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CLIMATE EMERGENCY SCIENCE LAW

Deadline D6 : 29th May 2026

Climate Change

EN0100166 Connah's Quay Low Carbon Power

Contents

Tables and Figures

D6 / Section A   Introduction

1 Climate Emergency Science Law (CESL), established in 2017 by Dr Andrew Boswell, brings together multidisciplinary expertise in science, computing, energy and climate governance, and evidence-based legal and policy analysis to deliver rigorous, scientifically grounded scrutiny of UK climate decision-making. A resume of my professional background was provided at Section F of my D1 Written Representation (D1 Part A submission, [REP1-077]).

2 This submission (deadline D6 submissions) provides:

- A response to the ExQ2 Q18.2 in section B;
- Short preview of CESL's indicative sensitivity analysis is provided in section C, with the full analysis given in the Appendices;
- Evidential updates at section D;
- Comments on the applicant's sensitivity analysis [REP5-063] at section E;
- A notification of a further issue at section F;
- CESL's indicative full lifecycle sensitivity test is provided at Appendix A, B and C

3 I have used AI to assist with drafting and refining the textual content of submissions to the examination for clarity and presentation. Following the recent update to the PINS guidelines, a full statement[1] on the use of AI is provided at Section I of [REP5-072].

4 This submission has <u>three</u> in-document appendices. In addition, <u>three</u> full documents have been submitted to the examination library, as noted in the footnote[2].

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[1] In accordance with PINS guidance on "Use of artificial intelligence in casework evidence", 6 September 2024, <u>as updated 20 February 2026</u>

[2] Appendices provided as full documents for the examination library:

(1) Climate Change Committee, Seventh Carbon Budget, 2025

(2) DESNZ, Carbon Budget and Growth Delivery Plan, 2025

(3) Energy and Environmental Research Associates, Well-to-Tank Carbon Intensity of European LNG Imports, 2024

D6 / Section B Response to ExQ2

> ***ExA Question EXQ2 18.2 (Upstream Emissions):*** *Please clarify succinctly which requirement(s) of Regulation 5(2) of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 you contend have not been met, and explain why, in your view, the matters raised amount to a legal deficiency in the Environmental Statement rather than a disagreement with the Applicant's exercise of professional judgement.*

B.1 Introduction

5 CESL's submissions on upstream emissions span the full examination. They are set out in the Written Representation [REP1-077], the D3 submission [REP3-085], the Legal Submissions [REP4-092], the D5 submission [REP5-072], and the D6 submission (i.e. the remaining sections of this submission). CESL is grateful for the opportunity to address the ExA's question directly.

6 The question has two limbs: (a) which specific requirements of Reg 5(2) of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 ("the EIA Regulations") have not been met; and (b) why the matters raised amount to a legal deficiency of the ES rather than a disagreement with the Applicant's exercise of professional judgment. Each limb is addressed in turn.

B.2 The Applicable Legal Framework

7 The applicable statutory provisions are as follows.

8 **Regulation 5(2)** requires that the EIA process must identify, describe and assess the direct and indirect significant effects of the development on, amongst other things, the climate. The EIA must do so "in an appropriate manner": [REP4-092], para 8.

9 **Regulation 14(3)(b)** requires the Environmental Statement ("ES") to take into account "current knowledge and methods of assessment": [REP4-092], para 9. The ES must describe the likely significant effects of the project.

10 **Schedule 4, paragraph 5** requires the description to include "the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions)", the "technologies and the substances used", and "short-term, medium-term and long-term" effects: [REP4-092], para 10.

11 **Schedule 4, paragraph 6** requires the description of the "forecasting methods or evidence, used to identify and assess the significant effects on the environment, including details of difficulties (for example technical deficiencies or lack of knowledge) encountered compiling the required information and the main uncertainties involved": [REP4-092], para 10.

12 **Regulation 30(2)(b)(i)(aa)** requires the Decision to include a "reasoned conclusion" on the significant effects of the development on the environment, taking into account the results of the Examination: [REP4-092], para 14.

13 Additionally, the Rochdale Envelope principle — confirmed in *R. v Rochdale M.B.C. exp Milne (no 1)* [2000] Env. L.R. 1 — requires that the ES must assess the reasonable worst-case environmental effects that could arise from the development, so that the decision-maker has "full knowledge" of its likely significant effects: [REP4-092], para 11. PINS Advice Note Nine confirms this principle is not confined to spatial parameters but extends to quantified environmental parameters such as GHG emission inputs that bound the scale of assessed impact.

14 In *R (Finch) v Surrey CC* [2024] UKSC 20, Lord Leggatt confirmed that the EIA obligation extends to all likely significant indirect effects that are a reasonably foreseeable consequence of the project. While conjecture and speculation have no place in the EIA process, where an effect is "likely", its identification, description and assessment are obligatory: [REP4-092], para 12.

15 In *R (Whitehaven Town Council) v Secretary of State* [2024] EWHC 2349 (Admin), Holgate J held that where GHG emissions from a project are a likely significant indirect effect, the ES is required to assess those emissions. Substitution and displacement arguments are irrelevant to whether that obligation arises: [REP5-072], Section F.8(A).

B.3 The Reg 5(2) Requirements CESL Contends Have Not Been Met

16 CESL contends that the ES fails to meet the requirements of Reg 5(2), read with Schedule 4 paragraphs 5 and 6 and Reg 30(2)(b)(i)(aa), in three distinct and cumulative respects, each of which is addressed below.

B.3.1 Deficiency 1: Failure to describe and assess ex-territorial upstream Scope 3 emissions [Reg 5(2) / Sch 4 para 5 / Reg 30(2)(b)(i)(aa)]

12. The ES identifies the global climate as the environmental receptor for GHG assessment: [APP-058], para 20.3.9. It acknowledges that upstream well-to-tank (WTT) supply chain emissions constitute approximately 63.4% of the assessed operational lifecycle emissions: [REP4-092], para 3. CESL's own parameter isolation ladder analysis in [REP5-072] and [D6, Appendix B in this submission] demonstrates that, under realistic supply conditions, upstream emissions constitute an even larger share of the full lifecycle total.

13. Of those upstream emissions, the dominant component consists of ex-territorial emissions — methane and CO_2 arising outside UK territory in the gas supply chains. UK carbon budgets are set under Climate Change Act 2008 ("CCA 2008") s.89 on a strict territorial basis. They do not include overseas methane from imported gas supply chains. This is confirmed by the CCC's Seventh Carbon Budget: "*our Balanced Pathway covers territorial UK emissions, as required under the Climate Change Act*": [REP5-072], Section E.1(A).

14. Despite this, the ES benchmarks the totality of lifecycle emissions — including ex-territorial upstream Scope 3 emissions — against UK carbon budgets as the primary basis for its significance conclusion: [APP-058], paras 20.6.53–20.6.68. The Applicant's own D5 sensitivity analysis [REP5-063] expressly concedes that ex-territorial upstream emissions "*would also occur beyond the geographic boundaries of the UK or of Wales, and would similarly not be reported within the carbon budgets*" (para 1.5.5).

15. The ES provides no description of the ex-territorial emission component separately from the UK territorial component, no methodology for assessing the significance of ex-territorial upstream emissions, and no significance conclusion in respect of that component. It then simultaneously uses a benchmark (UK carbon budgets) that, by the Applicant's own concession, is structurally incapable of measuring the dominant emission category. CESL first identified this issue in [REP1-077] and has developed it in detail in [REP3-085, Section B; REP5-072, Sections E.1–E.5; section B.3.1 of this submission].

16. The consequence, as CESL submitted at [REP5-072], Section E.2, is that "*a fundamental issue which remains for the applicant is how to assess the ex-UK territorial upstream emissions which are by far the largest part of the operational lifecycle emissions*". Without a methodology capable of reaching a significance conclusion for the ex-territorial component, the SoS is unable to reach a Reg 30(2)(b)(i)(aa) "reasoned conclusion" on the material majority of the project's lifecycle climate impacts.

17. This failure is compounded by the para 20.6.54 [APP-058] assertion that post-2050 residual emissions will be "balanced" via agriculture and LULUCF removals. A later section of this D6 submission demonstrates this to be directly contrary to the CCC's Seventh Carbon Budget and the Government's own Carbon Budget and Growth Delivery Plan: those land-based sinks are already fully committed to offsetting the agriculture sector's own residual emissions, and engineered removals are pre-allocated to hard-to-abate sectors on a polluter-pays principle. The electricity supply sector, which the 7CB projects reaching (very close to) near-zero by 2050, is not a hard-to-abate sector for those purposes. The para 20.6.54 claim has no evidential foundation in either document and actively misleads the decision-maker.

B.3.2 Deficiency 2: Failure to assess absolute lifecycle GHG emissions [Reg 5(2) / Sch 4 para 5 / Whitehaven]

17 The primary assessment methodology in the ES is a substitution/displacement comparison with a counterfactual unabated CCGT, not an assessment of the project's absolute lifecycle GHG emissions. This approach is used as the principal basis for the significance conclusion at paras 20.6.42–20.6.68 [APP-058].

18 In *Whitehaven* [2024] EWHC 2349, Holgate J was unequivocal (para 101): the GHG emissions from the project are "*significant likely indirect effects*" and accordingly "*the EIA process to assess those emissions and their implications*" was mandatory. The court explicitly held that substitution and displacement arguments are irrelevant to whether this obligation arises. <u>The Applicant is obliged to assess the absolute GHG emissions of the project regardless of whether those emissions might (counterfactually) be higher or lower than a displaced alternative.</u>

19 The OPRED Supplementary Guidance on Scope 3 Emissions (June 2025) — which applies the same EIA Directive principles as the 2017 Regulations — requires that "*these downstream emissions from a new project will be presented in the ES against a no project ('do nothing') scenario (i.e. total quantity of scope 3 category 11 emissions from the project against zero scope 3 category 11 emissions for a no project scenario). Taking this approach confirms the absolute downstream emissions*". The same principle applies, by direct analogy, to upstream supply chain

emissions. The OPRED guidance further states: "*Substitution is not considered to be a factor affecting whether scope 3 emissions from a project's downstream activities are an effect that needs to be assessed in the ES*": [REP5-072], Section E.5(B).

20 Although the ES does contain a table of absolute emissions [APP-058, Table 20-8], this table does not constitute an assessment of absolute lifecycle GHG emissions for the purposes of Reg 5(2)/Sch 4 para 5, because: (a) the absolute emissions figure in Table 20-8 is not the object of significance assessment in its own right — it is deployed as an input to a benchmark comparison against UK territorial carbon budgets (para 20.6.68), which is itself structurally incapable of measuring the dominant ex-territorial emission component for the reasons set out at section B.3.1 above; the substitution analysis at paras 20.6.42–20.6.67, which is foregrounded throughout, actively displaces rather than supplements the absolute assessment obligation; (b) it does not separately identify UK and ex-territorial emission components; (c) it relies on the structurally deficient WTT methodology addressed at Section B.3.3 below; and (d) the Applicant's D5 sensitivity analysis [REP5-063] repeats the substitution methodology rather than remedying it. These issues are addressed in detail at [REP5-072, Section F; this submission].

B.3.3 Deficiency 3: Failure to describe material uncertainty and apply current knowledge in the assessment of LNG supply-chain emissions [Reg 5(2) / Sch 4 paras 5 and 6 / Reg 14(3)(b)]

21 The central issue raised by CESL is not that the Applicant selected a particular emissions factor. The issue is that the ES does not identify, describe or assess the material uncertainties associated with the WTT methodology on which the lifecycle emissions assessment depends, despite those uncertainties being directly relevant to the magnitude of the project's likely significant climate effects.

22 The ES uses a single DESNZ WTT emission factor for all upstream gas supply chain emissions, applied as a fixed ratio (0.165) to Scope 1 combustion emissions: [APP-058], para 20.6.23; [REP1-077], Section B. CESL's Government EIR response [EIR2026/02883], obtained and submitted to the examination at [REP5-072], Section B, established the following structural features of that factor:

(a) The upstream LNG intensity data is derived entirely from the Exergia (2015) study, based on data from the mid-2010s: [REP5-072], Section B.2; [REP3-085], Section B.3(A).

(b) All UK LNG imports are assigned the Qatar LNG intensity pathway from Exergia. Exergia's 2015 data contained no US LNG factor at all — the US was a net LNG importer in 2015: [REP5-072], Section B.2(B); [Section E.5 (emission intensity data) in this submission].

(c) The supply share weightings are frozen at 2021 DUKES data. The EIR response confirms that the 2023, 2024 and 2025 conversion factor publications all use the same 2021 supply data: [REP5-072], Section B.2(A); [See Table 1 in this submission].

(d) DESNZ has not updated the underlying supply share data for several years, as confirmed by the EIR response: [REP5-072], Section B.2(C).

23 The factual context in which these structural features must be assessed is: in 2025, 76% of UK LNG imports by volume originated from the United States [DESNZ Energy Trends, April

2026; REP5-072, Section B.1]. US LNG, derived from shale and fracked gas, carries materially higher upstream methane intensity than Qatari conventional gas. This is established by the EERA/T&E systematic review (2024) — which aggregated nearly 800 emission factors from 55 literature sources including 47 US-specific studies — and by the peer-reviewed Howarth (2024) study: [EERA is provided as stand-alone appendix to this submission, and discussed in the next section; REP1-077, Appendix C]. NESO's Future Energy Scenarios 2025 ("FES 2025") project that UK dependence on imported LNG will increase substantially over the period to 2050, the projected operational lifetime of CQLCP: [REP3-085], Section B.1.

24 The consequence is that the ES does not disclose or assess the extent to which the resulting lifecycle emissions estimate depends upon assumptions derived from historic LNG supply conditions and historic LNG intensity data. CESL submits that this omission is inconsistent with Regulation 14(3)(b) and Schedule 4 paragraph 6, which require the ES to take account of current knowledge and to describe the principal uncertainties affecting the assessment.

25 The Applicant's sensitivity analysis tests variation in LNG share but not variation in LNG emissions intensity. It therefore does not address the uncertainty identified by CESL. The analysis demonstrates sensitivity to one input parameter while holding the principal source of uncertainty constant. As a consequence, it does not enable the decision-maker to understand the range of lifecycle emissions outcomes that could arise from differing LNG supply-chain intensities.

26 Schedule 4, paragraph 6 requires disclosure of "the main uncertainties involved" in the assessment methodology. The ES neither acknowledges the structural limitations of the DESNZ WTT factor identified above, nor discloses the consequential uncertainty in the lifecycle emissions outcome. This compounds the Reg 5(2)/Sch 4 para 5 failure: even if the methodology were adequate, the obligation to describe its material uncertainties under Sch 4 para 6 would remain unsatisfied: [REP5-072], Section H.1(C); [REP4-092], para 25(b)(ii).

27 CESL's case is not that the Applicant should have adopted CESL's preferred LNG emissions factor; it is that the ES fails to identify, describe and assess the material uncertainty associated with LNG supply-chain emissions despite that uncertainty being capable of materially affecting the magnitude of the project's lifecycle greenhouse gas emissions.

B.4 Why These Deficiencies Are Legal Failures and Not Disagreements About Professional Judgment

28 The Applicant's legal response [REP5-066] characterises CESL's submissions as a challenge to the Applicant's exercise of professional judgment, deploying the evaluative judgment framework derived from *Blewett*, *Finch*, *LADACAN*, and *Bristol*. CESL addresses the legal/judgment distinction directly below in respect of each of the three deficiencies.

B.4.1 Deficiency 1 (territorial mismatch) is not a judgment matter

29 The evaluative judgment principle as stated by the Court of Appeal in *Boswell CA* [2025] EWCA Civ 669, paras 80–81, is that the significance of an estimated amount of GHG emissions and the choice of benchmark are matters of judgment for the decision-maker. That principle presupposes that there is a body of environmental information on which a judgment can be formed.

30 Deficiency 1 arises not from CESL's disagreement with a judgment the Applicant has made, but from the Applicant's own concession that the dominant emission category — ex-

territorial upstream Scope 3 emissions — lies entirely outside the benchmark against which significance has been assessed. The Applicant acknowledges in [REP5-063], para 1.5.5 that those emissions fall outside UK and Welsh carbon budgets. There is therefore no significance assessment of that category of effect at all: the Applicant provides no methodology for assessing it, reaches no conclusion on it, and presents no evidence on which the SoS could reach a Reg 30(2)(b)(i)(aa) reasoned conclusion in respect of it.

31 The "evaluative judgment" umbrella requires that there be a judgment to evaluate. An absence of assessment of a category of effect is not an exercise of judgment capable of attracting that protection — it is a gap in the environmental information that precludes the decision-maker from forming any judgment, however wide that judgment may be. The Applicant's own concession establishes the gap. CESL does not need to prove that a different methodological choice would have been better: it is sufficient that the Applicant itself acknowledges the dominant emission component cannot be assessed against the chosen benchmark.

B.4.2 Deficiency 2 (absence of absolute assessment) is not a judgment matter

32 The obligation to assess absolute GHG emissions is established by *Whitehaven* as a mandatory legal requirement, not a methodological preference. Holgate J held that substitution and displacement arguments are irrelevant to whether the obligation arises. The choice between assessing absolute emissions and assessing net savings against a counterfactual is not a matter of professional judgment operating within a legally permissible range — one of those choices discharges the Reg 5(2) obligation and the other does not.

33 This is not analogous to the Blewett principle that an ES need not be perfect or optimally comprehensive. The point is not that the Applicant has assessed absolute emissions imperfectly. The ES structure foregrounds substitution analysis across twenty-five paragraphs (paras 20.6.42–20.6.67 [APP-058]) before arriving, at para 20.6.68, at a single-paragraph comparison of the absolute figure against UK carbon budget headroom. That comparison does not constitute a lawful absolute significance assessment for the reasons set out in section B.3.1 above: it benchmarks a figure that includes ex-territorial upstream emissions against a territorial-only metric, producing a result the Applicant itself acknowledges cannot measure the dominant emission component. Whether the significance conclusion is understood to rest on the substitution analysis, on the carbon budget benchmark, or on both in combination, it does not rest on an assessment of the project's absolute effects that is capable of supporting a Reg 30(2)(b)(i)(aa) reasoned conclusion. The Applicant may also provide substitution analysis as a planning balance consideration, but that cannot substitute for, or cure, the underlying failure.

B.4.3 Deficiency 3 (uncertainty and current knowledge) is not a judgment matter

34 CESL accepts that the selection of an emission factor methodology is ordinarily a matter for the developer's professional assessment, subject to the general Wednesbury standard. However, the professional judgment principle has purchase only where the developer is making a choice between reasonable methodological approaches applied to genuine uncertainty. It does not have purchase where the chosen methodology:

(a) is applied to a factual position that has demonstrably changed since the methodology was developed — here, the shift to US LNG-dominated supply that is not captured in any of the DESNZ factor's underlying data;

(b) is known to be no longer being updated by the issuing government department, as the EIR response confirms; and

(c) produces results the ES does not disclose to be uncertain, when Reg 14(3)(b) requires the ES to take account of current knowledge, and Sch 4 para 6 requires disclosure of the main uncertainties.

35 Reg 14(3)(b) imposes a positive obligation to take account of "current knowledge and methods of assessment". Application of an outdated factor which the government issuing body has ceased to update, whose underlying intensity data dates from 2015, and which assigns a single Qatari intensity to what are now predominantly US LNG imports, cannot satisfy that obligation. This is not a case where a developer has chosen between two reasonable and current methodologies. The EIR evidence demonstrates that the chosen methodology was not capable, even at the time of application, of describing upstream LNG emissions under then-current supply conditions — still less under projected 2035–2065 conditions.

36 The Applicant's sensitivity analysis [REP5-063] does not remedy this deficiency for the reason identified in Deficiency 3 above: it tests supply share sensitivity but not emissions intensity sensitivity. A sensitivity analysis that holds the central contested input constant while varying a peripheral parameter does not demonstrate methodological robustness. It demonstrates, at most, that the assessment is internally consistent with its own assumptions — which is not the same as demonstrating that those assumptions are adequate.

B.5 The Cumulative Position

37 The three deficiencies identified above are cumulative and mutually reinforcing. Taken together, they produce the following position: the dominant emission category (ex-territorial upstream Scope 3 emissions) is unassessed; the significance conclusion rests on a substitution methodology that cannot discharge the Reg 5(2) duty to assess absolute effects, or to the extent the absolute emissions are assessed, the largest component of ex-territorial emissions are assessed against UK carbon budgets; and the emission intensity data underpinning even the incomplete assessment that has been provided is structurally incapable of representing current and projected supply conditions under Reg 14(3)(b).

38 As a consequence, the SoS cannot reach a lawful Reg 30(2)(b)(i)(aa) "reasoned conclusion" on the significant effects of the project on the climate: [REP5-072], Sections E.3, E.5(C), H.1(C), H.1(E); [REP4-092], para 14. The deficiencies are not cured by the Applicant's sensitivity analysis, which, as CESL demonstrates later in this submission, reproduces all three structural flaws of the original assessment.

39 CESL accordingly invites the ExA to conclude that the ES, as currently constituted (including as supplemented by [REP5-063]), fails to meet the requirements of Reg 5(2) read with Sch 4 paras 5 and 6 and Reg 30(2)(b)(i)(aa), and that those failures constitute legal deficiencies of the ES, not matters of evaluative judgment within the Applicant's protected range of discretion.

B.6 CESL's Remedy

40 CESL's primary remedy request, carried across all examination submissions from [REP1-077] onwards, is that the Applicant be required to provide, as a minimum:

(a) A full lifecycle sensitivity analysis using realistic and current upstream LNG emission intensity data, with separate identification of UK territorial and ex-UK territorial emission components;

(b) An absolute emissions assessment (against a no-project baseline) as the primary basis for the significance conclusion, incorporating the sensitivity range generated under (a); and

(c) A methodology for assessing the significance of the ex-territorial upstream Scope 3 emission component, which must be consistent with the global climate receptor identified in [APP-058], para 20.3.9.

41 CESL's own indicative parameter isolation ladder sensitivity analysis in the Appendices to this submission demonstrates what such an analysis would show: a lower-bound full lifecycle range of 58–121 $MtCO_2e$ and an upper-bound range of 232–331 $MtCO_2e$, with ex-UK territorial emissions constituting the dominant share at all scenario levels and remaining entirely unassessed in the application.

D6 / Section C   Short preview of CESL indicative sensitivity analysis

42 CESL has provided in the Appendices an indicative sensitivity analysis which is designed to provide a demonstrator of resolving the Regulation 5(2) issues in the application (as described above in response to Q18.2. The sensitivity analysis method is a parameter isolation ladder ("PIL"), and it:

- Identifies and describes the full lifecycle emissions, and also four component constituents: the CH4 share, the CO2 share, the UK share, the ex-UK share. This provides a robust computational framework which overcomes Deficiency 1 above (the failure to describe and assess ex-territorial upstream Scope 3 emissions). The ex-UK emissions may be assessed in their own right via an appropriate significance methodology [see REP5-072, section E.5].

- The PIL framework deals entirely in absolute emissions, including the key outputs - full lifecycle emissions, and also four component constituents: the CH4 share, the CO2 share, the UK share, the ex-UK share. This overcomes Deficiency 2 above "Failure to assess absolute lifecycle GHG emissions".

- The PIL identifies 3 lower bound scenarios with these ranges: 58 - 121 MtCO2e (full lifecycle), comprised of 24 – 30 MtCO2e UK share emissions, and 31 - 91 MtCO2e ex-UK share emissions). And 4 upper bound scenarios with these ranges: 232 - 331 MtCO2e (full lifecycle), comprised of 27 – 68 MtCO2e UK emissions, and 202 - 303 MtCO2e ex-UK emissions. The methodology uses future gas supply data from the government owned NESO, and both peer reviewed science and a recent literature review of over 800 LNG emission factors (from EERA as described in section D). This overcomes Deficiency 3 above "Failure to describe material uncertainty and apply current knowledge in the assessment of LNG supply-chain emissions".

43 Whilst the PIL is indicative and not intended as a substitute EIA, it provides solutions to the issues which CESL has raised throughout the examination. It shows that determining the uncertainty ranges, and full knowledge of the project's lower and upper bound impacts is entirely feasible. Such knowledge is required for the decision maker to make a reasoned conclusion of the environmental impacts under Regulation 30(2)(b)(i)(aa).

D6 / Section D Evidential updates: Recent systematic review of LNG emission factors

D.1 Energy and Environmental Research Associates, Well-to-Tank Carbon Intensity of European LNG Imports, 2024

44 The EERA/T&E report (Well-to-Tank Carbon Intensity of European LNG Imports, Energy and Environmental Research Associates, LLC, August 2024), the "EERA report", is provided as a stand-alone appendix. It is a systematic review and quantitative aggregation of nearly 800 greenhouse gas emission factors drawn from peer-reviewed, government, and industry literature, reporting well-to-tank (WtT) carbon intensity estimates in gCO_2e/MJ for the LNG and natural gas supply chains of eight countries supplying the European Union — Algeria, Nigeria, Norway, Qatar, Russia, Trinidad and Tobago, the United Kingdom, and the United States — across AR4, AR5, and AR6 GWP frameworks and for both GWP100 and GWP20 timescales.

45 EERA is substantially more current and comprehensive than the Exergia (2015) study that underpins the DESNZ WTT factor. While the Exergia report was based on data from a single EU-commissioned study drawing on supply chain data from the mid-2010s — with LNG supply shares and source intensities that predate the structural shift toward US LNG imports into Europe — the EERA/T&E report synthesises nearly 800 emission factors drawn from 55 literature sources published up to 2024, covering eight LNG-supplying countries including the United States, and presents results under the AR4, AR5, and AR6 IPCC assessment frameworks.

46 The report was commissioned by Transport + Environment, a Brussels-based organisation with a direct engagement role in EU energy and shipping policy. Its policy relevance extends beyond EU shipping: the EERA methodology was subsequently deployed in a formal submission to the IMO's Intersessional Working Group on GHG Emissions from Ships (ISWG-GHG 20, document ISWG-GHG 20-3-9, submitted by the Clean Shipping Coalition), in which EERA conducted a further literature review — applying the same methodology as the original FuelEU WtT LNG study — to inform the development of new default LNG WtT emission factors under the IMO's LCA Guidelines framework.

47 T&E's own November 2024 briefing based directly on the EERA report explicitly called on the IMO's GESAMP group — the body responsible for developing default emission factors for shipping fuels — to set realistic LNG WtT emissions values grounded in that review. A further IMO submission at MEPC 83 (document MEPC 83-7-28) built directly on the EERA methodology to propose a conservative global default WtT factor of 27.95 gCO_2eq/MJ (the 75th percentile of global values) to govern LNG compliance under the IMO Net-Zero Framework. The EERA/T&E study has become the evidential foundation being deployed at the international regulatory level precisely to replace the outdated source intensity data embedded in frameworks equivalent to the DESNZ WTT factor.

D.1.1 UK Government support

48 The UK actively supported the IMO Net-Zero Framework and the GESAMP process at MEPC 83, and that process is itself deploying the EERA methodology as the basis for updating LNG WtT default emission factors. The UK's support for the IMO process is consistent with the regulatory relevance of updated LNG WtT evidence in the EERA report[3].

[3] https://www.hilldickinson.com/our-view/articles/the-uks-maritime-decarbonisation-strategy-and-mepc-83-impacts-on-the-marine-cargo-industry/

D6 / Section E ***The applicant's sensitivity analysis***

49 The applicant has submitted a "Natural gas supply chain and Greenhouse Gas emissions reporting sensitivity analysis" [REP5-063].

50 This document does not assist the applicant in meeting the requirements of Regulation 5(2) of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. In many ways, it does not add anything to the original application [APP-058], and CESL now lays out why.

E.1 Territorial vs ex-territorial emissions not addressed

51 In [REP5-072], CESL laid out why UK and ex-UK emissions need to identified, described, and assessed differently. See especially [REP5-072, section E.5 (B) "OPRED – principles of Scope 3 emission assessment"].

52 The applicant's sensitivity analysis gets no closer to resolving this issue than the original application [APP-058]. The original application compares all the operational emissions against UK (and Welsh) carbon budgets although it is clearly known that a large proportion of the emissions fall outside the UK. I addressed this flaw in the applicant's EIA [REP5-072, section E.2] concluding *"a fundamental issue which remains for the applicant is how assess the ex-UK territorial upstream emissions which are by far the largest part of the operational lifecycle emissions".*

53 [REP5-063] does acknowledges that the increased upstream supply chain emissions in the LNG scenarios "*would also occur beyond the geographic boundaries of the UK or of Wales, and would similarly not be reported within the carbon budgets*." Those numbers are, by the applicant's own acknowledgment, incapable of being evaluated against the benchmark on which the significance conclusion in the original ES rests.

54 This is a key methodological issue: the data in the applicant's sensitivity test is incapable of supporting a lawful significance conclusion because the dominant emission component (ex-territorial upstream Scope 3[4]) cannot be validly assessed against UK and Welsh carbon budgets. The applicant's sensitivity test [REP5-063] offers no analysis, no corrected methodology, and no alternative approach to significance assessment. It concedes the issues but then simply repeats the original ES position.

55 [REP5-063] para 1.5.5 then states that ex-territorial emissions "*will not affect the ability of UK or Welsh Ministers to meet their legal obligations*". This may be a truism, but it does not help address how to assess and reach a reasoned conclusion on the largest impact in the EIA description. [REP5-063] para 1.5.5 and [APP-058] para 20.3.9 accept the global climate impact is the identified receptor for EIA purposes. The sensitivity test thereby simultaneously identifies the global climate as the receptor *and* frames the significance question exclusively by reference to UK domestic carbon budget compliance. This is incoherent as already identified in [REP5-072, Section E.2] for the original application.

56 The applicant's argument in their legal response [REP5-066, para 59) — that the sensitivity testing means the 'criticisms' "*do not go anywhere as a matter of fact*" — fails on this point alone (although it fails on each of the other issues raised below in this section too). The sensitivity test does not address the territorial issue at all.

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[4] which the applicant itself describes as 63.4% of the emissions, and which rises over 90% in CESL's previous sensitivity test [REP5-072, Table 1].

57 This is not an 'academic' point. The structural flaw in the applicant's assessment methodology precludes a reasoned conclusion by the decision maker of the materially largest impact in the EIA. The sensitivity test has neither engaged with nor attempted to remedy this situation.

E.2 The Sensitivity Analysis uses a fictitious unabated CCGT as 'Counterfactual'

58 This is fundamentally a substitution approach. Substitution may be a contextual or planning-balance consideration, but it cannot substitute for the primary EIA task of identifying, describing and assessing the project's own absolute likely significant effects. This was laid out in [REP5-072] in detail, for example, in section F.8 "Legal issues for substitution" on the Whitehaven case, and section E.5 (B) on the principles of Scope 3 emissions assessment from the recent OPRED guidance.

59 OPRED requires, as per [REP5-072], "*the use of a baseline scenario which includes the 'do nothing' or 'no action' scenario and clearly state the additional total GHG emissions arising from the proposed project, including scope 3 emissions*". Page 7 of OPRED requires, for downstream emissions, "*substitution is not considered to be a factor affecting whether scope 3 emissions from a project's downstream activities are an effect that needs to be assessed in the ES".*

E.2.1 The CCS Energy Penalty Is Absent from the Counterfactual Calculation

60 Whilst, in any case, the substitution method does not meet legal requirements, a methodological issue with it is that like the carbon intensity based substitution analysis at paras 20.6.42 – 20.6.47 [APP-058] of the original application, the sensitivity analysis does not disclose the CCS energy penalty in applying the substitution method.

61 The CQLCP plant consumes more fuel per MWh output when the CCS plant is running than it would unabated. As CESL showed in [REP5-072, Section F.6(A)], the CCS energy penalty amounts to 7.23% of net electrical efficiency. Not enumerating the emissions associated with this energy penalty leads to a significant material underreporting within the EIA. The quantum of the emissions can be seen on REP5-072, Figure 4 for the substitution exercise carried out in original application (see also section F.5(A) and Table 4).

62 The applicant's sensitivity test assumes a counterfactual unabated CCGT at 52% thermal efficiency [REP5-063, para.1.2.21]. CESL has derived from the applicant's own ES data that the CQLCP plant's implied unabated efficiency is 57.26% and abated efficiency is 50.03% ([REP5-072, Section F.6(A)]. A like-for-like comparison requires the plant-specific figure, not a generic industry assumption.

63 The CCS energy penalty means the abated plant burns 14.5% more fuel per MWh than it would unabated (50.03% vs 57.26% efficiency). This generates correspondingly higher upstream WTT emissions on the project side per MWh of net output — emissions which cannot be captured. This is not corrected anywhere in the sensitivity test, and is not disclosed as a consequence of operating the CCS system.

64 The arguments relating to the energy penalty from [REP5-072, Section F] apply in full to the sensitivity analysis as it has not attempted to correct them. They are not repeated further here.

E.3 The Analysis does not present full lifecycle absolute emissions

65 The recent OPRED guidance requires, for downstream emissions, that absolute emissions should be presented (without substitution): "*OPRED expects that these downstream emissions from a new project will be presented in the ES against a no project ('do nothing') scenario (i.e. total quantity of scope 3 category 11 emissions from the project against zero scope 3 category 11 emissions for a no project scenario). Taking this approach confirms the absolute downstream emissions that may be associated with the combustion of the produced hydrocarbons over the lifetime of the project*" By analogy — and applying the same OPRED principles that derive from the EIA Directive itself — the same approach should apply to upstream supply chain emissions.

66 Whilst the applicant's sensitivity analysis generates total hourly emissions, it merely uses those figures to generate emissions intensities as part of its substitution methodology. It doesn't at any point calculate the full lifecycle emissions (of all types, and including phases like construction and decommissioning), or UK and ex-UK full lifecycle emissions.

67 In Whitehaven Holgate, J, made the EIA obligation to assess absolute emissions absolutely clear[5]. The absolute GHG emissions from the project must be assessed as likely significant indirect effects — substitution/displacement arguments are entirely irrelevant to whether this obligation arises [REP5-072, section F.8 (A)].

68 The applicant's sensitivity test does not meet this threshold, so provides no additional information that assists with the assessment step. This is the same as for the carbon intensity based substitution analysis at paras 20.6.42 – 20.6.47 [APP-058] in the original application, and fails for the same reason as laid out at [REP5-072, section F].

E.4 Static and dynamic aspects of LNG market supply not engaged

69 CESL has laid out the static and dynamic aspects of LNG market supply based on institutional research and analysis by the Government's own NESO, OIES and National Gas [REP3-085, section B]. NESO's 2025 Gas Supply Security Assessment (GSSA) document particularly explored marginal supply sources during peak demand conditions – the conditions under which CQLCP would operate in dispatchable mode. Additional gas demand during such periods is drawn from the flexible import tranche, including the LNG-dominated Group 3 sources [REP3-085, paragraph 49]. I repeat for emphasise REP3-085, paragraph 57:

> "*Thus, within the modelled UK gas supply architecture described by National Gas, NESO and GSSA, it is reasonably foreseeable that marginal system supply — during periods in which dispatchable plant operates — will draw from the flexible import layer, of which LNG is a principal component. As established above, the EIA duty requires that foreseeable variability in the upstream intensity of that supply to be tested, not merely that its annual average share be identified."*

70 The applicant's analysis has not taken this on board. Rather, the applicant claims at REP5-063, paragraph 1.2.6 that it does not consider its 60% and 100% LNG scenarios "realistic or reasonable". Given that this is the applicant's view, it is not clear why it then continued with

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[5] Whitehaven [101] "*Taking into account the common ground that the burning of the Whitehaven coal is an inevitable consequence of its extraction from the mine, in my judgment it is plain, following the decision of the Supreme Court in Finch, that the GHG emissions from that combustion are significant likely indirect effects of the project the subject of the planning application. Accordingly, the 2011 Regulations required WCM's ES and the EIA process to assess those emissions and their implications. The Secretary of State was obliged to take into account that environmental information (including the GHG emissions from combustion of the Whitehaven coal) before deciding whether or not to grant planning permission on the application.*"

its analysis. The applicant characterises these scenarios as unreasonable, then proceeds to calculate them — without explaining how a scenario it deems unreasonable can serve as a useful test of the assessment's robustness. However, these choices of LNG shares are not unreasonable given the dynamic nature of the LNG market, especially under supply stress as evident from the esteemed work of NESO and OIES. The flaw in the applicant's analysis lie in the other issues being raised in this section.

E.5 Emission intensity data

71 To model "60% LNG" and "100% LNG" case, the applicant uses the DESNZ WTT factors. The DESNZ FoI response [REP5-072, section B] has already demonstrated that:

- The upstream LNG emissions are derived from Exergia (2015);
- All UK LNG imports are represented using the Qatar LNG pathway because Exergia only provides a Qatar LNG factor. The Qatar LNG factor is significantly lower than US LNG which is now the predominant LNG import stream to the UK. Qatar have also faced criticism for underreporting its LNG emissions[6].
- The supply shares are frozen at historic values. The DUKES year used for 2023, 2024 and 2025 conversion factors is the same (whilst 2022 DUKES use 2021 DUKES data). This can be seen in the Table below (an update to REP3-085, Table 2].

DESNZ Year	Natural Gas WTT ($kgCO_2e$/kWh Net CV)	Natural Gas WTT ($kgCO_2e$/GJ, Net CV)	LNG WTT ($kgCO_2e$/kWh Net CV)	LNG WTT ($kgCO_2e$/GJ, Net CV)	DUKES Year	Source basis
2021	0.03474	9.65	0.07055	19.597	2019	Exergia (2015) weighted UK mix
2022	0.03446	9.57	0.07055	19.597	2020	Exergia (2015) weighted UK mix
2023	0.03347	9.30	0.07214	20.039	2021	Exergia (2015) weighted UK mix
2024	0.03347	9.30	0.07214	20.039	2021	FoI
2025	0.03347	9.30	0.07214	20.039	2021	FoI

Table 1: Natural gas WTT and LNG factors, 2021 - 2025

72 The analysis fails on this choice of emission intensity metric in the same way that the original application does [APP-058].

73 The sensitivity analysis does not test LNG emissions intensity uncertainty. In reality, it only tests uncertainty in LNG share. The underlying LNG emissions intensity is held fixed throughout at Qatar LNG intensities from the Exergia (2015). Consequently, the Applicant's "100% LNG" scenario is not a test of contemporary LNG emissions intensity of UK imports. It is a test of a hypothetical supply mix using a fixed LNG emissions factor whose methodological basis remains the Exergia (2015) Qatar LNG pathway.

74 The analysis therefore assumes, rather than tests, the central issue raised by CESL: whether the LNG emissions intensity used in the assessment remains representative of current and future UK LNG supply.

75 This distinction is important. The Applicant varies the proportion of LNG within the gas supply, but does not vary the emissions intensity of LNG itself. No sensitivity testing is

[6] Reproduced from EERA report, page 33: "*Qatar has faced criticism for underreporting or failing to report national emissions. Although the U.N. Framework Convention on Climate Change (UNFCCC) requires countries to provide regular and detailed updates on their GHG emissions, Qatar's last formal submission only included emissions up to 2007.*"

undertaken for alternative LNG supply chains, different upstream methane leakage rates, updated measurement evidence, or the now dominant role of US LNG within UK LNG imports. The exercise therefore examines only one dimension of uncertainty while holding the other constant.

76 The result is that the Applicant's highest-emissions scenario is not a true upper-bound sensitivity test. It represents 100% LNG share, but not a high-emissions LNG intensity. The analysis therefore cannot demonstrate that the assessment is robust to the principal uncertainty identified by CESL, namely the uncertainty associated with the upstream methane intensity of LNG supply.

E.6 CO_2/CH_4 split

77 This analysis provides no information on this.

E.7 Frozen LNG Supply data

78 Whilst the applicant does vary the LNG supply, the analysis effectively only varies a hypothetical amount of (emissions-underreported) Qatari LNG between that inherent in the DESNZ Natural Gas WTT factor and 60% and 100%.

79 This does not capture the real-world situation in 2025 of US LNG, which is known to have much higher emissions factors, and also known to already be 76% of UK LNG imports (DESNZ Energy Trends April 2026 [REP5-081]).

80 The Applicant's analysis also relies upon DESNZ emissions factors that are no longer being updated annually for supply shares. The FoI response confirms that the 2023, 2024 and 2025 conversion factor publications all use the same DUKES 2022 dataset (2021 energy data). The LNG WTT factor itself remains unchanged between the 2023, 2024 and 2025 datasets. Accordingly, the Applicant's sensitivity analysis is not testing current LNG supply conditions but is instead applying a historic emissions factor that is effectively fixed at 2021 supply assumptions.

81 This is particularly significant because the period since 2021 has seen substantial changes in LNG provenance and international gas markets. The Applicant's analysis contains no mechanism by which such changes can influence the emissions intensity assumptions used in the assessment.

E.8 The Analysis does not fully Test Combinations of Uncertainties

82 The scenarios in the document are structured as: gas supply scenarios (Section 1.2, GWP100) and short-term climate impact scenarios (Section 1.3, which combine supply scenarios with GWP20). The capture rate sensitivity (Section 1.4) is then presented separately.

83 None of the scenarios combine a lower capture rate with the GWP20 and high LNG stress scenarios simultaneously. This methodological approach does not capture a reasonable worst case scenario.

E.9 Realistic project timeline not addressed

84 Critically, the analysis is locked in to historic (2021) and hypothetical (60% and 100%) <u>Qatari only</u> LNG supply mixes. It does not address future supply mixes based on US LNG.

D6 / Section F Notification

85 This section notifies the ExA and SoS of a further methodological issue with the applicant's submission, further to my previous submissions, which I became aware of in the preparation of this submission.

F.1 Applicant relies on mitigating CQLCP emissions (unsupported by UK climate policy)

86 The Applicant asserts at para 20.6.54 [APP-058] that the scheme's emissions after 2050 would be "*balanced at a national level via removals within sectors such as agriculture and land use, land use change and forestry*". The implication is that agriculture/LULUCF will generate *surplus* removals that can soak up CQLCP's post-2050 residual emissions.

87 This does not align with UK climate policy as set out in the CCC's Seventh Carbon Budget report ("7CB advice") and the government's own Carbon Budget and Growth Delivery Plan ("CBGDP") - both these documents are supplied as stand-alone appendices:

- Agriculture is itself one of the principal sources of residual emissions in 2050, not a provider of surplus removals. The 7CB advice states explicitly that in 2050, under the Balanced Pathway, "*the main sources of residual emissions … are agriculture and aviation, with smaller contributions from waste, industry, and other sectors*" (7CB, Section 3.3.2). 7CB Figure 3.9 shows that land-based removals are already fully committed to offsetting agriculture's own residual emissions, with nothing available to absorb emissions from other sectors. The agriculture and land use sectors are modelled together as a closed internal balance, reaching approximately net zero in aggregate by 2050, as confirmed also in the Figure 3.9 figure caption text.

- The CCC is explicit: "*The land-based removals offset residual emissions from agriculture, while the engineered removals offset residual emissions from the remaining sectors*" (7CB, Figure 3.9 caption). There is no surplus removal capacity within that pairing that is available to compensate for the residual emissions of a gas-fired power station.

- The government's own statutory CBGDP climate plan confirms the same position. The CBGDP's sector definition table (Appendix A, Table 2) states that "Nature-based solutions, such as afforestation, are included in the Agriculture and LULUCF subsector." The CBGDP thus formally accounts for land-based sinks within the agriculture and LULUCF sector's own budget, not as a free-standing national reserve.

- Engineered greenhouse gas removals (GGRs) are similarly pre-committed to hard-to-abate sectors under a polluter-pays principle, not to gas-fired power generation. The 7CB explains that residual emissions from sectors outside the agriculture and land use balance "*must be offset through engineered removals*," and that the Balanced Pathway "*largely assumes a 'polluter pays' principle, where those sectors with residual emissions, notably aviation, are expected to reduce their net contribution to UK emissions to Net Zero*." (7CB, Section 3.3.2.) 7CB, Figure 2.9 shows the hard-to-abate sectors to be primarily aviation, waste and industry. The CBGDP echoes this, stating that engineered GGRs "*will be important for meeting net zero and enabling our carbon budgets to be met, balancing emissions from hard-to-abate sectors*" (para 74).

- The electricity supply sector is not hard-to-abate in the sense used by either document. The 7CB projects electricity supply emissions falling to 1.0 $MtCO_2e$ by 2050 — "close to zero" — with residual emissions in 2050 attributed to agriculture and aviation, not power generation [7CB advice, Sections 3.3.2 and 7.5.2]. The removal capacity reserved by both documents for hard-to-abate sectors is therefore not available to a gas-fired power station for which clean alternatives exist and are already assumed in the Balanced Pathway.

- The Applicant's assertion in paragraph 20.6.54 is therefore contrary to both documents. It treats the land-based sinks of the agriculture and LULUCF sector as a national absorption buffer available to accommodate the Proposed Development's residual emissions, <u>when both the CCC's 7CB and the government's own CBGDP make clear that those sinks are already fully allocated to the agriculture sector's own internal balance</u>. The assertion provides no analysis of what removal headroom, if any, exists above and beyond the committed allocations in the national framework; without such analysis, the claim that residual emissions "would require to be balanced" by these sectors is not a reasoned conclusion. It is an unexplained transfer of the significance problem onto a framework that, on the evidence of both key policy documents, has no provision to accommodate it.

- The logical direction of any dependency is in any case the reverse of that implied by paragraph 20.6.54. When the full lifecycle of the Proposed Development is properly assessed—including well-to-tank upstream emissions and unabated emissions during periods of T&S system unavailability—the Proposed Development is a net positive emitter, both in the UK and ex-UK. This is evidenced by all absolute emissions descriptions of its impacts (ie: [APP-058, Table 20-8] and all derivatives of it including the CESL analysis in Appendix B of this submission). The UK component itself, now clearly described in the tables in Appendix A and B, requires removal capacity from the national budget. The agriculture and land use sector is not going to support CQLCP; on the contrary, if this hypothetic mitigation for CQLCP happened, it would place additional demands on an already constrained national removal framework.

- The ExA and SoS are respectfully asked to take particular note of the claim at paragraph 20.6.54 of the ES. The assumption that CQLCP's residual emissions — both before and after 2050 — can be balanced against national removal allocations is directly contrary to the Secretary of State's own statutory climate plans and the CCC's advice on which those plans are based.

Appendix A: CESL's indicative full lifecycle sensitivity test

88 CESL provides here an indicative sensitivity test of the full lifecycle greenhouse gas emissions from CQLCP. This is presented as a "parameter isolation ladder" (PIL) in which only one, or a few, parameters are changed in each step to show the effects of changing single input parameters. Only a top-level table, and charts, will be shown here with all the background technical derivation given in the further Appendices.

A.1 Key elements of the sensitivity analysis

89 Ten steps are presented in the PIL, the first step being the application itself, and the final step being CESL's previous reasonable worst case example. Key elements of the 8 new intervening steps include:

- Introduction of the data on CO2 and CH4 emission intensities in LNG supply chains from the recent EERA/T&E report (2024) as provided as a stand-alone appendix. Note, the CO2 and CH4 emission intensities for UKCS and Norwegian pipeline imports to the UK use the Exergia (2015) data: this is a conservative assumption particularly on the CH4 emissions involved. However, CESL has used this hybrid approach as the EERA data is only for LNG supply chains, and CESL has not found more recent reliable data on pipeline supply chains.

- CESL considers that the EERA data is a suitable dataset to use for LNG emission factors for a comprehensive sensitivity analysis because:

    - it is based on a recent systematic review of nearly 800 greenhouse gas emission factors drawn from peer-reviewed, government, and industry literature; and

    - has been already been used in developing international regulatory policy as it informed the development of new default LNG WTT emission factors under the International Maritime Organisations' LCA Guidelines framework; and

    - provides clear statistical information on data (minimum, mean, maximum values and standard deviations) which allows different data to be used for lower bound ranges and upper bound ranges.

- Introduction of future projections of natural gas supply sources based on the official NESO FES 2025 document.

- Modelling for the project lifetime, itself, ie 2035-2065.

- Modelling of both long-term climate impacts and short term climate impacts.

- Modelling of four sub-types of emission factor (in each of the 8 scenarios, not using DESNZ WTT) for:

    - UK CO2 emissions;
    - UK CH4 emissions;
    - ex-UK CO2 emissions; and
    - ex-UK CH4 emissions.

This enables UK and ex-UK emissions to be separately described and identified – ready for separate assessment of UK and ex-UK emissions. It also enables the CO2 and CH4 split to described, although it is not formally required for assessment.

- Full lifecycles with construction and other emissions included, as based on the application data.

90 The approach is presenting the model in these Appendices is top-down.

91 As a first stage, the top level parameter isolation ladder Sensitivity analysis is shown in Table 2 below. This provides the decision maker with the overall ladder in 10 steps, and the key outputs: the overall full lifecycle emissions, upstream share, UK share, ex-UK share, CO2 share and CH4 share (in tCO2e).

92 This data is illustrated in the two charts (Figure 1 and Figure 2) on the pages following the top-level data table.

93 For each of the 10 ladder steps, the full lifecycle, upstream share, UK share, ex-UK share, CO2 share and CH4 share are shown. The overall parameters of the RHS shown which parameters are changed at each level by yellow highlighting.

	10 scenarios (tCO2e)	Full lifecycle	Upstream	UK share	ex-UK share	CO2 share	CH4 share	NG Source	Emission intensity	Long/ Short term impact	Date	Capture rate
1st	**Application - pre-2025 supply chains, DESNZ WTT**	43,590,062	24,242,682	**	**	**	**	Historic DUKES	DESNZ WTT	GWP100	2025	95%
2nd	**2025 supply chains, CESL reconstructed 2025 DESNZ-style factor**	43,096,908	23,749,529	**	**	**	**	2025 DUKES	DESNZ WTT	GWP100	2025	95%
3rd	**2025 supply chains, EERA LNG Mean intensities**	46,741,866	27,394,486	30,248,343	16,493,522	36,577,249	10,164,617	2025 DUKES	EERA Mean	GWP100	2025	95%
4th	**Lower-bound sensitivity (A) - Start year (2035): NESO supply projections, EERA LNG mean intensities**	58,860,467	39,513,087	27,241,037	31,619,430	44,105,596	14,754,871	NESO FES 2025	EERA Mean	GWP100	2035	95%
5th	**Lower-bound sensitivity (B) - Mid-project (2050): NESO supply projections, EERA LNG mean intensities**	79,380,290	60,032,911	24,620,326	54,759,965	57,221,547	22,158,743	NESO FES 2025	EERA Mean	GWP100	2050	95%
6th	**Lower-bound sensitivity (C) - Mid-project (2050) + short-term impacts: NESO supply projections, EERA LNG mean intensities**	121,434,092	102,086,712	30,146,678	91,287,414	57,221,547	64,212,544	NESO FES 2025	EERA Mean	GWP20	2050	95%
7th	**Upper-bound sensitivity (A) - Mid-project - EERA LNG MAX**	232,583,584	213,236,205	30,146,678	202,436,906	56,439,149	176,144,435	NESO FES 2025	EERA Maximum	GWP20	2050	95%
8th	**Upper-bound sensitivity (B) - 100% Dynamic US LNG - EERA LNG MAX**	331,653,875	312,306,496	27,966,410	303,687,465	61,863,540	269,790,335	Dynamic 100% LNG	EERA Maximum	GWP20	2035-2065	95%
9th	**Upper-bound sensitivity (C) - 100% Dynamic US LNG - peer-reviewed science**	268,319,058	248,971,679	33,452,213	234,866,846	82,550,864	185,768,194	Dynamic 100% LNG	Howarth	GWP20	2035-2065	95%
10th	**Upper-bound sensitivity (D) - (C) + min subsidy level CO2 capture**	303,544,270	248,971,679	68,677,425	234,866,846	117,776,076	185,768,194	Dynamic 100% LNG	Howarth	GWP20	2035-2065	70%

**** The DESNZ WTT factor does not facilitate separation of UK and ex-UK, and CO2 and CH4, effects**

Table 2: Top-level "parameter isolation ladder" CQLCP GHG sensitivity analysis

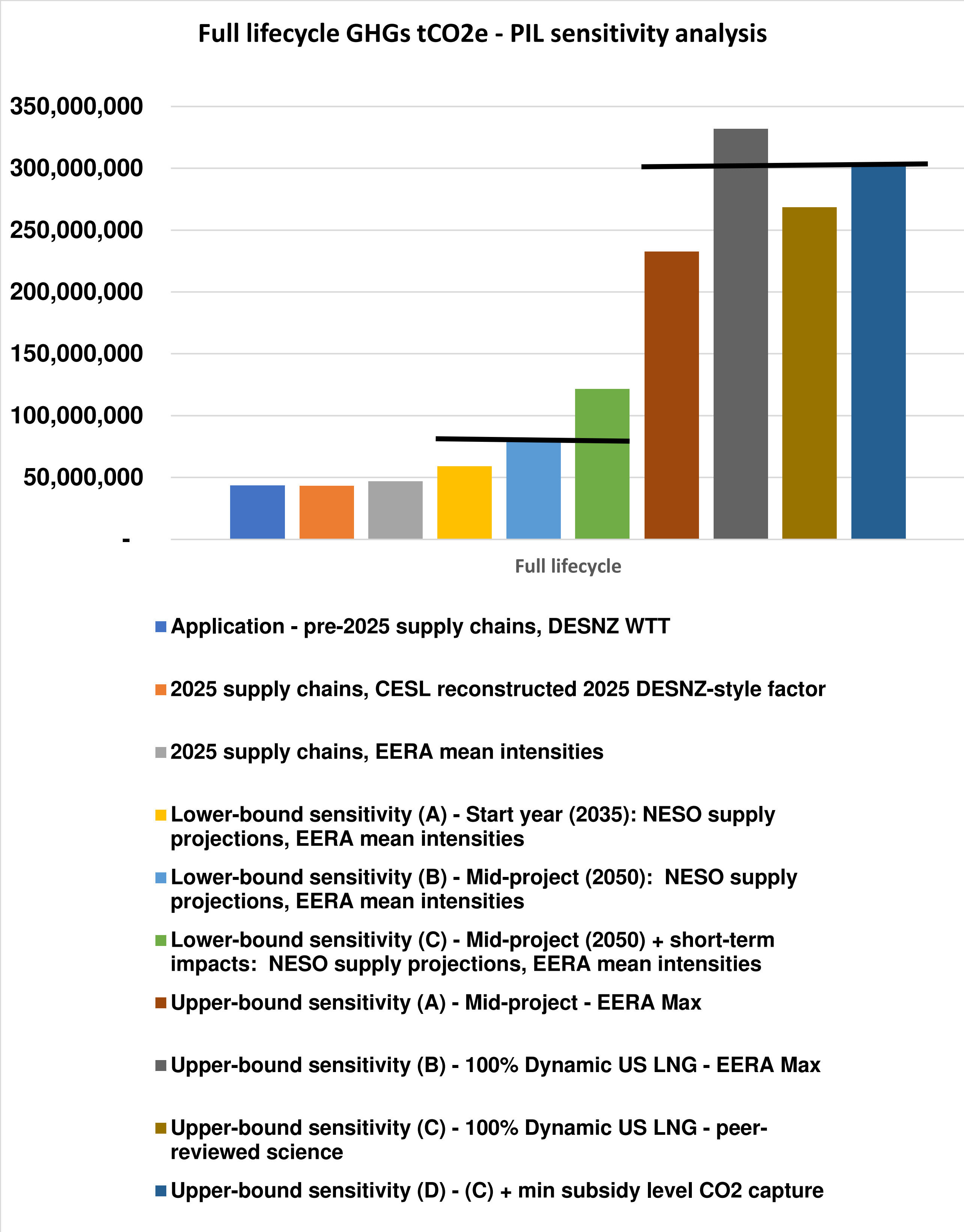

Figure 1: Full lifecycle GHGs tCO2e - PIL sensitivity analysis chart

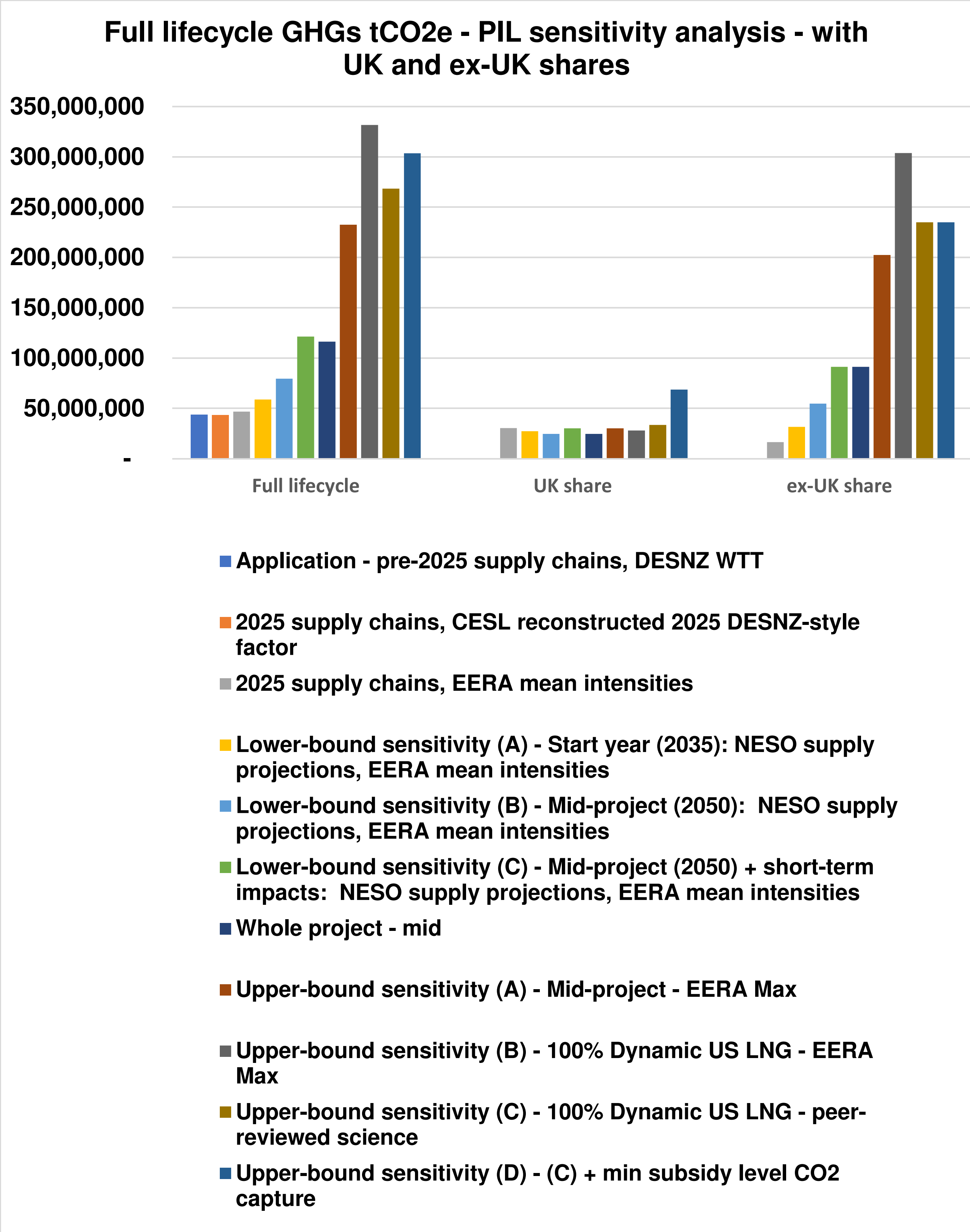

Figure 2: Full lifecycle GHGs tCO2e - PIL sensitivity analysis - with UK and ex-UK shares

A.1 Results and discussion

94 The PIL can be summarise as:

1st	applicant / DESNZ baseline;
2nd	updated supply mix;
3rd	updated LNG intensity evidence;
4th	project-start-year supply conditions;
5th	mid-project supply conditions;
6th	short-term methane impact;
7th	EERA Max range;
8th	dynamic 100% US LNG;
9th	Howarth peer-reviewed comparator;
10th	Capture rate

95 The 1st PIL scenario is the application. The 2nd scenario substitutes 2025 DUKES supply data for the 2021 DUKES data implicit in the DESNZ WTT factor, but uses the same Exergia based emissions intensities. The 3rd scenario substitutes the EERA Mean emission factors for the Exergia data also in 2025. These steps show the effects of correcting the supply data and the emissions data for 2025. However, the project does not start until 2035, and CESL submits that none of these scenarios are a realistic lower bound case, see below – that requires the modelling of likely supply scenarios in the project lifetime of 2035 to 2065.

96 The 5th PIL scenario which is based on the project mid-year of 2050, NESO supply projections, and EERA Mean emission intensities provides a good basis for a lower-bound scenarios: this is indicated by the line in Figure 1. CESL submits the 4th and 6th scenarios a "wing" lower bound scenarios (the 4th being based on the 2035 start year and 6th being based on 2050 with short-term methane impacts included). This gives three lower-bound scenarios, with the ranges presented for the key outputs required for assessment – full lifecycle, UK share and ex-UK share:

	Three lower-bound scenarios (tCO2e)	**Full lifecycle**	**UK share**	**Ex-UK share**
4th	**Lower-bound sensitivity (A)** - Start year (2035): NESO supply projections, EERA mean intensities	58,860,467	27,241,037	31,619,430
5th	**Lower-bound sensitivity (B)** - Mid-project (2050): NESO supply projections, EERA mean intensities	79,380,290	24,620,326	54,759,965
6th	**Lower-bound sensitivity (C)** – Mid-project (2050) + short-term impacts: NESO supply projections, EERA mean intensities	121,434,092	30,146,678	91,287,414

Table 3: Three lower-bound scenarios

97 The purpose of the Rochdale envelope is to provide the decision maker with an understanding of the uncertainty in the GHG description, and not as such to provide exact numbers. On the basis of its sensitivity analysis, CESL considers that the lower-bound for the project is 58-121 MtCO2e (full lifecycle), comprised of 24 – 30 MtCO2e UK share emissions, and 31-91 MtCO2e ex-UK share emissions.

98 CESL submits that the application scenario (ie 1st scenario in this analysis) does not capture the lower-bound situation **because**:

- the gas supply conditions modelled are outside the project timespan. The supply weighting is fixed to 2021 conditions and not updated thereafter (ie pre-2025 as opposed to 2035-2065);

- the emission intensity is incorrect because the LNG provenance is not modelled (all LNG is modelled at Qatar LNG);

- the underlying emission intensities are fixed to a 2015 dataset; and
- short-term methane impacts were not modelled at all.

99 These points were also made in previous submissions including at [REP5-072, section B.2(C)]. CESL has set out to correct these issues in the three lower bound scenarios above.

100 CESL notes the UK part of the CESL's lower bound ie 24 – 30MtCO2e is less than, but the same of order of magnitude, the figure which the applicant compares to the carbon budgets in its assessment (APP-058, 20.6.53-20.6.59) ie 42MtCO2e of operational emissions. <u>However, the applicant has not provided a methodology for, nor made any assessment, of ex-UK emissions.</u> The lower-bound range of the ex-UK emissions is the predominant share at 31 - 91MtCO2e <u>and remains unassessed in the application.</u>

101 The 7th, 8th, 9th and 10th scenarios provide "upper bound scenarios" as follows:

	Four upper-bound scenarios (tCO2e)	**Full lifecycle**	**UK share**	**Ex-UK share**
7th	Upper-bound sensitivity (A) - Mid-project - EERA MAX	232,583,584	30,146,678	202,436,906
8th	Upper-bound sensitivity (B) - 100% Dynamic US LNG - EERA MAX	331,653,875	27,966,410	303,687,465
9th	Upper-bound sensitivity (C) - 100% Dynamic US LNG - peer-reviewed science	268,319,058	33,452,213	234,866,846
10th	Upper-bound sensitivity (D) - (C) + min subsidy level CO2 capture	303,544,270	68,677,425	234,866,846

Table 4: Four upper-bound scenarios

102 The purpose of the Rochdale envelope is to provide the decision maker with an understanding of the uncertainty in the GHG description. On the basis of its sensitivity analysis, CESL submits that the upper-bound for the project is 232 - 331 MtCO2e (full lifecycle), comprised of 27 – 68 MtCO2e UK emissions, and 202 - 303 MtCO2e ex-UK emissions.

103 CESL notes the UK share of the CESL's upper bound range is 27 – 33 MtCO2e when only scenarios at the 95% capture rate are consider (ie scenarios 7-9). This is less than, but the same of order of magnitude, the figure which the applicant compares to the carbon budgets in its assessment (APP-058, 20.6.53-20.6.59) ie 42MtCO2e of operational emissions. The 10th scenario tests the uncertainty of the CO2 capture rate, varying it from 95% (in the 1st to 9th scenarios) to 70% the legal level for subsidy payment (see REP1-077, section B.6) where the UK figure is 68 MtCO2e – greater than the figure in the applicant's assessment.

104 This clearly indicates the sensitivity of the UK share emissions to the CO2 capture rate. CESL has provided evidence that 95% CO2 capture rate has never been achieved in post-combustion CCS [REP1-077, section B.6, REP3-085, section D].

105 Most notably the ex-UK emissions are 202 - 303 MtCO2e in the upper-bound ranges: this is in line with ex-UK upstream emissions from methane bearing much of the climate impact, and especially short-term climate impacts, as CESL has maintained throughout the examination.

106 We emphasise again that the applicant has not provided a methodology for, nor made any estimate or assessment, of this upper bound which CESL calculates via multiple

methodologies as being 200 - 300 MtCO2e – the equivalent of around 2 – 3 years' worth of UK domestic transport emissions[7].

A.2 Other conclusions

107 The EERA max scenario produces a significantly higher dynamic-US-LNG upper bound than the peer-review Howarth study. Scenario 8 is 331.7 MtCO_2e, whereas Scenario 9 is 268.3 MtCO_2e. This indicates that the EERA literature-review maximum, using a dataset already employed in the international regulatory context, is more severe than the Howarth peer-reviewed study.

108 The main variation in the lower bound scenarios come from the short term climate impacts of future LNG dependence in the UK supply chain under the NESO projections. By 2035, this is projected by official UK data from NESO to predominate, even as a static share of supply as CESL has already substantially evidenced [REP3-085, section B.1]. These short-term climate impacts – corresponding to real global temperature rises - would trail the project timeline by around 0 - 10 years ie: approximately in the years 2035-2075. This is predicted by climate sciences as a critical period when overshoot of global temperature that will have already passed international agreed threshold of 1.5ºC (likely this decade) need to be brought down – the short-term climate impacts from the project would work in precisely the opposite direction at this time.

109 The ex-UK component becomes dominant even in the lower-bound cases - short-term methane impact is significant in the lower-bound range with the full lifecycle of scenario 5 to 6 increasing from 79.4 MtCO_2e to 121.4 MtCO_2e — an increase of about 42 MtCO_2e. The applicant has not addressed how to assess the ex-UK emissions, and its UK-only assessment framing excludes this major climate effect.

[7] Department for Transport, 2024, "Greenhouse gas emissions from transport in 2022", https://www.gov.uk/government/statistics/transport-and-environment-statistics-2024/greenhouse-gas-emissions-from-transport-in-2022 reported UK domestic transport emissions as 113.2 MtCO_2e for 2022.

Appendix B: High level calculation table: "parameter isolation ladder" CQLCP GHG sensitivity analysis

110 The table on the next page follows the same format as Tables presented in previous submissions[8]. For consistency, the formulae used in those tables are maintained as before. New data and formulae are given in the green highlighted section for sub emission factor ratios and sub Scope 3 emissions. The calculation of the sub emission factors is given in Appendix C.

111 This enables the calculation of full lifecycle shares for "CH4 share", "CO2 share", "UK share" and "ex-UK share" in additional to the full lifecycle across all sub emissions in the yellow highlighted section.

112 The data in the yellow highlighted section is transferred to Table 2 ("Top-level "parameter isolation ladder" CQLCP GHG sensitivity analysis").

113 The table on the next page presents the absolute emissions contributing to each category of the full lifecycle, and also the "CH4 share", "CO2 share", "UK share" and "ex-UK share".

114 All figures are rounded to the nearest tCO_2e and some minor rounding propagation may be expected.

[8] Ie: REP1-077, Table 2; REP3-085, Table 5.

1		Emission sub-division / information	2	3	4	5	6	7	8	9	10
Pre-2025		Year	2025	2025	2035	2050	2050	2035-2065	2035-2065	2035-2065	
2021 DUKES		Gas supply source data	2025 DUKES	2025 DUKES	NESO FES 2025	NESO FES 2025	NESO FES 2025	NESO FES 2025	Dynamic 100% LNG	Dynamic 100% LNG	Dynamic 100% LNG
DESNZ WTT		Emission intensity data	DESNZ WTT	EERA Mean	EERA Mean	EERA Mean	EERA Mean	EERA Max	EERA Max	Howarth	Howarth
GWP100		Short / Long term methane impacts	GWP100	GWP100	GWP100	GWP100	GWP20	GWP20	GWP20	GWP20	GWP20
Application APP-058											
146,925,347	A	Scope 1 : unabated natural gas combustion	146,925,347	146,925,347	146,925,347	146,925,347	146,925,347	146,925,347	146,925,347	146,925,347	146,925,347
5%	B	T&S Unavailability = 5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
7,346,267	C=A*B	Scope 3: emissions to atmosphere (T&S unavailability)	7,346,267	7,346,267	7,346,267	7,346,267	7,346,267	7,346,267	7,346,267	7,346,267	7,346,267
139,579,080	D=A-C	Remaining emissions available for CCS	139,579,080	139,579,080	139,579,080	139,579,080	139,579,080	139,579,080	139,579,080	139,579,080	139,579,080
95.2367%	E	Capture rate parameter	95.2367%	95.2367%	95.2367%	95.2367%	95.2367%	95.2367%	95.2367%	95.2367%	70.0000%
132,930,567	F=D*E	Captured emissions	132,930,567	132,930,567	132,930,567	132,930,567	132,930,567	132,930,567	132,930,567	132,930,567	97,705,356
6,648,512	G=D-F	Scope 1: Natural Gas : Non-captured emission	6,648,512	6,648,512	6,648,512	6,648,512	6,648,512	6,648,512	6,648,512	6,648,512	41,873,724
0.165	H	Emission factor ratio: Upstream natural gas supply chain emissions	0.1616	0.1865	0.2689	0.4086	0.6948	1.4513	2.1256	1.69455	1.69455
-	α	Sub Emission factor ratio – UK CH4	-	0.0327	0.0294	0.0265	0.0641	0.0641	0.0587	0.0960	0.0960
-	β	Sub Emission factor ratio – ex-UK CH4	-	0.0365	0.0710	0.1243	0.3729	1.1347	1.7776	1.1684	1.1684
-	γ	Sub Emission factor ratio – UK CO2	-	0.0415	0.0243	0.0094	0.0094	0.0094	0.0000	0.0000	0.0000
-	δ	Sub Emission factor ratio – ex-UK CO2	-	0.0758	0.1442	0.2484	0.2484	0.2431	0.2894	0.4302	0.4302
24,242,682	J=A*H	Scope 3: Upstream natural gas supply chain emissions	23,749,529	27,394,486	39,513,087	60,032,911	102,086,712	213,236,205	312,306,496	248,971,679	248,971,679
-	$J(\alpha)=A*\alpha$	Sub Emission Scope 3 – UK CH4	-	4,806,991	4,319,080	3,893,891	9,420,243	9,420,243	8,619,031	14,104,833	14,104,833
-	$J(\beta)=A*\beta$	Sub Emission Scope 3 – ex-UK CH4	-	5,356,498	10,434,663	18,263,725	54,791,174	166,723,065	261,170,176	171,662,233	171,662,233
-	$J(\gamma)=A*\gamma$	Sub Emission Scope 3 – UK CO2	-	6,093,973	3,574,578	1,379,056	1,379,056	1,379,056	-	-	-
-	$J(\delta)=A*\delta$	Sub Emission Scope 3 – ex-UK CO2	-	11,137,025	21,184,767	36,496,240	36,496,240	35,713,842	42,517,289	63,204,613	63,204,613
4806	K	Scope 1: Diesel: 50tonnes/yr, 30 years (EF=3203.9/1000)	4806	4806	4806	4806	4806	4806	4806	4806	4806
1128	L	Scope 3: Diesel (EF ratio = 0.2347)	1128	1128	1128	1128	1128	1128	1128	1128	1128
6,653,318	M=G+K	Total Scope 1 "Fuel Usage (CCGT emissions and other fuels)"	6,653,318	6,653,318	6,653,318	6,653,318	6,653,318	6,653,318	6,653,318	6,653,318	41,878,530
31,590,078	N=J+L+C	Total Scope 3 "Fuel Usage (CCGT emissions and other fuels)"	31,096,924	34,741,882	46,860,483	67,380,306	109,434,108	220,583,600	319,653,891	256,319,074	256,319,074
38,243,396	P=M+N	Total Scope 1 & 3 "Fuel Usage (CCGT emissions and other fuels)"	37,750,242	41,395,200	53,513,801	74,033,624	116,087,426	227,236,918	326,307,209	262,972,392	298,197,604
4,411,200	Q	Non-fuel usage Operational Emissions / Table 20-12	4,411,200	4,411,200	4,411,200	4,411,200	4,411,200	4,411,200	4,411,200	4,411,200	4,411,200
42,654,596	R=P+Q	Total Operational	42,161,442	45,806,400	57,925,001	78,444,824	120,498,626	231,648,118	330,718,409	267,383,592	302,608,804
467,733	S	Construction / Table 20-6	467,733	467,733	467,733	467,733	467,733	467,733	467,733	467,733	467,733
467,733	T	Decommissioning / 20.6.71 /	467,733	467,733	467,733	467,733	467,733	467,733	467,733	467,733	467,733
4,417,134	Y	Other Operational emissions - excl Scope 1, Scope 3 + diesel	4,417,134	4,417,134	4,417,134	4,417,134	4,417,134	4,417,134	4,417,134	4,417,134	4,417,134
5,352,600	Z	Other Lifecycle emissions - excl Scope 1, Scope 3 + diesel	5,352,600	5,352,600	5,352,600	5,352,600	5,352,600	5,352,600	5,352,600	5,352,600	5,352,600
43,590,062	U=R+S+T	Full Lifecycle	43,096,908	46,741,866	58,860,467	79,380,290	121,434,092	232,583,584	331,653,875	268,319,058	303,544,270
	$AA= J(\alpha)+ J(\beta) +L$	CH_4 share		10,164,617	14,754,871	22,158,743	64,212,544	176,144,435	269,790,335	185,768,194	185,768,194
	$BB=C+ G+ J(\gamma)+ J(\delta)+K+Q+S+T$	CO_2 share		36,577,249	44,105,596	57,221,547	57,221,547	56,439,149	61,863,540	82,550,864	117,776,076
	$CC=C+ G+ J(\alpha)+ J(\gamma)+K+L+Q+S+T$	UK territorial allocation		30,248,343	27,241,037	24,620,326	30,146,678	30,146,678	27,966,410	33,452,213	68,677,425
	$DD= J(\beta)+ J(\delta)$	ex-UK allocation		16,493,522	31,619,430	54,759,965	91,287,414	202,436,906	303,687,465	234,866,846	234,866,846

Table 5: High-level calculation table: "parameter isolation ladder" CQLCP GHG sensitivity analysis

Appendix C: Calculation of sub emission factors

115 The sub-emissions factors – for CH4, CO2, UK and ex-UK are based on the general formula for weighted emission factors, in equation 1 below:

$$EF_{\text{total}} = \sum_{i=1}^{n} (S_i \times EF_i)$$

EF_{total} is the total weighted WTT emissions factor

S_i fractional share of gas supply from source (i)

EF_i emissions intensity for source (i)

n number of gas supply sources

116 Emission factor data is provided for upstream and midstream emissions – this is the case for the Exergia study which the DESNZ WTT factors is based on, and also for the EERA data. To calculate the full supply chain, it is necessary to add in the downstream factor – for the UK, this is emissions from the UK distribution network and UK processing of gas (whether it is UKCS or ex-UK gas supply). So the formula is extended as follows in equation 2 below for the UK based emission share. CESL also uses the assumption that the $EF_{\text{UK-network}}$ factor is 100% methane leakage.

$$EF_{\text{total}} = \sum_{i=1}^{n} (S_i \times EF_i) + EF_{\text{UK-network}}$$

117 CESL has calculated the additional UK downstream gas-network emissions factor $EF_{\text{UK-network}}$ is 1.39 $kgCO_2e/GJ$.

118 As an example of this formula – consider a UK gas mixture of UKCS, Norwegian, Qatar LNG and US LNG as follows:

Source	**Share**	**GWP100 Emission intensity**
UKCS	40%	6.777 $kgCO_2e/GJ$
Norway	45%	4.719 $kgCO_2e/GJ$
Qatar LNG	5%	17.035 $kgCO_2e/GJ$
US LNG	10%	27.25 $kgCO_2e/GJ$
UK network residual	—	1.39 $kgCO_2e/GJ$

119 On a GWP100 basis, the UK gas emission factor, for all shares in this case, is then calculated as follows:

$$EF_{\text{total}} = (S_{\text{UKCS}} \times EF_{\text{UKCS}}) + (S_{\text{Norway}} \times EF_{\text{Norway}}) + (S_{\text{Qatar LNG}} \times EF_{\text{Qatar LNG}}) + (S_{\text{US LNG}} \times EF_{\text{US LNG}}) + EF_{\text{UK-network}}$$

$$EF_{\text{total}} = (0.40 \times 6.777) + (0.45 \times 4.719) + (0.05 \times 17.035) + (0.10 \times 27.25) + 1.39$$

$$EF_{\text{total}} = 2.711 + 2.124 + 0.852 + 2.725 + 1.390 = 9.802 \text{ kgCO}_2\text{e/GJ}$$

To convert this to a Scope 1 combustion uplift[9]:

$$\frac{9.802}{56.31} = 0.174$$

120 In this example, the WTT factor would add 17.4% to the scope 1 emissions.

121 Note that CESL uplifts the downstream gas-network emissions factor is uplifted in GWP20 cases to 3.3 $kgCO_2e/GJ$, and included in the calculations at this level.

122 CESL's model applies this formula for each respective share (CH4, CO2, UK, ex-UK) as well as for all shares together. These share calculations are presented in the table above at a high-level by the α, β, γ and δ sub-emission factors and the **$J(\alpha)$, $J(\beta)$, $J(\gamma)$,** and **$J(\delta)$** absolute emissions for each respective share. The details of the calculations under these high-level figures are now explained in terms of how equation 2 is applied.

C.1 Supply sources

123 **Assumption:** For scenarios used the EERA emission intensities (scenarios 3-8), the proportion of US LNG is taken at the 2025 level ie 76% of all LNG [REP5-072, section B.1]. This is a conservative assumption given that US LNG proportion is projected to increase.

124 Scenarios 2 and 3 use full year 2025 DUKES data calculated from the UK Government spreadsheet[10]. Scenarios 4 to 7 use the NESO FES 2025 projections for 2035 and 2050 (see below). Scenarios 8 to 10 uses a 100% "dynamic" LNG on the basis that LNG forms a core component of the flexible marginal supply layer under stressed or elevated demand conditions, exactly the conditions under which CQLCP would be supplying dispatchable power [REP3-085, section B.1 (B)].

125 The NESO data is taken from the NESO FES 2025 workbook, Tab F.21, sub table "Annual gas supply snapshot. bcm/yr" using the "Falling Behind" scenarios 2035 and 2050. The LNG and "Generic imports" types are assumed to be supplied by LNG (as discussed at [REP3-085, section B.1 (A)].

126 LNG is split into US LNG (76%) and non-US LNG (24%).

127 Based on this the supply matrix is:

[9] **56.31 $kgCO_2e/GJ$** is the Scope 1 combustion emissions factor for natural gas, expressed per unit of fuel energy input on a Net Calorific Value (Net CV) basis. It is derived from the DESNZ / UK Government combustion factor of 0.2027 tCO_2e/MW.

[10] "Gas_APR_26.ods", from https://www.gov.uk/government/statistics/gas-section-4-energy-trends

	Scenarios 2-3		Scenario 4		Scenarios 5-7	Scenarios 8-10
	DUKES[11]	NESO FES **(2035)**	NESO FES **(2035)**	NESO FES **(2050)**	NESO FES **(2050)**	**2035-2065**
	2025	**2035** Falling behind **bcm/yr**	**2035** Falling behind %	**2050** Falling behind **bcm/yr**	**2050** Falling behind %	
UKCS	41.12%	13.63	21.63%	2.26	3.89%	0.00%
Green gas	0.00%	1.57	2.49%	3.15	5.42%	0.00%
Norway	40.51%	21.35	33.88%	4.94	8.50%	0.00%
Continent	0.77%	0	0.00%	0	0.00%	0.00%
LNG - US	13.39%	20.12	31.92%	36.32	62.47%	100%
LNG - not UK	4.22%	6.35	10.08%	11.47	19.73%	0.00%

Table 6: Supply source data

C.2 Emission intensities

128 EERA Mean data is used for LNG data in Scenarios 3-6 (with GWP20 for scenario 6), and EERA Max data for scenarios 7-8. CO2 and CH4 proportions for each source may be calculated from the relative GWP20 and GWP100 data.

129 **Assumption:** US LNG is modelled on US LNG specific data (from 47 different studies in the EERA AR5 data, EERA Tables 8 and 9). As EERA does not provide data for all the other LNG sources to the UK, non-US LNG types are grouped and modelled as Qatari LNG for which there is ready data (from 15 different studies in the EERA AR5 data, EERA Tables 8 and 9). This is conservative estimate, and CESL notes EERA comment that Qatari underreporting[12].

130 The Table below gives the emission factor matrix for the EERA Mean case.

131 **Assumptions:** As EERA provides no data for UKCS and Norwegian pipeline supply, CESL use a hybrid approach where the Exergia data is used (for the shaded rows in the table below) for pipeline supply from UKCS and Norway, and EERA is used for LNG supply. UK Green gas is modelled as the same as UKCS pipeline. The UK and Norwegian pipeline figure are conservative estimates.

132 So the Table gives EERA LNG mean intensities, with Exergia pipeline values for UKCS and Norway, with UK network emissions added in to each supply source.

Emission intensities $kgCO_2e/GJ$	**Exergia**	**EERA Mean**	**EERA Mean**	**EERA Table 8 (Mean)**	**EERA Mean**	**EERA Mean**	**EERA Table 9 (Mean)**
		GWP100 CO2	**GWP100 CH4**	**GWP100**	**GWP20 CO2**	**GWP20 CH4**	**GWP20**
UKCS Pipeline	6.777	5.68	1.1	6.78	5.68	3.3	8.98
Green gas		5.68	1.1	6.78	5.68	3.3	8.98
Norway (pipeline)	4.719	3.29	1.43	4.72	3.29	4.29	7.58
LNG - US	17.035	16.775	10.475	27.25	16.775	31.425	48.2
LNG - not UK (Qatar)	17.035	16.365	1.695	18.06	16.365	5.085	21.45

Table 7: EERA LNG mean intensities

133 These figures are derived from EERA (supplied as stand-alone appendix), Table 8 at page 22, and Table 9 at page 23. The US LNG GWP100 figure is the mean from 47 studies, and the US LNG GWP20 figure is the mean of 12 studies.

[11] "Gas_APR_26.ods", from https://www.gov.uk/government/statistics/gas-section-4-energy-trends

[12] Reproduced from EERA report, page 33: "*Qatar has faced criticism for underreporting or failing to report national emissions. Although the U.N. Framework Convention on Climate Change (UNFCCC) requires countries to provide regular and detailed updates on their GHG emissions, Qatar's last formal submission only included emissions up to 2007.*"

134 For the EERA Max case, the data is as below. The approach is again hybrid, so the Table gives EERA LNG Max intensities, with Exergia pipeline values for UKCS and Norway, with UK network emissions added in to each supply source.

Emission intensities $kgCO_2e/GJ$	Exergia	EERA Max	EERA Max	EERA Table 8 (Max)	EERA Max	EERA Max	EERA Table 9 (Max)
		GWP100 CO2	GWP100 CH4	GWP100	GWP20 CO2	GWP20 CH4	GWP20
UKCS Pipeline	6.777	5.68	1.1	6.78	5.68	3.3	8.98
Green gas		5.68	1.1	6.78	5.68	3.3	8.98
Norway (pipeline)	4.719	3.29	1.43	4.72	3.29	4.29	7.58
LNG - US	17.035	16.295	33.365	49.66	16.295	100.095	116.39
LNG - not UK (Qatar)	17.035	16.365	1.695	18.06	16.365	5.085	21.45

Table 8: EERA LNG Max intensities

135 These figures are derived from EERA (supplied as stand-alone appendix), Table 8 at page 22, and Table 9 at page 23. The US LNG GWP100 figure is the maximum from 47 studies, and the US LNG GWP20 figure is the maximum of 12 studies.

136 These emission factors are cross calculated with the supply matrices in the previous section, to produce the sub-emission factor ratios α, β, γ and δ in the High-level calculation table in Appendix A for scenarios 3-8 using equation 2.

137 Scenarios 9-10 use 100% dynamic LNG with the data from a recent peer-review academic paper. The shares of UK CH4, UK CO2, ex-UK CH4 and ex-UK CO2 are calculated directly from the data table in the paper (as reproduced at REP1-077, Appendix A, “2-stroke engine tankers powered by LNG” case). It is assumed that the vast majority (ie 100%) of UK based downstream emissions is methane leakage. This data, as reproduced in the table below, is then allocated to sub-emission factor ratios α, β, γ and δ for the High-level calculation table in Appendix A for scenarios 9-10 using equation 2.

Howarth / GWP20/2-stroke LNG		g CO2-eq/kg
Combustion	UK CO2	2750
Upstream/Midstream CH4	ex-UK CH4	2794
Upstream/Midstream CO2	ex-UK CO2	720
Liquefaction CH4	ex-UK CH4	300
Liquefaction CO2	ex-UK CO2	359
Tanker CH4	ex-UK CH4	119
Tanker CO2	ex-UK CO2	104
Final transmission CH4	UK CH4	264
Final transmission CO2	UK CO2	0