emissions Permit (for compliance with EU ETS obligations) or equivalent following Brexit.

4.3 Decommissioning phase

Magnitude of impact

4.3.1 Decommissioning phase GHG emissions, considering potential deconstruction activity and recycling at the time, are considered to be *de minimis* as they are estimated to be less than 1% of total operational-phase emissions. Further detail of this estimation is provided in Volume 6, Appendix 14.1: GHG Calculations.

Sensitivity of the receptor

4.3.2 The atmospheric mass of the relevant GHGs and consequent warming potential is considered to be of high vulnerability and limited recoverability. The sensitivity of the receptor is therefore considered to be **high**.

Significance of effect

4.3.3 Overall, it is predicted that the *de minimis* impact on the **high** sensitivity receptor would result in a **negligible** effect, which is not significant in EIA terms.

Further mitigation or enhancement

4.3.4 No significant adverse effects have been predicted and no further mitigation is considered to be required.

Residual effect

4.3.5 The residual effect is predicted to be **negligible**, which is not significant in EIA terms.

Future monitoring

4.3.6 No future monitoring of decommissioning phase GHG emissions is considered to be required.

4.4 Transboundary effects

4.4.1 A screening of transboundary impacts has been carried out and is presented in Volume 5, Appendix 4.2: Transboundary Impacts Screening Note. This screening exercise identified that there was no potential for significant transboundary effects with regard to climate change from Thurrock Flexible Generation Plant upon the interests of other EEA States.

4.5 Inter-related effects

4.5.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of the construction, operation or decommissioning of Thurrock Flexible Generation Plant on the same receptor. The following assessments have been made and a description of the likely inter-related effects on climate change is provided in Volume 4, Chapter 17: Summary of Inter-Related Effects.

Project lifetime effects

4.5.2 Assessment of the potential for effects that occur during more than one stage of the development's lifetime (construction, operation or decommissioning) to interact such that they may create a more significant effect on a receptor than when assessed in isolation for each stage.

Receptor-led effects

4.5.3 Assessment of the potential for effects via multiple environmental or social pathways to interact, spatially and temporally, to create a greater inter-related effect on a receptor than is predicted for each pathway (in its respective topic chapter) individually.

5. Cumulative Effects Assessment

5.1 Introduction

5.1.1 The process of identifying other consented or proposed developments and screening to create a shortlist of those having potential for cumulative effects with Thurrock Flexible Generation Plant is described in Volume 2, Chapter 4: Environmental Impact Assessment Methodology and Volume 5, Appendix 4.1: Cumulative Developments and Screening. Appendix 4.1 lists the shortlisted cumulative developments and the tier they have been assigned (guiding the weight that the decision-maker may place on each development's likelihood of being realised) in accordance with PINS Guidance Note 17.

5.2 Cumulative effects with specific developments

5.2.1 The sensitive receptor affected by the effects of the proposed development is the *'global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in CO_2-equivalents'* and its 'high' sensitivity has been defined taking into consideration the cumulative effects of all anthropogenic GHG emissions.

5.2.2 As GHG impacts are global, all cumulative sources are relevant: this is taken into account in the defined 'high' sensitivity of the receptor and statement that any additional GHG emissions may in principle be considered significant (see Section 2.5).

5.2.3 Cumulative effects due to other specific local development projects are therefore not individually predicted. The net effect of the proposed development, i.e. taking into account changes in GHG emissions from other energy generation sources affected by it, has formed the basis of the impact assessment reported in Section 4.

6. Conclusion and summary

6.1.1 The likely significant effects of greenhouse gas (GHG) emissions from the proposed development on climate change have been assessed in this PEIR chapter, based on the calculation of GHG emissions reported on Volume 6, Appendix 14.1. The global atmospheric mass of relevant GHGs and consequent warming potential, expressed in CO_2-equivalents, has been considered as a high sensitivity receptor affected by the proposed development.

6.1.2 Net total GHG emissions from operation of the proposed development have been calculated based on its expected fuel consumption and energy generation. These have been compared to GHG emissions from the current and future baseline operation of alternative generation sources.

6.1.3 Construction- and decommissioning-stage impacts have been evaluated and are considered not to be material to the total GHG emissions over the proposed development's lifetime, which are dominated by the supply and combustion of its natural gas fuel.

6.1.4 Key uncertainties in the assessment concern future climate and energy policy and market responses, which affect the likely future baseline carbon intensity of energy supplies. Government projections consistent with national carbon budget commitments and a range of scenarios have been considered in the assessment.

6.1.5 The proposed development is predicted to cause the gross emission of up to 38 million tonnes of carbon dioxide equivalent ($MtCO_2e$) over its operating lifetime.

6.1.6 Taking into account GHG emissions reductions from displacement of other gas-fired flexible generators (using different technologies with lower efficiency), plus the benefits of battery storage and of enabled renewable generation, the proposed development is estimated to have net negative GHG emissions (i.e. a net beneficial impact) of between -11 $MtCO_2e$ and -22 $MtCO_2e$.

6.1.7 The predicted GHG emission reductions would be a beneficial effect of the proposed development that is considered significant.

6.1.8 No further mitigation of operational phase GHG emissions has been proposed. The safeguarding of land for carbon capture readiness means that installation of carbon capture and storage technology in future could be feasible, which would further reduce net GHG emissions.

6.1.9 Notwithstanding the non-materiality of construction-stage emissions to the total, good-practice construction stage measures to reduce GHG emissions have been recommended in the CoCP, consistent with IEMA guidance that any GHG emissions (and hence opportunities for reductions) may be significant.

6.1.10 As GHG impacts are global, all cumulative sources are relevant: this is taken into account in the defined 'high' sensitivity of the receptor and the consideration of changes in GHG emissions from other energy generation sources affected by the proposed development (wherever located within the UK). Additional cumulative effects due to other specific local development projects are therefore not individually predicted.

6.2 Next Steps

6.2.1 Following consultation, relevant responses will be considered and this chapter will be updated where appropriate prior to production of the final ES.

Table 6.1: Summary of potential environment effects, mitigation and monitoring.

Description of impact	Measures adopted as part of the project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Construction							
Direct and indirect emission of greenhouse gases	Measures in CoCP to reduce emissions from construction plant and embodied carbon in materials	*De minimis*	High	Negligible (not significant in EIA terms)	Good practice goals to seek a lean design and minimise embodied carbon	Negligible (not significant in EIA terms)	None
Operation and maintenance							
Direct and indirect emission of greenhouse gases	CCR land ORC system	-11 $MtCO_2e$ to -22 $MtCO_2e$ (net)	High	Beneficial (significant in EIA terms)	Possible future use of CCS	Beneficial (significant in EIA terms)	Required by GHG Emissions Permit
Decommissioning							
Direct and indirect emission of greenhouse gases	n/a	*De minimis*	High	Negligible (not significant in EIA terms)	None proposed	Negligible (not significant in EIA terms)	None

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