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Registration ID number: [redacted]

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Written Representation, also incorporating submissions following ISH1

Climate Change

EN0110001 - The Keadby Next Generation Power Station Project

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 is provided at Section G.

2 This submission (my deadline D1 Written Representation) provides my submissions on Climate Change and the Keadby Next Generation Power Station (KNGPS) Project. This submission also acts to provide a summary of my oral submissions at ISH1. Much of the material here also addresses the issues raised at ISH1.

3 I have used an AI tool to assist with drafting and refining the textual content of this submission for clarity and presentation. A full statement[1] on the use of AI is provided at Section H. Please note that this statement should be applied retrospectively to my Relevant Representation as submitted on 22 November 2025.

4 This submission is structured as follows. Section A sets out the flexibilities and acknowledged uncertainties within the Environmental Statement (ES) that are relevant to the assessment of greenhouse gas effects. Section B identifies the two outcome-determinative uncertainties that most strongly influence forecasts of operational GHG emissions for developments of this type. Section C examines the applicant's treatment of upstream emissions, including whether the assumptions relied upon operate to upper-bound those impacts, and presents evidence indicating that the ES may not assess the full range of impacts that could realistically arise over the operational lifetime of the Proposed Development. Section D considers hydrogen supply, including whether the hydrogen co-firing scenarios assessed represent plausible operational modes of the Proposed Development, and whether the associated lifecycle greenhouse gas impacts have been properly identified, assessed, and bounded for the purposes of Environmental Impact Assessment (EIA). Section E addresses the legal implications of these matters, and Section F sets out conclusions.

[1] In accordance with PINS guidance on "Use of artificial intelligence in casework evidence", 6 September 2024

5 In short Sections A and B are background, Sections C and D address the factual adequacy of the assessment, while Section E addresses the legal consequences.

6 This submission has four in-document short appendices A, B, C and D provided as further background information directly related to the submission content. In addition, further appendix information is provided in eleven full documents which have been submitted to the examination library, as noted in the footnote[2].

D1 / Section A Background: Flexibilities and Uncertainties in EIA

A.1 The applicant's assessment approach

7 The applicant has set out its Assessment Methodology for Climate Change at [APP-050] section 18.3 of the ES which covers both Lifecycle GHG Impact Assessment and Climate Change Risk Assessment. CESL is only concerned with the Lifecycle GHG Impact Assessment in this submission.

8 At [APP-050] section 18.3, the applicant describes the study area as covering "*all direct GHG emissions from activities undertaken within the Site boundary during the construction, operation, maintenance and decommissioning phases*" and "*indirect emissions arising outside the Site, for example … upstream emissions associated with the production and transmission of fuels to the Site during operation (including fugitive emissions on the transmission network).*"

9 The applicant recognises uncertainties in its Lifecycle GHG Impact Assessment: for example, with upstream GHG emissions occurring within the natural gas fuel supply chain[3], the calculation of indirect effects (Scope 3 emissions)[4], the type of power generation to be replaced by the energy generated by KNGPS[5], the future UK hydrogen supply[6] and in decommissioning[7].

10 The applicant gives details of from where it draws on data for the assessment in [APP-050] sections 18.3.11 to 18.3.19, and notes at 18.3.08 "*where data was unavailable, reasonable assumptions have been made based on professional judgement.*"

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

(1) Supporting material for Howarth (2024) paper;
(2) Howarth (2024) paper;
(3) North Sea Future Plan, November 2025;
(4) Carbon Tracker (2024) report, "Kind of Blue";
(5) Digest of UK Energy Statistics (DUKES): Chapter 4 Natural Gas, update 31/07/2025;
(6) UK Low Carbon Hydrogen Standard, Version 4, January 2026
(7) Howarth, R.W. & Jacobson, M.Z. (2021), "How green is blue hydrogen?"
(8) Oleksiy Tatarenko et al, (2025) "Weak Emissions Accounting Can Undermine Hydrogen's Role in Global Decarbonization"
(9) Jonathan Stern, OIES Paper ET46, (April 2025)
(10) Examiner's Recommendation Report, Net Zero Teesside, 10 February 2023
(11) Decision letter, Net Zero Teesside, 16 February 2024

[3] [APP-050] sections 18.3.52

[4] [APP-050] sections 18.6.17

[5] [APP-050] section 18.4.6

[6] [APP-050] sections 18.3.41, 18.3.57 and 18.8.1

[7] [APP-050] section 18.3.75

11 The applicant's approach to the Rochdale Envelope is described in Chapter 2: Assessment Methodology [APP-036] at section 2.3:

> *"… Therefore, the Rochdale Envelope approach has been applied within the EIA to ensure a robust assessment is presented of the likely significant environmental effects of the Proposed Development, in accordance with the Planning Inspectorate's Advice Note Nine: The Rochdale Envelope (PINS, 2018). This involves assessing the maximum (and where relevant, minimum) parameters for the elements where flexibility needs to be retained, recognising that the worst-case parameter for one technical assessment may differ from another. Where this approach is applied, this has been confirmed within the relevant chapters of this ES."*

12 As Chapter 18 [APP-050] of the EIA "Climate Change" makes no mention the Rochdale envelope, it appears that the applicant considers that it has not applied a Rochdale envelope approach to its Lifecycle GHG Impact Assessment.

A.2 CESL's submission

13 Nothing in this submission seeks to substitute an alternative Environmental Statement. All sensitivity analysis and literature synthesis are provided solely to demonstrate that the applicant's chosen assumptions do not bound a reasonable worst case, and therefore that the ES is legally inadequate.

14 The legal question throughout is whether the Environmental Statement has demonstrated that its assumptions bound the reasonable worst case, not whether alternative modelling approaches exist.

A.3 Reasonable worst-cases and the Rochdale Envelope

15 The Rochdale Envelope approach exists to address situations where a development is promoted with inherent uncertainties and operational flexibilities, by ensuring that the Environmental Statement (ES) nonetheless assesses the maximum likely significant environmental effects, or reasonable worst-case environmental effects, that could arise within the scope of the consent sought. This is so that the decision-maker has full knowledge of the consequences of authorising the project.

16 The Rochdale Envelope is not confined to spatial dimensions or layout flexibility[8], but is concerned with ensuring that the Environmental Statement has assessed the maximum adverse environmental effects that could arise from the Proposed Development. The PINS Rochdale Envelope Advice Note[9] confirms that, where uncertainty exists, the ES must establish clearly defined parameters that are sufficient to enable a robust assessment of the likely significant environmental effects and must identify those parameters that would give rise to the worst-case scenario.

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[8] Where an Environmental Statement relies on quantified non-physical assumptions that drive the assessment of significant effects, and the bound of those physical effects for the purposes of assessment—such as traffic volumes, operational limits, design-case performance assumptions, GHG calculation parameters or other modelling inputs—those assumptions can function as Rochdale envelope-defining parameters.

[9] PINS (2018). Nationally Significant Infrastructure Projects - Advice Note Nine: Rochdale Envelope [online] (Accessed 23/01/2026). https://www.gov.uk/government/publications/nationally-significant-infrastructure-projects-advice-note-nine-rochdale-envelope/nationally-significant-infrastructure-projects-advice-note-nine-rochdale-envelope

17 In the context of climate change assessment, assumptions that mathematically determine the scale of greenhouse gas emissions—such as upstream emission factors—function as such parameters because they functionally bound the upper limit of environmental impact. Where those assumptions constrain the EIA assessed emissions below what could realistically occur during operation, the Proposed Development may later operate beyond the assessed Rochdale Envelope. In this situation, the ES cannot be said to provide the decision-maker with full knowledge of the project's likely significant effects, as required by the EIA Regulations and established case law.

18 In addition to the parameters in APP-036, which relate to the spatial aspects of the project, the applicant notes assumptions made in the description and assessment of the greenhouse gas emissions (GHGs) associated with the development in Chapter 18 under "Assessment Assumptions and Limitations" at [APP-050]:

- sections 18.3.45 – 18.3.47 ("Hydrogen Fugitive Emission" - sic);
- sections 18.3.48 – 18.3.51 ("Short Lived GHG Gases");
- sections 18.3.52 – 18.3.53 ("Upstream Natural Gas GHG Emissions and Decarbonisation");
- sections 18.3.54 – 18.3.61 ("Operational GHG emissions from fuel consumption" ; and
- sections 18.3.62 – 18.3.75 ("Other GHG Emissions").

19 These assumptions, and their associated quantified parameters as described below, functionally bound the upper limit of environmental impact for the GHG assessment, in addition to the Rochdale envelope parameters explicitly described in APP-036.

20 Section 18.3.56 states that the "Scope 1 (direct) and scope 3 (upstream) emissions from <u>natural gas consumption</u> have been estimated using the UK Government's conversion factor for natural gas and the associated 'well-to-tank' factor (DESNZ, 2025b), respectively[9]". With footnote 9, giving the values as scope 1 is 2.0891 $kgCO_2e/m^3$ and scope 3 is 0.3366 $kgCO_2e/m^3$. The relevant data is reproduced in Appendix B directly from the DESNZ spreadsheet, and will be referred to later. There are referred to as the "DESNZ emissions factors" in the rest of this document.

21 Section 18.3.52 notes the upstream emissions from venting, flaring and fugitive emissions of CH_4 in the supply chain, and that there are "no reliable projections" of how the leakage from natural gas supply chains <u>may be reduced over time</u>.

22 Section 18.3.53 says for the GHG assessment, the DESNZ emission factor has been applied across the whole assessment period to 2050, assuming no decarbonisation of the supply chain over time (ie no reductions in emission over time).

23 The effect of sections 18.3.56, 18.3.52 and 18.3.53 is that the upper limit of the environmental impact from upstream emissions in the natural gas supply chain is limited by the chosen DESNZ emission factor, and <u>assumes that no increases of emissions over time can occur</u>.

24 At 18.3.57, the carbon intensity of the hydrogen supply to KNGPS is assumed to be 20 gCO_2e/MJ_{LHV}, which is the maximum level which is compliant with the Low Carbon Hydrogen Standard (LCHS). Uncertainties surrounding the future supply of hydrogen in the UK are acknowledged.

A.4 Uncertainties in the ES for GHGs

25 This submission addresses uncertainties in the GHGs for the project, and specifically the Rochdale Envelope and the bounding of the maximum environmental effect from the project in relation to two particular assumptions introduced for GHGs in the KNGPS operational phase:

(A) that the GHG impacts of the Scope 3 upstream emissions in the natural gas supply chain are capped by the DESNZ emission factor described above as 0.3366 $kgCO_2e/m^3$ (or its equivalent in different units, see Appendix B);

(B) that the GHG impacts of the hydrogen supply chain to the development is capped at 20 gCO_2e/ MJ_{LHV} (which is the maximum level to meet the LCHS standard, see above).

26 These two assumptions are applied in the ES across the project lifespan (ie: 2031 to 2055), and across each of the seven operational scenarios presented at section 18.6.19 [APP-050].

27 These are each parameters to the Rochdale Envelope for the project's EIA GHG assessment, along with the principal components and other assumptions [APP-036], and they specify how the maximum assessed environmental effects have been capped in the Rochdale Envelope for the EIA.

28 CESL submits that the applicant has not demonstrated that it has considered the range and uncertainty of the possible climate impacts of the development, associated with these assumptions. In EIA, acknowledged uncertainty becomes legally material where the uncertain parameter mathematically determines the scale of assessed effects and no analysis is provided to test whether higher-impact outcomes are bounded.

29 CESL submits that there is significant evidence, to be provided in this submission, that the development would not always operate within the bounds on the applicant's assumptions. To understand this requires sensitivity analysis of operational GHG emissions against the available evidence of how the natural gas supply chain – both for natural gas supplied directly to KNGPS, and natural gas used in blue hydrogen production which may then supply hydrogen to KNGPS - would operate in the real world. The applicant has not provided this sensitivity analysis.

30 CESL submits that the applicant has not provided evidence of how its choice of the parameters for each of assumption (A) and assumption (B) supplies the maximum bound of the related (climate/GHG) environmental impacts of the project. Without such evidence, it has to be assumed that the EIA materially understates the likely significant effects of the project on the climate system. The subsequent operational GHG significance assessment and conclusions in the ES cannot be relied upon for decision making.

31 This submission does not seek to challenge the relevant National Policy Statements for energy infrastructure, but is confined to the adequacy of the Environmental Statement and compliance with the requirements of the EIA Regulations.

32 CESL is submitting that the reasonable worst-case assessment in the ES does not provide the Secretary of State with full knowledge of the project's likely climate impacts, and it therefore cannot be relied upon for decision making.

A.5 The applicant's referral to the Net Zero Teesside examination and decision

33 CESL notes that the applicant referred to the Examining Authority's Report and Decision Letter[10] for the Net Zero Teesside development at the ISH1 on 21 January 2026.

34 With respect to paragraphs 5.3.47 and 5.3.48 of the Examining Authority's Report for the Net Zero Teesside (NZT), these paragraphs must be read in their proper context : they do not resolve the issues now raised in this examination.

- First, at paragraph 5.3.47 the NZT Examining Authority expressly acknowledged "considerable uncertainty" over the future source of natural gas and recognised that upstream ("well-to-tank") emissions "could be higher" for imported fuel. The conclusion reached in that paragraph was not that uncertainty was absent, but that, on the evidence available at that time, the ExA considered use of the then-current BEIS/Defra emissions factor as reasonable, and representing the "best data and understanding available <u>at the current time</u>"[11]. The language used is explicitly time-bound and does not purport to establish an enduring approach to be applied irrespective of subsequent evidence.

- Secondly, the NZT Examining Authority's reference to "the current time" confirms that its conclusion was contingent on the state of evidence as at February 2023. The present examination is taking place more than three years later, on a different evidential record, and CESL's submission relies on more recent data and scientific analysis that were not before the NZT Examining Authority. The NZT conclusion cannot therefore be treated as determinative of how acknowledged uncertainty should be addressed in this examination.

- Thirdly, the NZT Examining Authority's reasoning at paragraph 5.3.47 included an expectation that "a concerted international effort to reduce methane emissions" could lead to reductions in carbon intensity. That expectation formed part of the context for the judgment made at that time. CESL does not invite the Examining Authority to resolve questions of international policy effectiveness here, but notes that the NZT paragraph was written against a particular regulatory and international backdrop and cannot be assumed to provide a settled answer for subsequent examinations conducted in materially different circumstances.

- Fourthly, paragraph 5.3.48 of the NZT ExAR addresses a specific draft DCO requirement proposed in that case, which would have constrained operation by reference to International Energy Agency projections. No equivalent operational control is sought by CESL in relation to the present application. Paragraph 5.3.48 therefore concerns a different issue—whether additional operational controls should be imposed via the DCO—and does not address the separate question now raised as to whether the Environmental Statement adequately bounds reasonable worst-case greenhouse gas effects for the purposes of EIA.

35 Accordingly, while paragraphs 5.3.47–5.3.48 provide context for this examination, they do not determine whether, on the evidence now before this Examining Authority, acknowledged uncertainty in upstream emissions has been addressed in a manner sufficient to ensure that the reasonable worst-case greenhouse gas effects of the present development have been properly assessed.

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[10] The Examining Authority's Report and Decision Letter for the Net Zero Teesside development are both provided as stand-alone appendices in the examination library

[11] Whilst CESL did not agree that the DESNZ factor was the best data at the time, either during the examination or at the decision time, this issue did not form part of the subsequent legal challenge that I made

36 With respect to the applicant's reliance on paragraph 4.46 of the Secretary of State's Decision Letter for the Net Zero Teesside (NZT) project.

- First, that paragraph records the Secretary of State's acceptance of the Examining Authority's conclusions on greenhouse gas assessment on the evidential record before her in that case, and does not determine the issues now raised in this examination.

- Secondly, Paragraph 4.46 reflects the Secretary of State's judgment that, at the time of the NZT decision, the Environmental Statement and examination process provided sufficient information to comply with the EIA Regulations, having regard to the evidence and arguments then advanced. It does not address, and was not required to address, the implications of subsequently available evidence, now three years later, nor does it consider whether acknowledged uncertainty in upstream emissions should be bounded through sensitivity testing or alternative scenarios where such uncertainty materially determines the scale of effects.

- Thirdly, paragraph 4.46 does not consider whether non-spatial, quantitative assumptions—such as upstream emission factors—operate as parameters defining the maximum scale of greenhouse gas effects for the purposes of a Rochdale-style assessment. That issue was not before the Secretary of State in the NZT decision and is now raised expressly in this examination.

37 Accordingly, while paragraph 4.46 is supporting narrative for the decision made on NZT decision, it does not resolve the distinct question now before this Examining Authority as to whether the Environmental Statement for the present application provides full knowledge of the likely significant greenhouse gas effects and adequately bounds the reasonable worst-case outcome on the evidence currently available.

38 In summary, the present submission advances issues that were not argued or determined in the NZT examination and decision.

D1 / Section B Uncertainties in GHG Forecasting Methodologies

39 As described above in Chapter 18 of the ES [APP-050], the applicant states how it derives the upstream emissions factor for the Scope 3 GHG emissions for natural gas supply from the published DESNZ 2025 emissions factors: this is taken forward as a fixed assumption for the EIA.

40 The following sub-sections introduce two uncertainties in the forecasting of GHGs associated with developments such as KNGPS, using natural gas, and hydrogen which may have been produced from natural gas (ie blue hydrogen):

41 The ES/EIA lacks any sensitivity analysis of the associated operational lifecycle GHG emissions associated with these uncertainties. CESL submits that the omission of reasonable sensitivity testing that is crucial for understanding the range of possible significant effects means that the ES fails to provide the decision-maker with full knowledge of the project's climate impacts.

B.1 The two uncertainties in forecasting operational GHG emissions

42 Some further expansion from the related recent scientific literature is given in Appendix C.

B.2 Issue (i): UK Supply sources of natural gas are evolving, and the uncertainty over time of the additional high-impact GHG effects being introduced into supply chains

43 This submission does not assert contractual attribution of LNG to KNGPS. It addresses system-level causation relevant to the assessment of likely environmental effects, consistent with established EIA practice. For EIA purposes, the relevant question is not contractual attribution but whether the assessed assumptions exclude high-impact supply-chain outcomes that could realistically arise during operation and materially affect the scale of emissions.

44 UK Continental Shelf (UKCS) gas supplies have been in decline for decades, and are forecast to continue to rapidly decline. The decline is further accentuated with the recent UK policy not to licence further UK North Sea gas fields (North Sea Future Plan[12], November 2025, provided as a stand-alone Appendix in the examination library).

45 In response to this, the UK has increased its imports of LNG. The US LNG export industry has also rapidly expanded in recent years. US LNG imports to the UK were already at 17% of all imports in 2024[13]. These imports are associated with the very high Scope 3 upstream emissions which were not present in the UK gas supply system a decade ago.

46 UK and Norwegian pipeline gas supplies have limited capacity to respond to short-term increases in demand, and this will rise over the future with imported LNG filling more of the gap. As a result, incremental gas demand associated with CCGT operation and blue hydrogen production may be met at the system margin, which in certain periods is cleared by LNG

[12] UK's North Sea Future Plan (Nov 2025), provided as a stand-alone appendix in examination library, also at https://assets.publishing.service.gov.uk/media/6926dede345e31ab14ecf507/north-sea-future-plan-government-response.pdf

[13] Digest of UK Energy Statistics (DUKES): natural gas, update 31/07/2025. https://www.gov.uk/government/statistics/natural-gas-chapter-4-digest-of-united-kingdom-energy-statistics-dukes

imports[14] rather than by additional pipeline. This is on top of the overall background of increasing LNG levels in the UK natural gas supply.

47 There is therefore a historic evolution of the gas supply to 2025 in which the growth of LNG is an established and known dynamic. And there is a future evolution of the natural gas supply between 2031 and 2055 corresponding to the project lifetime for which there are many uncertainties.

48 However, DESNZ's December 2023 report "*The role of gas storage and other forms of flexibility in security of supply*"[15], did suggest a forecasted peak of UK gas imports in 2045, indicating that LNG imports would grow for the first 15 years of the project's operation:

> *"… the UK's import dependence for both LNG and interconnector gas supply is projected to rise from a predicted 13% in 2023 to around 32% by 2030. This is forecast to peak at around 58% in 2045, falling to 50% by 2050. It is likely that LNG will make up a significant proportion of these future gas imports."*

B.3 Emission factors and uncertainties

49 Turning to the emissions in the future UK gas supply chains after 2030, the applicant assumes the DESNZ 2025 Scope 3 emission factor ratio is applicable for describing the reasonable worst-case scenario despite considerable uncertainties relating to the natural gas supply and its Scope 3 GHGs.

50 However, the applicant's choice is this single average upstream emissions factor which has been set by using historical data (see below). The applicant has not attempted to provide evidence that it correctly sets the bound of the maximum environmental effects of the evolving natural gas supply chain in the future and over the period to 2055. The Rochdale approach requires that where a key input is uncertain and can materially change the scale of its effect, as is the case for the natural gas supply, the ES must assess the reasonable worst-case environmental effects across the envelope. Establishing a reasonable upper-bound for this uncertainty could be approached by sensitivity analysis, which the applicant has not provided.

51 Such a sensitivity analysis of upstream emissions could be informed from available science. This has rapidly developed over the last few years (see Appendix C) with new studies from remote imaging and satellite data, and from peer-reviewed from-first-principles studies. A particular study from Professor Robert Howarth of Cornell University provides both types of information – a rigorous calculation of emissions at every step in the supply chain which integrates recent satellite data within the calculations.

52 In this submission, CESL generates an indicative sensitivity analysis. The upstream methane emission scenarios relied upon for this indicative sensitivity analysis are drawn from the recent, peer-reviewed Howarth study. This identifies materially higher emission outcomes than those reflected in the Environmental Statement and which, taken together, represent a credible indicator for the upper-range scenario that has not been tested or bounded in the applicant's assessment. As US LNG imports to the UK are increasing[16], this study is chosen for this

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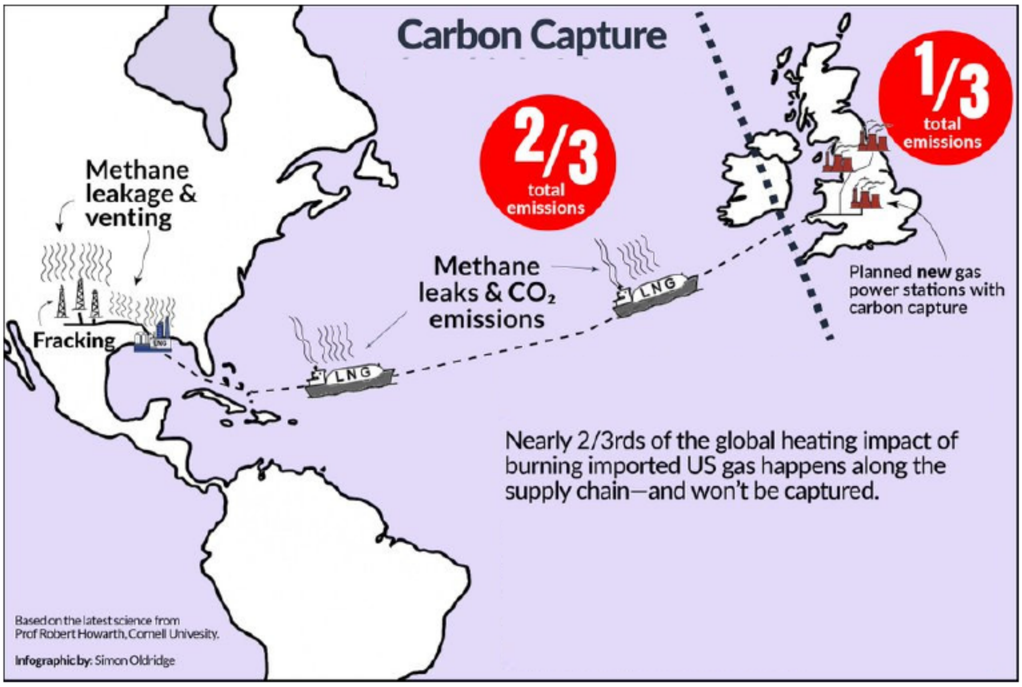
[14] Pipeline gas supplies are constrained by production and contractual limits and have limited short-run elasticity, whereas LNG functions as a globally traded, price-responsive balancing supply whose volumes and routing can adjust over days to weeks in response to demand signals, making it the marginal responder to short-term increases in gas demand at system level.

[15] DESNZ, December 2023, "Role of gas storage and other forms of flexibility in security of supply", pages 19-20, https://www.gov.uk/government/publications/role-of-gas-storage-and-other-forms-of-flexibility-in-security-of-supply

[16] The US LNG export market has rapidly expanded from scratch since 2015. In 2024, 68.2% of UK LNG imports were from the US; the corresponding figure for 2025Q1-3 is 73.9% (from GOV.UK spreadsheet "Energy Trends gas tables (ODS)"

sensitivity analysis as the study extremely meticulously calculates the supply chain from the US to the UK. Further information and details in given in Appendix C.

53 For scene setting, the graphic below shows the overall conclusion of this recent paper that, with an US export LNG supply chain, only ~⅓ of the total GHG emissions occur at point of Scope 1 CCGT gas combustion (ie in the UK), ~⅔ occur upstream and are uncapturable.



Figure[17] 1: Upstream LNG emissions in US-UK supply chain

B.4 DESNZ Emission factors

54 The DESNZ emission factors relied upon by the applicant are designed to provide national-level average estimates for consistency in reporting and high-level appraisal. They are historically anchored, reflecting past and recent observed conditions across the UK gas system as a whole, rather than forward-looking projections of evolving supply chains. They are not specified or intended to represent upper-bound or reasonable worst-case values for project-level Environmental Impact Assessment. Where such average factors are used in circumstances where upstream emissions materially determine the outcome of the assessment, additional analysis is required to demonstrate that higher-impact but plausible scenarios are adequately bounded.

55 For further background, the introduction of Scope 3 emissions into the UK Government conversion tables (ie the DESNZ emission factors referred to here) was based on self-reported industry data from before 2015 and assumptions stretching back decades (see Appendix C). As such, these emission factors provide modal or averaged estimates from the past. They are limited in that they do not reflect the rapid future evolution in the UK natural gas supply, including the emergence of LNG imports, and more recent scientific evidence. They do not

https://assets.publishing.service.gov.uk/media/6941a0e11ec67214e98f3045/Gas_DEC_25.ods) from GOV.UK webpage "Energy Trends: UK gas", last update 06/01/2026, downloaded 22/01/2026, https://www.gov.uk/government/statistics/gas-section-4-energy-trends

[17] I am grateful to Simon Oldridge for permission to use this graphic

provide sensitivity analysis on the uncertainty of Scope 3 upstream emissions in the future gas supply, and cannot provide the maximum bound for the Rochdale Envelope.

56 In a report last year[18] (supplied to the examination library as a stand-alone Appendix), Distinguished Research Fellow at the Oxford Institute for Energy Studies, Jonathan Stern concluded that despite clear technical potential for rapid methane abatement, methane emissions from the oil and gas sector are not falling at the pace or scale required, and in many regions continue to be under-reported. He finds that measurement, reporting and verification (MRV) regimes remain uneven, slow to mature, and largely incapable of supporting project- or supply-chain-specific assessment, with reliable, reconciled measurement still confined to a limited number of jurisdictions:

> *"Detailed technical studies demonstrate the problems of measuring emissions from a supply chain and the limitations of using a single figure for LNG emissions from countries with complex supply chains, with assets of different vintages"[19].*

57 Such factors were never designed to operate as reasonable worst-cases or upper bounds in project EIAs. Where an applicant nevertheless uses such a factor in a way that constrains the maximum emissions reported in the ES, it operates in practice as a Rochdale-envelope parameter regardless of its original design intent.

58 Where such factors are used as outcome-determinative caps on assessed impacts, additional analysis is required to demonstrate that they bound plausible higher-impact outcomes.

59 Thus KNGPS, operating in a future UK natural gas supply different from the past, may give rise to greenhouse gas emissions materially in excess of those assessed in the EIA and based on the DESNZ emission factors.

60 A reasonable worst-case for the EIA must reflect credible high-impact scenarios, including upper-bound LNG scenarios.

61 Where such factors are used in a manner that mathematically constrains the maximum assessed impacts, the question for EIA is not whether they are 'reasonable averages', but whether they demonstrably bound plausible higher-impact outcomes.

62 The applicant notes in APP-050 that "there are considerable uncertainties with the calculation of the indirect effects (Scope 3 emissions)" [18.6.17], that there are "no reliable projections" of how the leakage from natural gas supply chains may be reduced over time [18.3.52], and assumes implicitly that no increases of emissions over time can occur (see above) [18.3.56, 18.3.52 and 18.3.53].

63 As a result, the Environmental Statement relies on a single emission factor without undertaking sensitivity analysis of uncertainty in this parameter, and without testing whether higher-impact upstream emission scenarios—expected to increase over the period to 2055—are bounded within the Rochdale Envelope for the project.

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[18] Jonathan Stern, OIES Paper ET46, (April 2025) "*Measurement Reporting and Verification of Methane Emissions from the Gas and Oil Sector and Consequences for LNG Trade: a three year progress report*", https://www.oxfordenergy.org/publications/measurement-reporting-and-verification-of-methane-emissions-from-the-gas-and-oil-sector-and-consequences-for-lng-trade-a-three-year-progress-report/ , Supplied as stand-alone Appendix to the examination library.

[19] Stern (2025), ibid, section 8.3

64 CESL submits that its indicative sensitivity analysis shown later (in Section C) provides evidence that the KNGPS project would not operate with Scope 3 emissions bound within the maximum values reported in the EIA, consequentially the proposed development may give rise to greenhouse gas emissions materially in excess of those assessed.

B.5 Issue (ii): Uncertainty from the high-impact short-term impacts of supply chain methane.

65 This relates to the choice of climate metric used to model the atmospheric effects of methane, another factor which contributes to the value of the chosen emission factor for upstream emissions. The emission factors chosen in the EIA (ie the DESNZ emission factors) model climate impacts over a 100 year "Global Warming Potential" (referred to as GWP100). GWP100 is appropriate for long-lived climate pollutants like CO_2 which can persist in the atmosphere for centuries. However, methane is a short-lived pollutant, making GWP20, which models 20-year climate impacts, more accurate especially for near-term climate impacts to 2050, and during the KNGPS project lifetime to 2055.

Due to a historical quirk, described in Appendix C, Government modelling (including the DESNZ conversion factors) use GWP100. This masks methane's short-term but much greater (than CO_2) heating impacts over a 10-20 year period. This compounds the existing issues with UK emissions factors by a further factor to 2-3 times underestimating the real climate impact in addition to the underlying under forecasting of future supply chain emissions, now evidenced in more recent scientific literature.

66 This submission does not contend that GWP20 must replace GWP100 in EIA. It demonstrates that reliance on GWP100 alone, without sensitivity testing, masks materially higher short-term impacts that are relevant to reasonable worst-case assessment. Without sensitivity testing with GWP20, it fails to identify the upper range of near-term climate effects relevant to reasonable worst-case assessment.

67 The combined impacts of issues (i) and (ii) give rise to considerable uncertainty in the GHG forecasting of upstream supply chain emissions. The applicant has omitted sensitivity analysis on these impacts, and consequentially the proposed development may give rise to greenhouse gas emissions materially in excess of those assessed.

D1 / Section C Treatment of upstream emissions (natural gas only), assumptions and assessing the full range of impacts

68 A key argument in this submission is that KNGPS may give rise to greenhouse gas emissions materially in excess of those assessed in the EIA, based on the DESNZ 2025 emissions factor[20] being used to forecast the reasonable worst-case of the Scope 3 upstream GHG emissions. This has been explained above to be because the UK natural gas supply chain is evolving, and scientific literature demonstrating high-impact scenarios for GHG generation in supply chains with imported LNG. The applicant has omitted developing a reasonable worst-case consistent with the evolving nature of the natural gas supply chain and the uncertainty of the value of the upstream emissions in future supply chains.

69 In EIA law, it is sufficient to show that plausible variation in a key parameter produces materially different outcomes; precision is not required to establish that the assessed envelope is non-bounding. Therefore, the purpose of this analysis is not to quantify precise emissions, but to demonstrate that plausible parameter variation produces materially higher outcomes than those assessed in the ES. That demonstration alone is sufficient to show that the ES does not bound a reasonable worst case.

70 Initially, this analysis will only examine Operation Scenario G "Natural Gas Full Lifetime" ("scenario-G").

71 The next sub-sections first show how the scenario-G GHG emissions are calculated in the EIA via a stepwise and numerical explanation. Then an indicative reasonable worst-case forecast of the emissions is made based on the evolving natural gas supply, and to provide an indicative upper bound for a Rochdale Envelope for the uncertainty in the GHG forecasting based on the scientific literature.

C.1 applicant's derivation of upstream emission factors

72 As described above, Section 18.3.56 [APP-050], footnote 9 give the values as scope 1 is 2.0891 $kgCO_2e/m^3$ and scope 3 is 0.3366 $kgCO_2e/m^3$. The applicant's reference to this data source from page 96 of APP-050 is copied in the footnote below[21]. The relevant items of data are reproduced in Appendix B, and will be referred to later.

73 A non-critical point which is illustrated in Appendix B is that the applicant appears to have chosen emissions factors for the "Natural gas (100% mineral blend)" fuel type. CESL suggests that the appropriate fuel type is "Natural gas" which is stated in the source spreadsheet to be the factors for standard natural gas from the UK gas grid and includes some biogas (so therefore not 100% mineral). The numbers are therefore slightly different, but by less than a 1.1% difference, and this does not affect the conclusions of this submission.

74 Appendix B shows that the DESNZ emission factors are shown in four different units: $kgCO_2e$ by (1) tonnes (2) cubic metres ie m^3 (3) kWh (Net CV) and (4) kWh (Gross CV). Following a change to a more appropriate unit (which also has no effect on the calculations), the Scope 1 emission factor for "Natural gas" is taken forward 0.20270 $kgCO_2e$/KWh (Net CV) for CESL's

[20] Also referred to as "conversion factors"

[21] Department for Energy Security and Net Zero (DESNZ) (2025b) *Greenhouse Gas Reporting: Conversion Factors 2025* (online). Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2025 [Accessed 04 April 2025].

indicative calculations which are based on the applicant's grid export figure for KNGPS in MW (1,416 MW_{TH}[22]).

C.2 Upstream (natural gas) emission factors with upper-bound for uncertainty analysis

75 The purpose of the following material is not to define a single 'correct' emissions value, but to demonstrate that credible, peer-reviewed evidence exists for materially higher outcomes than those bounded in the ES.

76 The point is the existence of such credible peer-reviewed evidence, demonstrates that the ES envelope may be non-bounding.

77 For the indicative sensitivity test on scenario-G, CESL provides the Howarth (2024) paper as a source from the scientific literature for deriving an upper-bound for the uncertainty, or reasonable worst-case, in future natural gas supplies. As mentioned above, this is a key peer-reviewed paper on the upstream Scope 3 supply chain emissions of natural gas supplied as exports from the US. Supplementary Table B specifically calculates the emissions for the commercial LNG tanker route from Sabine Pass, Texas to the UK (9070 km each way). Therefore it provides a reasonable worst-case of emissions for natural gas supplied to the UK by US LNG imports. Appendix A gives a CESL-annotated extract from Supplementary Table B of the Howarth (2024) paper which shows and explains the data.

78 The complete Howarth paper and its separate supplementary data document have been supplied as separate (out of document) appendices to the Examination library.

79 It should be noted that Howarth also calculates and longest regular commercial route from the United States to China (27,961 km each way, Sabine Pass, TX to Shanghai) with significantly higher figures due to higher LNG tanker emissions. Clearly, the US to UK calculation is the appropriate one for a reasonable worst-case for UK natural gas installations.

80 The Howarth (2024) analysis is not relied upon as a forecast of future UK gas supply, but as a scientifically credible indicator of upper-range upstream emissions that the ES has not tested or bounded.

81 In Appendix A, I show how the Scope 1 combustion and Scope 3 Upstream emissions are tabulated in the paper supplementary data. In the table below, I have extracted the top-level data, sufficient to calculate below, Scope 3 emission factors in each of 4 of different LNG tanker vessel types. The data in column D provides direct comparator Scope 3 emissions factors to the Scope 3 emission factor derived by the applicant based on the DESNZ data.

[22] APP-050 / 18.3.54

Scope 3 Emission Factors (Howarth Supplementary Table B)	A	B	C	D = (0.20270)*(B/A)
	Combustion gCO_2e/kg	Upstream gCO_2e/kg	Total gCO_2e/kg	Scope 3 emission factor $kgCO_2e/KWh$
Steam-turbine tankers powered by LNG	2,750	4,695	7,445	0.35
4-stroke engine tankers powered by LNG	2,750	4,841	7,591	0.36
2-stroke engine tankers powered by LNG	2,750	4,661	7,411	0.34356
Diesel-powered tankers	2,750	4,471	7,221	0.33

Table 1: Scope 3 emission factors calculation from scientific literature

82 Dual-fuel two-stroke tankers have greater fuel efficiencies and so are likely to become more common in the future (see references for this in Howarth paper in stand-alone Appendix submitted to examination library). Steam-turbine and 4-stroke engines, with higher emissions in the Table above, will decline as a share of the LNG tanker fleet. So as highlighted in the table above, CESL has taken the emission factor of 0.34356[23] forward as a reasonable worst-case for the future UK natural gas supply in the project lifetime, noting that this is not the most conservative figure that could have been chosen.

83 This emission factor of 0.34356 may then be used, for sensitivity analysis purposes, to calculate a reasonable worst-case for the operational GHG emissions, or upper-bound for the uncertainty of the natural gas supply chain.

84 CESL submits that the current absence of any sensitivity test for the high impact of the upstream emissions, consistent with the uncertainties of future and evolving natural gas supply chains, leaves the applicant with an EIA and Rochdale Envelope that would be breached by the development.

85 Such an indicative sensitivity test using the data described above and in Appendix A is now presented.

C.3 Sensitivity tests of operational GHG emissions (scenario-G – natural gas full lifetime)

86 The applicant's Table 18.10 [APP-050] is reproduced below. We are only concerned here with the row G (Operating Scenario), "Natural Gas Full Lifetime", and the bottom ringed number for Scope 3 emissions in Figure 3 below.

87 Whilst analysing the applicant's data, and in trying to reproduce Table 18.10, CESL found a number of issues which it could not fully resolve. A summary of these is provided in Appendix D in this document. CESL respectfully requests that the applicant provides any necessary clarifications.

[23] Full precision given so the figures in Table 2 are reproducible without rounding error

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Table 18.10: GHG emissions and GHG emissions intensities of each scenario, broken down by those in the direct control of the Proposed Development, and total lifecycle GHG emissions including those outside the direct control of the Proposed Development

Operating scenario	Description	Construction, maintenance & decommissioning GHG emissions (tCO_2e)	Scope 1 operational GHG emissions (tCO_2e) – operational fuel use	Scope 1 operation, construction, maintenance and decommissioning emissions		Scope 3 operational GHG emissions (tCO_2e) – operational fuel supply	Scope 1 + Scope 3 operational, and construction, maintenance and decommissioning emissions	
				Direct lifecycle GHG emissions (tCO_2e)	Direct Lifecycle GHG emissions intensity (tCO_2e/GWh)		Total Lifecycle GHG emissions (tCO_2e)	Total Lifecycle GHG emissions intensity (tCO_2e/GWh)
A	H_2 Full Lifetime	162,229	3,041	165,270	3	7,027,112	7,030,153	119
B	Early Full Decarbonisation	162,229	2,033,413	2,195,642	36	6,625,570	8,658,983	147
C	Full Decarbonisation by 2035	162,229	5,078,972	5,241,200	87	6,023,255	11,102,227	187
D	Blending Ramp-up	162,229	12,817,300	12,979,529	216	4,492,861	17,310,161	290
E	Late Full Decarbonisation	162,229	15,230,832	15,393,061	256	4,015,541	19,246,373	322
F	Late Partial Decarbonisation	162,229	18,605,910	18,768,139	312	3,348,058	21,953,968	367
G	Natural Gas Full Lifetime	162,229	19,581,630	19,743,859	328	3,155,092	22,736,722	380

Figure 2: applicant's Table 18.10

88 In Table 2 below[24], the scenario-G upstream operational emissions in tCO_2e are forecast for:

- (A) the application (ie reproducing the data in Table 10.8); and
- (B) a sensitivity test (ST1) for the upstream emission factor

Upstream emissions (tCO_2e) over 25-year operation period Scenario-G "Natural Gas Full Lifetime"				
			Application	Evolving nature of natural gas supplies
Data/Assumption Source	**Description**	**Formulae**	**Column 1 (Table 10.8)**	**Column 2 (ST1)**
APP-050 / 18.3.54	**Grid Export MW**	**A**	1,416	1,416
AS-016 / 5.3.9	**Hours over first 15 years**	**B =15 * 3500**	52,500	52,500
AS-016 / 5.3.9	**Hours over last 10 years**	**C = 10 * 1500**	15,000	15,000
	MWh over 25 years	**D = (B + C) * A**	95,580,000	95,580,000
Emission factor from DESNZ for Column 1 and recent science for Column 2	**Scope 3 EF (Net CV) $kgCO_2e/KWh$ "Natural Gas"**	**E**[25]	0.03347	0.34356
	Calculation Offset	**F**	-43,971	-43,971
	Scope 3: Upstream natural gas supply chain emissions tCO_2e	**G = (D * E) + F**	3,155,092	32,793,310

Table 2: Sensitivity test Scenario-G upstream emissions – Indicative sensitivity tests of uncertainties of GHG forecasting
(for bounding purposes only; not a substitute ES)

89 For (A) the application, I am unable to precisely stepwise calculate the ringed figure from Table 10.8 above in column 1 of Table2 . I find that my calculation requires an "offset" of -43,971 tCO_2e to align with the applicant's Scope 3 operational emissions (operational fuel supply).

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[24] Reproduced from CESL's own Excel spreadsheet model

[25] E is shown rounded in table; the calculation uses unrounded value as derived from Table 1.

90 The existence of this offset does not reduce the validity of the sensitivity test, which alters only a single parameter (the upstream emission factor) and demonstrates order-of-magnitude sensitivity irrespective of minor reconciliation differences. It does not affect the conclusions of my submission. It would be helpful if the applicant could clarify its calculation steps to the examination.

91 For (B) a sensitivity test (ST1) for the upstream emission factor, the emission factor based on the DESNZ conversion factors is replaced with the emission factor calculated from the Howarth paper above in column 2 of Table 2 (this is the sole input change to the forecasting from column 1, and is highlighted green). This provides a sensitivity test which takes into account the high-impact GHG scenarios that arise from the evolving nature of natural gas supplies. The only different forecast output for ST1 is the upstream emissions figure, highlighted yellow.

92 For each row, the calculation formulae are given column to the left of the figures in Table 2.

93 In this indicative sensitivity analysis, the forecasts in Table 2 provide reasonable worst-cases for the upper-bound of the uncertainty for the EIA assumptions on upstream supply chain emissions.

94 Table 2 shows that when the high impacts from the future evolution of the natural gas supply chain are included (ST1, column 2), KNGPS may give rise to greenhouse gas emissions materially in excess of those assessed in the ES (ie as shown in “Column 1 (Table 10.8)”).

95 This sensitivity analysis is included solely to demonstrate that plausible variation in an outcome-determinative parameter yields materially different results, indicating the ES has not demonstrated a bounded reasonable worst case.

96 These same upstream uncertainties carry directly into hydrogen-fuelled operation as covered in Section D which follows.

C.4 Scenario-G significance assessment

97 The above indicative sensitivity analysis suggests the scale of how the KNGPS power station, operating in scenario-G or natural gas only may give rise to greenhouse gas emissions materially in excess of those assessed is such that the operational emissions significance assessment (APP-050, sections 18.6.51 - 18.6.58 “Summary of GHG Impacts” , Table 18.12, and sections 18.6.59 - 18.6.63) cannot be valid. For this reason, CESL makes no submissions on these sections of the application yet.

D1 / Section D Hydrogen Supply, Plausibility of Operational Scenarios, and the Rochdale Envelope

D.1 Scope and purpose of this section

98 This section addresses the Environmental Statement's assessment of hydrogen-fuelled operational scenarios (Scenarios A–F) presented in Chapter 18 of the ES.

99 It considers whether those scenarios represent plausible operational modes of the Proposed Development, and whether the associated lifecycle greenhouse gas (GHG) impacts have been properly identified, assessed, and bounded for the purposes of Environmental Impact Assessment.

100 The issue is not whether hydrogen production infrastructure is consented elsewhere, but whether the emissions associated with producing the hydrogen relied upon by the applicant are realistically bounded in the assessment.

101 The development of this section reflects further clarification provided at ISH1, which has enabled the implications of the hydrogen scenarios assessed in the ES to be examined more fully. CESL's Relevant Representation already identified that certain hydrogen scenarios (Scenarios A–C) were not logically possible. For the reasons now set out in greater detail, this submission concludes that none of the hydrogen scenarios assessed (Scenarios A–F) represent realistically achievable operational modes of the Proposed Development (see Section D.8, "Scenarios A–F are not plausible operational scenarios").

102 I respectfully request to the ExA that I defer further substantive comment on hydrogen supply, and operation scenarios A to F, until deadline D3 (April 1st) following the applicant's submissions at D2 which may provide further clarifications. This deferral reflects procedural fairness: meaningful engagement with hydrogen scenarios depends on clarification of supply assumptions and evidence that the applicant has not yet provided. Preliminary comments follow below.

D.2 Hydrogen supply is integral to the assessed operation of the Proposed Development

103 Hydrogen is not a naturally occurring fuel in the UK. Any hydrogen-fuelled operation at the Proposed Development necessarily depends on the production, transport, and supply of hydrogen from infrastructure external to the site[26].

104 Where an applicant chooses to present hydrogen-fuelled operation as part of the operational envelope of a development, the environmental effects associated with producing and supplying that hydrogen are integral to the operation of the development for EIA purposes, notwithstanding that the hydrogen production infrastructure itself is not part of the consent sought.

105 Accordingly, hydrogen operational scenarios cannot be treated as plausible unless hydrogen supply pathways, provenance, and lifecycle characteristics are evidenced and realistically assessed.

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[26] There was considerable discussion on hydrogen supplies at the ISH1. And I note, the action point for the applicant to provide further information regarding the East Coast Hydrogen project [EV3-010 / action point 2] for deadline D2 (February 25th).

106 I note that only blue and green hydrogen are being put forward as possible sources for hydrogen fuel for KNGPS. Whilst pink, and yellow, and other colours of hydrogen were briefly mentioned at the ISH1, the applicant spoke only of green and blue hydrogen as likely in the hydrogen supply to KNGPS. The applicant excluded gray hydrogen completely [EV3-003/page 6]. Blue and green hydrogen as the predominant likely hydrogen sources is also reflected in the APP-050. The comments below, therefore, relate only to green and blue hydrogen.

D.3 Absence of evidence for green hydrogen supply

107 Green (electrolytic) hydrogen is a hydrogen production pathway that avoids upstream methane emissions associated with natural gas supply with blue hydrogen production.

108 However, the Environmental Statement does not provide evidence that green hydrogen will be available at sufficient scale to supply the Proposed Development during the assessment period. No production facilities, delivery routes, or credible supply mechanisms are identified.

109 At ISH1, the applicant said that, in the current market, the current scale of production of green hydrogen in the UK today is relatively small[27], and short-term plans for blue hydrogen production is an order of magnitude higher than green hydrogen[28]. The applicant recognised within the hydrogen economy and the hydrogen industry that use of green hydrogen is probably <u>not</u> going to be focused on power generation, such as at KNGPS[29].

110 In effect, at ISH1 the applicant indicated, in substance, that green hydrogen is unlikely to be available to the project[30] within the relevant timescales.

111 In the absence of evidence of green hydrogen supply, it is not reasonable to treat green hydrogen as a plausible contributor to Scenarios A–F.

112 As there is considerable uncertainty on this, CESL respectfully requests that the ExA requires that, in responding to action point 2 [EV3-010], the applicant clarifies both the realistic likelihood of non-stored green hydrogen and stored green hydrogen within the fuel supply for KNGPS from the ECH network, and as a proportion total hydrogen fuel. It would be helpful for estimates of this over the project lifetime (2031 – 2055) are provided to the examination.

D.4 The hydrogen scenarios therefore depend on blue hydrogen supply

113 Given the absence of evidenced green hydrogen supply, the hydrogen scenarios assessed in Chapter 18 [APP-050] necessarily rely on hydrogen produced from natural gas, i.e. blue hydrogen.

114 Variations in natural gas supply is not explicitly examined in the Environmental Statement. Instead, hydrogen is treated as a homogeneous fuel with a fixed assumed lifecycle carbon intensity.

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[27] EV3-003 / page 3

[28] EV3-003 / page 3

[29] EV3-003 / page 10

[30] At ISH1, the applicant did refer to the possibility storing green hydrogen in caverns or saline aquifers to use excess energy from wind farms, and avoid curtailment, and then deploying the hydrogen later when required. However, the applicant has not provided evidence of a viable commercial route to storing green hydrogen and using it in the ECH network.

115 This omission is material, because the lifecycle GHG impacts of blue hydrogen are dominated by upstream gas supply conditions.

D.5 Blue hydrogen lifecycle emissions are dominated by upstream gas supply conditions

116 Where hydrogen is produced from natural gas, its lifecycle GHG emissions are materially determined by upstream processes, including:

- methane emissions from natural gas extraction, processing, and transport;
- the provenance of gas supply, including the increasing role of LNG imports;
- CO_2 capture performance across the full reforming system, not merely nominal capture rates;
- venting of CO_2 during periods of hydrogen production when the CO_2 Transport and Storage system are unavailable (e.g. for maintenance); and
- operational variability over time, including start-up, shutdown, and part-load operation.

117 As set out elsewhere in this submission, UK natural gas supply is increasingly met at the margin by LNG imports, a trend expected to increase and persist over the operational lifetime of the Proposed Development.

118 These upstream emissions are uncapturable, occur outside the site boundary, and dominate lifecycle emissions for blue hydrogen.

D.6 The ES caps hydrogen production impacts at the LCHS threshold without evidential justification

119 Chapter 18 [APP-050] of the Environmental Statement states that lifecycle greenhouse gas emissions associated with hydrogen supply have been included in the assessment by assuming a hydrogen carbon intensity of 20 gCO_2e/MJ (LHV), corresponding to the maximum permitted value under the Low Carbon Hydrogen Standard (LCHS) [31].

120 That value is applied:

- uniformly across all hydrogen-fuelled scenarios (A–F);
- across the full assessment period; and
- as a fixed upper bound, without sensitivity analysis above that level.

121 In effect, the Environmental Statement caps the assessed environmental impacts of hydrogen production at the LCHS threshold[32], and treats that cap as representative of the reasonable worst case.

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[31] UK Low Carbon Hydrogen Standard, Greenhouse Gas Emissions Methodology and Conditions of Standard Compliance, Version 4, January 2026. section 1.2 – "*The Standard defines what constitutes 'low carbon hydrogen' up to the point of production.*"; section 3.1 "*The concept of Standard Compliance (or 'complying with the Standard') shall be applied to Consignments rather than a Hydrogen Production Facility.*"; section 3.3 "*Definition of 'Standard Compliance*".

[32] Just for absolute clarity, the LCHS assesses greenhouse gas intensity at the point of production on a consignment-by-consignment basis, tied to the specific hydrogen production pathway and facility. The Standard does not permit blending or averaging of hydrogen

122 Where an applicant relies on an assumed emissions threshold to cap assessed impacts, the evidential burden lies on the applicant to demonstrate that the threshold is achievable across realistic operating and supply conditions. Compliance with a policy standard cannot be assumed as a matter of fact for EIA purposes where the evidence shows that compliance depends on highly contingent upstream conditions that are neither evidenced nor controlled by the applicant.

123 However, the Environmental Statement does not provide evidence demonstrating that blue hydrogen supplied to the Proposed Development can reliably and consistently achieve lifecycle emissions at or below this level across the operational lifetime of the project.

124 There is now substantial evidence demonstrating that blue hydrogen cannot be assumed, as a general or reliable case, to achieve lifecycle emissions below 20 gCO_2e/MJ under realistic upstream gas supply conditions [33,34], particularly where LNG-derived gas forms a material part of the supply chain. A 2024 report from Tatarenko et al[35] (supplied to the examination library as a stand-alone Appendix) specifically addresses this issue, and finds that '*given proven variance in upstream emissions for natural gas, locking in theoretical methane leakage values leads to perverse incentives for developers and will allow certain highly emissive hydrogen products to qualify as "clean," jeopardizing climate impact'*. For three scenarios of European blue hydrogen production using US LNG being imported to Europe (a similar LNG tanker trip to that to the UK, and so a reasonable comparison), they calculate emissions intensities of 65.3 gCO_2e/MJ ("Measured: US National Average"), 76.0 gCO_2e/MJ ("Low: Permian Basin") and 116.9 gCO_2e/MJ ("High: Permian Basin")[36] – far in excess of the LCHS standard of 20 gCO_2e/MJ.

125 Achieving LCHS-compliant blue hydrogen requires extreme best-case assumptions, including exceptionally low upstream methane leakage and sustained, near-perfect CO_2 capture performance (above 95%). The Environmental Statement does not demonstrate that such conditions can be assumed to hold universally or persistently over the decades of operation of KNGPS.

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from different production routes or facilities, nor does it allow compliance to be demonstrated on a hydrogen-network or grid-average basis. Hydrogen produced by a non-compliant production facility therefore remains non-compliant irrespective of any downstream mixing. The LCHS standard (version 4, January 2026) is supplied as a stand-alone Appendix.

[33] Even before the more recent evidence on upstream emissions in the natural gas supply chain, as presented elsewhere in this submission, studies showed that for blue hydrogen production to comply with the LCHS would be structurally unattainable, except in unlikely best-case examples. For example, independent analysis from Carbon Tracker (Kind of Blue report, see stand-alone Appendix) concluded blue hydrogen produced from imported LNG could exceed the UK LCHS by approximately 80–170%, and in some cases by up to 2.5 times the permitted limit, even assuming high capture rates, and based on GWP100: the main factor being the upstream emissions from the evolving natural gas supply chain in the future, as already described.

[34] Howarth, R.W. & Jacobson, M.Z. (2021), doi.org/10.1002/ese3.956, "How green is blue hydrogen?". Supplied as a stand-alone Appendix to the examination library. The study finds the GHG intensity of blue hydrogen as 135–139 gCO_2e/MJ with worst-case scenario 182 g CO_2-eq/MJ

[35] Oleksiy Tatarenko et al, "Weak Emissions Accounting Can Undermine Hydrogen's Role in Global Decarbonization", [redacted]

[36] See Exhibit C1 in the stand-alone Appendix provided to examination library for Oleksiy Tatarenko et al (2025). These figures have been calculated from the figures on their Exhibit with conversion factor Hydrogen LHV ≈ 120 MJ per kg H_2. So 7.83 $kgCO_2e/kgH_2$ = 65.3 gCO_2e/MJ etc.

D.7 Use of the LCHS cap to constrain, rather than assess, hydrogen production impacts

126 The Environmental Statement does not omit hydrogen production impacts; rather, it includes them only insofar as they fall below an assumed LCHS cap, and does not assess the consequences where hydrogen production exceeds that level.

127 In doing so, the applicant treats LCHS compliance as determinative of hydrogen lifecycle impacts, rather than as a policy threshold whose achievability must itself be tested against realistic supply conditions.

128 For EIA purposes, this approach is not sufficient. Where an assumed emissions threshold is used to cap assessed impacts, the applicant must demonstrate that the threshold represents a reasonable upper bound on the impacts that could realistically arise.

129 The Environmental Statement does not do so in relation to hydrogen production.

D.8 Scenarios A–F are not plausible operational scenarios

130 Taken together:

- green hydrogen supply is not evidenced and is highly unlikely to be available;
- hydrogen supply must therefore be predominantly blue hydrogen;
- blue hydrogen lifecycle emissions are dominated by upstream gas supply conditions;
- under realistic LNG-influenced supply chains, LCHS compliance cannot be assumed; and
- the Environmental Statement caps hydrogen production impacts at a level that is not demonstrated to be universally achievable.

131 Scenarios A–F therefore depend on fuel characteristics that are not realistically achievable across the expected operating context of the Proposed Development.

132 EIA requires assessment of realistic scenarios. There is no obligation on an interested party to engage with scenarios that are unsupported by evidence and not plausibly achievable. In such circumstances, continued numerical assessment of those scenarios would risk lending false credibility to operational modes that the Environmental Statement itself has not shown to be achievable.

D.9 Hydrogen assumptions as Rochdale-envelope parameters

133 The assumed lifecycle carbon intensity of hydrogen functions in practice as a Rochdale-envelope parameter, because it mathematically constrains the maximum greenhouse gas impacts assessed for hydrogen-fuelled operation.

134 Where such a parameter is based on an assumed compliance threshold that has not been shown to bound realistic outcomes, the Rochdale envelope is artificially constrained and does not provide the decision-maker with full knowledge of the likely significant environmental effects.

135 The Environmental Statement does not demonstrate that the assumed hydrogen carbon intensity bounds the reasonable worst case, nor does it provide sensitivity analysis to test higher-impact but plausible hydrogen production scenarios.

D.10 Implications for the adequacy of the Environmental Statement

136 By relying on hydrogen-fuelled scenarios that are capped at an unproven emissions threshold, the Environmental Statement:

- fails to assess the full range of likely lifecycle greenhouse gas impacts;
- understates the climate impacts associated with hydrogen use; and
- obscures the likelihood that, in practice, the Proposed Development would operate predominantly on natural gas.

137 This is not a challenge to hydrogen policy or to the existence of the LCHS. It is a failure to demonstrate that the assumptions used to cap hydrogen production impacts represent a reasonable worst case for EIA purposes. The issue is evidential, not normative: whether the Environmental Statement has demonstrated, on the facts, that the assumed emissions threshold bounds the impacts that could realistically arise.

D.11 Scenarios A-F significance assessment

138 The hydrogen scenarios assessed in Chapter 18 of the Environmental Statement (Scenarios A–F) rely on an assumed cap on hydrogen lifecycle greenhouse gas emissions that has not been shown to be achievable across realistic supply conditions or across the lifetime of the Proposed Development.

139 Because that assumed cap functions to constrain the Rochdale envelope for greenhouse gas impacts, the Environmental Statement does not provide the Secretary of State with a sound or complete understanding of the potential climate impacts of the Proposed Development.

140 As the scale of the upstream emissions in the hydrogen production supply chain, operating in scenarios A-F, based on hydrogen co-firing, may give rise to greenhouse gas emissions materially in excess of those presented in Table 18.10. It follows that the assessment of the operational emissions significance assessment (APP-050, sections 18.6.51 - 18.6.58 "Summary of GHG Impacts" , Table 18.12, and sections 18.6.59 - 18.6.63) cannot be valid. For this reason, CESL makes no submissions on these sections of the application yet.

141 These factual deficiencies described in Sections C and D give rise to the legal consequences described in the next section (E).

D1 / Section E Legal Considerations

142 CESL has submitted evidence that KNGPS may give rise to greenhouse gas emissions materially in excess of those described and assessed as the reasonable worst-case, in Table 18.10 [APP-050], and the assumptions on the upstream emissions factor in the EIA as described above. For upstream emissions, this is because the evolution of the natural gas supply chain, the scientific literature on the uncertainty of forecasting of upstream methane emissions in that supply chain (affecting both the natural gas supply and the hydrogen fuel supply), and the physical timings of near-term warming impact of methane have not been accounted for in the applicant's assumptions and forecasting.

143 This submission invites the Examining Authority to consider the application of established EIA principles to the specific characteristics of climate change assessment. The Rochdale Envelope, as reflected in case law and Planning Inspectorate guidance, is concerned with whether the Environmental Statement has lawfully bounded the maximum adverse environmental effects that could arise from the development if consented, so that the decision-maker has full knowledge of its likely significant effects. In the context of climate impacts, those effects are determined not by the spatial dimensions of the project alone but by quantified emission assumptions that define the numerical scale of impact over time. Applying sensitivity analysis to the relevant parameters applies the core logic of Rochdale —assessment of the reasonable worst-case—to impacts whose drivers are mathematical rather than spatial parameters, and where the effects over time are uncertain.

144 This submission does not contend that the applicant must model all external futures, but that where the applicant's chosen single-value assumptions cap outcome-determinative emissions, the ES must demonstrate that those caps bound plausible higher-impact outcomes.

145 Advice Note Nine[37] makes clear that the approach is not confined to spatial dimensions or layout flexibility, but is concerned with ensuring that the Environmental Statement has assessed the maximum adverse environmental effects that could arise from the Proposed Development. The Advice Note emphasises that a cautious worst-case approach must be adopted, that decision-makers must have full knowledge of likely significant environmental effects, and that the parameters defining the Rochdale Envelope must be sufficiently detailed to enable a proper assessment of those effects and the identification of mitigation.

146 Even if the upstream emission assumptions were not treated as defining parameters of a Rochdale Envelope, the Environmental Statement would still fail to assess a reasonable worst-case scenario for operational greenhouse gas emissions. And it would not provide the decision-maker with full knowledge of the project's likely significant climate effects, given the evidenced uncertainties in upstream gas supply, especially in the future, and the absence of any sensitivity testing of these higher-impact scenarios (either for KNGPS operating on 100% natural gas in scenario G, or with proportions of hydrogen in scenarios A - F). .

147 The applicant suggests that the electricity from the proposed KNGPS plant would replace electricity from existing unabated gas (see for example APP-050, section 18.6.28[38]) of similar capacity and therefore deliver net greenhouse gas savings against a future baseline in which that existing plant continues to operate. Even if such a future baseline scenario were assumed, it does not remove the requirement under the EIA Regulations for the Environmental Statement

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[37] PINS (2018). Nationally Significant Infrastructure Projects - Advice Note Nine: Rochdale Envelope [online] (Accessed 23/01/2026). https://www.gov.uk/government/publications/nationally-significant-infrastructure-projects-advice-note-nine-rochdale-envelope/nationally-significant-infrastructure-projects-advice-note-nine-rochdale-envelope

[38] Also APP-050, Table 18.1 (response to Lincolnshire Wildlife Trust); sections 18.3.19; 18.6.28; 18.6.31; 18.6.60; 18.6.61; 18.8.4;

to assess the likely significant greenhouse gas emissions of the proposed development itself on a reasonable worst-case basis. Relative comparisons with speculative counterfactual futures cannot cure deficiencies in the assessment of the project's own impacts. In any event, the claimed replacement benefit is critically dependent on assumptions regarding upstream methane emissions; where those assumptions materially understate emissions, the asserted net savings may not arise. It is therefore not possible to rely on replacement arguments without first establishing a robust and lawful assessment of KNGPS's own lifecycle emissions.

148 The Rochdale Envelope principle reflects the long-standing interpretation within the UK of the EIA regime derived from the EU EIA Directive[39]. Withdrawal from the EU has not altered the requirement that development consent may not be granted on the basis of an assessment which leaves environmentally determinative parameters unresolved, nor has it displaced the binding pre-exit jurisprudence which established that principle.

149 In these circumstances, the EIA also does not satisfy the legal tests articulated in the recent UK *Finch*[40] and *Whitehaven*[41] cases regarding the need for decision-makers to be provided with "*full knowledge of the environmental cost*" and for likely significant effects to be assessed on a scientifically credible, forward-looking basis. The applicant has not demonstrated that a lawful reasonable worst-case forecast of operational emissions has been established, and therefore the EIA does not meet the standard of forecasting and assessment required.

150 Where an applicant relies on quantitative assumptions to cap environmental effects, the burden lies on the applicant to show that those assumptions bound the reasonable worst case; in the absence of such demonstration, the Environmental Statement is legally deficient. This is not a request for the Examining Authority to resolve contested science, but to determine whether the Environmental Statement has lawfully bounded the consequences of scientific uncertainty.

151 The failures outlined above are not remedied by policy compliance (for example, by compliance with the relevant national policy statements). A procedurally fair, transparent, and scientifically robust EIA process must exist before decision-makers can rightfully balance environmental, economic, and social interests.

[39] While the EIA Directive no longer applies directly, the UK EIA Regulations retain its wording in unchanged terms; accordingly, pre-exit CJEU authority interpreting those provisions remains binding, and later European jurisprudence is properly relied upon as persuasive confirmation of the orthodox interpretation that significant indirect effects and environmentally determinative parameters may not be deferred beyond consent.

[40] R (on the application of Finch on behalf of the Weald Action Group) v Surrey County Council and others, paragraphs 9 and 72

[41] R (on the application of Friends of the Earth and another) v Secretary of State for Levelling Up, Housing and Communities and others, paragraphs 60 and 61

D1 / Section F Conclusions: Why This Matters for the Adequacy of the Environmental Statement

152 This submission does not ask the Examining Authority to resolve contested scientific questions, to determine future energy policy, or to substitute its own emissions modelling for that of the applicant. It asks a narrower and legally orthodox question: whether the Environmental Statement has demonstrated that the greenhouse gas impacts of the Proposed Development have been assessed against a reasonable worst-case envelope, as required by the EIA Regulations.

153 Across the greenhouse gas assessment, the Environmental Statement relies on a small number of quantitative assumptions that materially determine the scale of reported impacts, most notably assumptions relating to upstream natural gas emissions, future variations in UK natural gas supply including imported LNG, methane treatment, and the lifecycle emissions of blue hydrogen derived from natural gas. Where such assumptions are outcome-determinative, EIA law requires that they either bound plausible higher-impact outcomes or are tested through sensitivity analysis to demonstrate that higher impacts would not materially alter the assessment.

154 The Environmental Statement does not do so. It relies on nationally averaged, historically anchored upstream emission factors and policy-derived thresholds that were not designed to represent reasonable worst cases, and it applies them in a manner that constrains the maximum impacts reported. The issue for the Examining Authority is not whether those inputs are “official” or “reasonable averages”, but whether the applicant has demonstrated that they bound the range of upstream emissions that could realistically arise during the operational lifetime of the development.

155 This upstream emissions issue is fundamental. The lifecycle greenhouse gas impacts of the Proposed Development are highly sensitive to assumptions about natural gas supply chains, including methane leakage rates and the increasing role of LNG in marginal UK supply. These upstream emissions are uncapturable, occur outside the site boundary, and are capable of materially altering the scale of total emissions. The Environmental Statement acknowledges uncertainty in these parameters but does not test whether that uncertainty could give rise to materially higher impacts than those assessed.

156 Hydrogen does not introduce a new category of problem; it amplifies the same one. Where hydrogen is produced from natural gas, its lifecycle emissions are dominated by the same upstream gas supply assumptions. The Environmental Statement treats hydrogen-related emissions as bounded by an assumed lifecycle emissions cap, without demonstrating that this cap is achievable across realistic upstream conditions or over the lifetime of the development. As with natural gas combustion, the issue is not policy compliance but whether the assessment envelope has been shown to bound plausible higher-impact outcomes.

157 In these circumstances, continued numerical assessment of operational scenarios based on untested upstream assumptions risks lending false precision to results that are in fact highly sensitive to parameters that have not been bounded. Acknowledged uncertainty becomes legally material where the uncertain parameter determines the magnitude of effects and no analysis is provided to demonstrate that higher-impact outcomes are excluded. That is the position here.

158 The combined effect of these issues is that the Environmental Statement does not provide the decision-maker with a secure understanding of the upper range of greenhouse gas impacts that could realistically arise from the Proposed Development. This is not a matter of improving accuracy or resolving scientific debate, but of ensuring that the assessment envelope is not

artificially constrained by assumptions that have not been demonstrated to represent a reasonable worst case.

159 Accordingly, CESL submits that the Environmental Statement is presently inadequate in respect of greenhouse gas assessment, not because its assumptions are necessarily incorrect, but because it has not been demonstrated that those assumptions bound the reasonable worst case. Without that demonstration, the Examining Authority cannot be satisfied that the likely significant greenhouse gas effects of the Proposed Development have been fully and lawfully assessed.

160 I look forward to assisting the ExA on the issues raised in this submission in any way that I can.

<u>D1 / Section G</u> Resume

Dr Andrew Boswell – Professional Background

Climate Emergency Science Law (CESL), established in 2017 by Dr Andrew Boswell, provides independent, evidence-based scrutiny of UK climate- and energy-related decision-making. CESL brings together expertise in physical sciences, high-performance computing and modelling, energy systems, and climate governance, with a particular focus on the robustness of assumptions used in environmental assessment, policy appraisal, and regulatory decision-making.

Dr Boswell was educated as a scientist, obtaining a first degree in Chemistry from Imperial College London (1977) and a DPhil from the University of Oxford (1981) in structural biology, with a focus on molecular structure, protein binding dynamics, using the then very new field of nuclear magnetic resonance. This training underpins a career-long engagement with complex systems analysis and the interpretation of scientific evidence.

During the 1980s and 1990s, Dr Boswell worked as a software engineer specialising in the design, modelling, simulation, verification, testing and fault analysis of advanced software systems used to design Very Large Scale Integrated (VLSI) circuits, also a new field then. This work required rigorous design, formal mathematical verification methods, and validation of complex computational systems - skills directly transferable to the forensic analysis of environmental modelling and impact assessment.

From 1995 to 2006, Dr Boswell led the high-performance computing (HPC) service at the University of East Anglia (UEA), which he designed and developed from its initial implementation. Several incarnations of the hardware later, the service continues in operation today providing vital computing resources for campus wide scientific research at UEA. In parallel with developing the service, he supported researchers across multiple scientific disciplines, including climate science, in the execution, diagnosis, and optimisation of large-scale numerical models. His work included advising on model architecture, computational assumptions, executing large ensemble computer runs, and forensic investigation for scientists of model failures.

Between 2005 and 2017, Dr Boswell served as an elected councillor on Norfolk County Council and Norwich City Council whilst maintaining and developing his interests in scientific and environmental issues. Since 2017, he has worked as an expert adviser through his consultancy CESL (formerly Climate Emergency Planning and Policy, CEPP). For over two decades, he has submitted detailed, evidence-based responses to Government consultations, the Climate Change Committee, and Parliamentary select committees on climate, energy, and environmental policy. His work consistently focuses on scientific credibility, transparency of assumptions, and legal and policy compliance in the context of the UK's climate obligations.

D1 / Section H Statement on the use of Artificial Intelligence

161 This statement is made in accordance with PINS guidance on "*Use of artificial intelligence in casework evidence*", 6 September 2024.

162 This submission was prepared over the period approximately from 17 January 2026 to 27 January 2026.

163 During this period, I used a standard commercially available artificial intelligence tool (OpenAI ChatGPT v5.2) to assist with researching issues, and drafting and refining textual content for clarity, structure, and readability.

164 The AI tool was used solely in response to prompts provided by me and drew on publicly available information and the content of documents and material supplied by me; it was not used to generate original evidence or data.

165 The text in this submission may therefore have been influenced by the use of AI for research support and proof-reading during the drafting process.

166 I submit that any use of AI in preparing this submission has been responsible and lawful, and has been directed to clarifying and structuring the issues presented.

167 I am responsible for the factual accuracy of this submission. All information has been reviewed and checked by me and, to the best of my knowledge and understanding, is true and accurate.

168 Any numerical work, including any tables of figures or graphs in this document, is entirely my own work.

169 No images[42], video, or visual material have been created, altered, or enhanced using artificial intelligence in this submission.

170 This submission does not contain any personal data, and no personal information has been disclosed or processed using AI. Any use of AI complies with data protection, confidentiality, and copyright requirements.

[42] Figure 1 was supplied to me by the author of the image who is attributed in the footnote. Figure 2 was extracted directly from the source document referenced in the relevant footnote.

D1 / Section I Appendix A

171 This Appendix does not introduce new evidence, but collates and summarises published material to demonstrate the implications of assumptions already adopted in the Environmental Statement."

I.1 Annotated extract from Howarth (2024) Supplementary Table B

172 The full supplementary materials document is supplied as a separate document "CESL_D1_APP_1_HOWARTH_ese31934-sup-0001-on_line_supplemental_materials.docx". Supplemental Table 2 reproduced in full below provides a summary Scope 1 and Scope 3 emissions from the LNG supply chain of a "shortest voyages (21.4 days round-trip)".

173 The main Howarth paper (supplied as separate document "CESL_D1_APP_2_HOWARTH_2024_MAIN_PAPER.pdf" explains what this "shortest voyages (21.4 days round-trip)" is on page 6:

> *"For the length of the voyage, I use the global average distance for LNG tankers (16,200 km each way) as well as the shortest regular commercial route from the United States (9070 km each way, Sabine Pass, TX to the UK) and the longest regular commercial route from the United States (27,961 km each way, Sabine Pass, TX to Shanghai). Most of the LNG exports from the United States are from the Sabine Pass area, so these distances well characterize US exports."*

174 The data for the Sabine Pass, TX to UK continues on the next page with my annotations.

Supplemental Table B. Full lifecycle greenhouse gas emissions for LNG for 4 different tanker-transport scenarios, using shortest voyages (21.4 days round-trip). Methane emissions are shown both as mass of methane and mass of CO_2 equivalents based on GWO_{20}. Values are per final mass of LNG consumed. Numbers in parentheses indicate the percent for each component of the total CO_2 equivalents.

A typographical error, this should read GWP_{20}

	Carbon Dioxide	Methane		Total combined
	g CO_2/kg	g CH_4/kg	g CO_2-eq/kg	g CO_2-eq/kg
Steam-turbine tankers powered by LNG				
Upstream & midstream emissions	735 (9.9%)	34.6	2,854 (38%)	3,589 (48%)
Liquefaction	366 (4.9%)	3.7	306 (4.1%)	673 (9.0%)
Emissions from tanker	169 (2.3%)	0	0 (0%)	169 (2.3%)
Final transmission & distribution	0 (0%)	3.2	264 (3.5%)	264 (3.5%)
Combustion by final consumer	2,750 (37%)	0	0 (0%)	2,750 (37%)
Total	**4,021** (54%)	**41.5**	**3,424** (46%)	**7,445**

Scope 1 combustion GHGs

Total Scope 1 and Scope 3 GHGs.
Scope 3 = 7,445-2,750 = 4,695 g CO_2-eq/kg

4-stroke engine tankers powered by LNG				
Upstream & midstream emissions	727 (9.6%)	34.2	2,819 (37%)	3,545 (47%)
Liquefaction	362 (4.8%)	3.7	303 (4.0%)	665 (8.8%)
Emissions from tanker	126 (1.7%)	2.9	242 (3.2%)	367 (4.8%)
Final transmission & distribution	0 (0%)	3.2	264 (3.5%)	264 (3.5%)
Combustion by final consumer	2,750 (36%)	0	0 (0%)	2,750 (36%)
Total	**3,964** (52%)	**44.0**	**3,627** (48%)	**7,591**
2-stroke engine tankers powered by LNG				
Upstream & midstream emissions	720 (9.7%)	33.9	2,794 (38%)	3,514 (47%)
Liquefaction	359 (4.8%)	3.6	300 (4.0%)	659 (8.8%)
Emissions from tanker	104 (1.4%)	1.4	119 (1.6%)	224 (3.0%)
Final transmission & distribution	0 (0%)	3.2	264 (3.6%)	264 (3.6%)
Combustion by final consumer	2,750 (37%)	0	0 (0%)	2,750 (37%)
Total	**3,933** (53%)	**42.2**	**3,478** (47%)	**7,411**
Diesel-powered tankers				
Upstream & midstream emissions	693 (9.6%)	32.6	2,689 (37%)	3,381 (47%)
Liquefaction	345 (4.8%)	3.5	289 (4.0%)	634 (8.8%)
Emissions from tanker	183 (2.5%)	0.1	8.3 (0.1%)	192 (2.6%)
Final transmission & distribution	0 (0%)	3.2	264 (3.7%)	264 (3.7%)
Combustion by final consumer	2,750 (38%)	0	0 (0%)	2,750 (38%)
Total	**3,971** (55%)	**39.4**	**3,250** (45%)	**7,221**

Ex-UK Scope 3 GHGs

UK Scope 3 GHGs

UK Scope 1 GHGs

D1 / Section J Appendix B

175 This Appendix does not introduce new evidence, but collates and summarises published material to demonstrate the implications of assumptions already adopted in the Environmental Statement."

185 The following have been snapshot[43] from spreadsheet at the reference given in APP-050 - Department for Energy Security and Net Zero (DESNZ) (2025b) Greenhouse Gas Reporting: Conversion Factors 2025 (online)[44].

186 The spreadsheet rows are given for reference against the original, and only the relevant data is shown, along with version information, and physical unit headings. The relevant data for $kgCO_2e$ for natural gas is highlighted in yellow.

Row						
2	**Fuels**					
3	Index					
5	**Emissions source:**	Fuels	**Next publication date:**	June 2026	**Factor set:**	Full set
6	**Scope:**	Scope 1	**Version:**	1.0	**Year:**	2025

Row	Activity	Fuel	Unit	kg CO_2e	kg CO_2e of CO_2 per unit	kg CO_2e of CH_4 per unit	kg CO_2e of N_2O per unit
39	Gaseous fuels	Natural gas	tonnes	2575.46441	2570.42000	3.85280	1.19161
40			cubic metres	2.06672	2.06270	0.00307	0.00095
41			kWh (Net CV)	0.20270	0.20229	0.00031	0.00010
42			kWh (Gross CV)	0.18296	0.18259	0.00028	0.00009
43		Natural gas (100% mineral blend)	tonnes	2603.30441	2598.26000	3.85280	1.19161
44			cubic metres	2.08906	2.08504	0.00307	0.00095
45			kWh (Net CV)	0.20489	0.20448	0.00031	0.00010
46			kWh (Gross CV)	0.18494	0.18457	0.00028	0.00009

187 The applicant states a Scope 1 factor of 2.0891 $kgCO_2e/m^3$ in APP-050 footnote 9. CESL believes that corresponds to the "Natural gas (100% mineral blend)" fuel type, as highlighted in yellow. CESL suggests that the appropriate fuel type is "Natural gas" which is stated in the source spreadsheet to be the factors for standard natural gas from the UK gas grid and includes some biogas. The numbers are therefore slightly different, but by less than 1.1% difference, and this does not affect the conclusions of this submission.

188 For the indicative uncertainty analysis, CESL uses the appropriate fuel type as "Natural gas", and the green highlighted figure of 0.20270 $kgCO_2e$/KWh for Scope 1 calculations.

[43] Using a straightforward screen image capture tool on my computer

[44] Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2025

189 The corresponding data for Scope 3 emissions is shown below.

2	**WTT- fuels**						
3	Index						
5	**Emissions source:**	WTT- fuels	**Next publication date:**	June 2026	**Factor set:**	Full set
6	**Scope:**	Scope 3	**Version:**	1.0	**Year:**	2025

21	Activity	Fuel	Unit	kg CO_2e
38	Gaseous fuels	Natural gas	tonnes	423.16368
39			cubic metres	0.33660
40			kWh (Net CV)	0.03347
41			kWh (Gross CV)	0.03021
42		Natural gas (100% mineral blend)	tonnes	423.16368
43			cubic metres	0.33660
44			kWh (Net CV)	0.03347
45			kWh (Gross CV)	0.03021

190 For the indicative uncertainty analysis, CESL uses the appropriate fuel type as “Natural gas”, and the green highlighted figure of 0.03347 kgCO_2e/KWh for reproducing the applicant’s Scope 3 calculations.

D1 / Section K Appendix C

K.1 FURTHER SCIENTIFIC CONSIDERATIONS ON SUPPLY CHAIN EMISSION UNCERTAINTIES

191 This Appendix does not introduce new evidence, but collates and summarises published material to demonstrate the implications of assumptions already adopted in the Environmental Statement.

192 This Appendix provides background technical evidence solely to support the factual proposition that upstream methane emission factors used in the ES are derived from data which is limited for worst-case bounding analysis for EIA purposes.

K.2 Upstream emission factors

193 Upstream emissions relate to the supply chain emissions in the natural gas supply. They involve leakage of methane (natural gas) from extraction and pipelines. Where Liquefied Natural Gas (LNG) is the supply, they also involve methane leakage from compressing the gas, and regasifying it, and also shipping emissions. These are upstream Scope 3 emissions, both CO_2 and methane. To obtain an accurate measure of these emissions is a very complex area as it is dependent upon varying industry practices, and the changing nature of the UK natural gas supply.

194 The most important aspect is that, in evolving, the UK natural gas supply chain is moving to more imported LNG with higher upstream emissions from historically supplied UK and Norwegian gas. There is now significantly better evidence, both from real-world evidence such as satellite methane detection, and academic analysis of the quantities of methane leakage and other aspects. This has led to more precise forecasting which can be found in recent academic studies which have calculated both upstream methane and CO_2 emissions from supply chains from first principles (for example, Zhu et al (2024)[45], Howarth (2024)[46]). Carbon Tracker[47] also produced a 2024 report which consolidated its conclusions from a considerable array of science papers.

195 The October 2024 paper by Professor Robert Howarth[48] is a landmark study which shows that due to the powerful warming impact of methane leaks and shipping emissions along the supply chain for LNG exported from the US, only a third of greenhouse gas emissions occur at the point of use (eg at a UK unabated plant such as KNGPS, a UK gas-CCS or UK blue hydrogen plant). So even if CCS were to achieve a high capture rate, around the 2/3rds of the carbon footprint arising elsewhere in the supply chain cannot be mitigated. Pre-publication drafts of this paper resulted in the Biden administration pausing new licences for LNG export from the US[49] in January 2024.

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[45] https://pubs.acs.org/doi/10.1021/acssuschemeng.4c07255

[46] https://scijournals.onlinelibrary.wiley.com/doi/10.1002/ese3.1934

[47] https://carbontracker.org/reports/kind-of-blue/

[48] Howarth, “The greenhouse gas footprint of liquefied natural gas (LNG) exported from the United States”, Energy Science & Engineering, October 2024, [redacted]

[49] White House Fact Sheet, “Biden-Harris Administration Announces Temporary Pause on Pending Approvals of Liquefied Natural Gas Exports”, https://www.whitehouse.gov/briefing-room/statements-releases/2024/01/26/fact-sheet-biden-harris-administration-announces-temporary-pause-on-pending-approvals-of-liquefied-natural-gas-exports/

196 It is important to note, as it is used for indicative sensitivity analysis in the main sections of this submission, that the Howarth paper has been fully peer reviewed and was revised to reflect review comments. The paper calculates upstream emissions from first principles – calculating the emissions at every stage. Table 1 of the paper (see stand-alone appendix provided in the examination library) summarises this and includes stages for: Upstream and midstream methane and CO_2; Downstream methane; Liquefaction for methane and CO_2; Tankers for Methane slip, Fuel consumption, Boil-off using Cargo volume and Voyage times data. Each of the major parameters comes from the latest references in the literature. It also integrates the latest remote sensing data: Howarth's methane emission factor is "*derived from the very latest data set from a large body of independent observations from nearly one million aerial site measurements*[50] *and far better reflects the current state of the science*". The Howarth paper is thorough and must be treated as a significant contribution to the evidential science on LNG supply chain emissions.

197 The DESNZ emission factors for upstream emissions are mostly based on a 2015 report from Exergia[51]. The eleven-year old report does not benefit from the latest scientific findings on upstream emissions, described above, particularly the more accurate measurement by satellites and remote sensing available now.

198 Although minor changes are made to the DESNZ emission factors annually[52], it is clear from examination of the data since 2015 that no major review has been made against the latest science described above[53].

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[50] Sherwin ED, Rutherford JS, Zhang Z, et al. US oil and gas system emissions from nearly one million aerial site measurements. Nature. 2024;627:328-334. doi:10.1038/s41586-024-07117-5

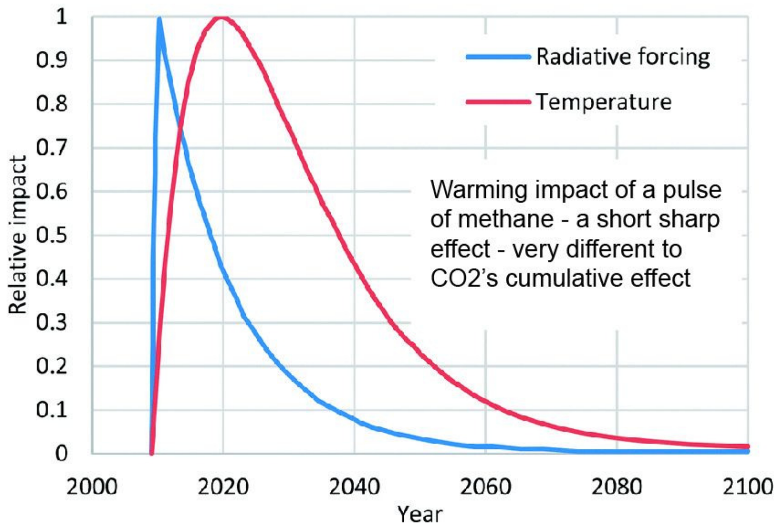
[51] [redacted]

[52] See parliamentary question on Fuels: Greenhouse Gas Emissions from Adrian Ramsay, MP, 21/07/2025 - "*To ask the Secretary of State for Energy Security and Net Zero, with reference to the research entitled Greenhouse gas reporting: conversion factors 2024, published on 8 July 2024, whether the conversion factors for (a) fuels and (b) well-to-tank fuels have been reviewed since 2015.*"
[redacted]

[53] Analysis of the Government data tables from 2015, by CESL, at https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting. Note the EIA references Department for Energy Security and Net Zero (DESNZ) (2025b) *Greenhouse Gas Reporting: Conversion Factors 2025* (online). Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2025 .

K.3 Methane emissions and their impact on the global climate

199 Methane has a half-life in the atmosphere of around 10 years which means that its effects on global heating is concentrated in the first 20 years from its release. This is shown in the figure[54] below which shows the atmospheric effect, known a "radiative forcing" (blue line), of a methane pulse in 2010 being largely complete by 2030 (although actual physical temperature change trails in time).



From Study: "Methane emissions: choosing the right climate metric and time horizon"

Figure 3: The rapid impact of methane emissions

200 Emissions factors, such as the DESNZ ones, use outdated modelling of the radiative effects and climate impacts, shown in graph above, which is limited for worst-case bounding analysis. This is due to a historical quirk from international standards developed in the 1990s which model methane's climate impact over 100 years rather than over the much more realistic 20 years. By effectively spreading the radiative forcing effect behind global heating over 100 years, this approach significantly underestimates methane's impact over the 20 years in which most of its global heating impact originates. There are now international moves to fix this historical quirk[55].

201 Technically, this is described as the emission factor being based on a 100-year Global Warming Potential (GWP) called GWP100 rather than a 20-year GWP called GWP20.

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[54] From: Balcombe etc al, 2018, "Methane emissions: choosing the right climate metric and time horizon", https://pubs.rsc.org/en/content/articlelanding/2018/em/c8em00414e

[55] The Intergovernmental Panel on Climate Change (IPCC) Working Group III is reviewing emissions across entire value chains, including upstream Scope 3 emissions. The IPCC has highlighted the relevance of shorter-term methane reductions measures to international climate goals. It is anticipated that the forthcoming IPCC Seventh Assessment Report (AR7) will provide enhanced guidance on supply chain emissions and methane modelling, with implications for infrastructure and energy-related decision-making, including the relevance of 20-year GWP (GWP20) values to reflect methane's near-term warming effects.

202 Recently Professor Robert Howarth of Cornell University who has advised the US Government and given evidence to the Senate Climate Change Task Force published a landmark paper[56] in which he explains the issue with the different GWPs follows:

> *"While the 100-year time frame of GWP100 is widely used in lifecycle assessments and greenhouse gas inventories, it understates the extent of global warming that is caused by methane, particularly on the time frame of the next several decades. The use of GWP100 dates to the Kyoto Protocol in the 1990s, and was an arbitrary choice made at a time when few were paying much attention to the role of methane as an agent of global warming. As the Intergovernmental Panel on Climate Change stated in their AR5 synthesis report, "there is no scientific argument for selecting 100 years compared with other choices" (IPCC 2013). The latest IPCC AR6 synthesis reports that methane has contributed 0.5^{o} C of the total global warming to date since the late 1800s, compared to 0.75^{o} C for carbon dioxide (IPCC 2021). The rate of global warming over the next few decades is critical, with the rate of warming important in the context of potential tipping points in the climate system (Ritchie et al. 2023). Reducing methane emissions rapidly is increasingly viewed as critical to reaching climate targets (Collins et al. 2018; Nzotungicimpaye et al. 2023). In this context, many researchers call for using the 20-year time frame of GWP20 instead of or in addition to GWP100 (Ocko et al. 2017; Fesenfeld et al. 2018; Pavlenko et al. 2020; Balcombe et al. 2021, 2022). GWP20 is the preferred approach in my analysis presented in this paper, as was the case for our earlier lifecycle assessment of blue hydrogen (Howarth & Jacobson 2021)."*

[56] "The greenhouse gas footprint of liquefied natural gas (LNG) exported from the United States", Energy Science & Engineering, October 2024, [redacted]

L.1 *Issues with data: Scope 3*

203 In section C.3 of the main document, CESL reproduces the applicant's calculation of the Scope 3 operational emissions for scenario-G, as described in Table 18.10 as 3,155,092 tCO_2e. Using the applicant's assumptions of Grid Export = 1,416 MW and the DESNZ Scope 3 emission factor (numerically the same as in [APP-050] footnote 9), CESL obtains a slightly figure. To resolve the figures CESL applies a "Calculation offset" of -43,971 tCO2e to arrive at the applicant's precise figure. An explanation would be helpful. The issue is reproduced below in a copy of Table 2.

Upstream emissions (tCO_2e) over 25-year operation period Scenario-G "Natural Gas Full Lifetime"				
			Application	Evolving nature of natural gas supplies
Data/Assumption Source	**Description**	**Formulae**	**Column 1 (Table 10.8)**	**Column 2 (ST1)**
APP-050 / 18.3.54	**Grid Export MW**	**A**	1,416	1,416
AS-016 / 5.3.9	**Hours over first 15 years**	**B =15 * 3500**	52,500	52,500
AS-016 / 5.3.9	**Hours over last 10 years**	**C = 10 * 1500**	15,000	15,000
	MWh over 25 years	**D = (B + C) * A**	95,580,000	95,580,000
Emission factor from DESNZ for Column 1 and recent science for Column 2	**Scope 3 EF (Net CV) $kgCO_2e/KWh$ "Natural Gas"**	**E**	0.03347	0.34356
	Calculation Offset	**F**	-43,971	-43,971
	Scope 3: Upstream natural gas supply chain emissions tCO_2e	**G = (D * E) + F**	3,155,092	32,793,310

Table 3: Reproduction of Table 2 showing calculation offset required

L.2 Issues with data: Scope 1

204 CESL finds a similar issues in trying to reproduce the applicant's calculation of the Scope 1 operational emissions for scenario-G, as described in Table 18.10 as 19,581,630 tCO_2e. Using the applicant's assumptions of Grid Export = 1,416 MW and the DESNZ Scope 1 emission factor of 0.20489 $kgCO_2e/kWh$ (numerically the same as 2.0891 $kgCO_2e/m3$ as [APP-050] footnote 9 for "Natural gas (100% mineral blend)" in the DESNZ tables), CESL obtains a slightly figure. To resolve the figures CESL applies a "Calculation offset" of -36,118 tCO_2e to arrive at the applicant's precise figure. An explanation would be helpful. The issue is reproduced below.

205 The purpose of Table 4 is not to dispute the applicant's reported Scope 1 total, but to demonstrate that it cannot be reproduced step-by-step from the stated inputs without the introduction of an unexplained offset.

Upstream emissions (tCO_2e) over 25-year operation period Scenario-G "Natural Gas Full Lifetime"			
			Application
Data/Assumption Source	**Description**	**Formulae**	**Column 1 (Table 10.8)**
APP-050 / 18.3.54	**Grid Export MW**	**A**	1,416
AS-016 / 5.3.9	**Hours over first 15 years**	**B =15 * 3500**	52,500
AS-016 / 5.3.9	**Hours over last 10 years**	**C = 10 * 1500**	15,000
	MWh over 25 years	**D = (B + C) * A**	95,580,000
Emission factor from DESNZ for Column 1	**Scope 1 EF (Net CV) $kgCO_2e/KWh$ "Natural gas (100% mineral blend)"**	**E**	0.20489
	Calculation Offset	**F**	- 36,118
	Other operational emissions	**G**	34,362
	Scope 3: Upstream natural gas supply chain emissions tCO_2e	**H = (D * E) + F + G**	19,581,630

Table 4: Calculation offset for Scope 1 operational emissions

L.3 Construction emissions

206 Table 18.10 gives the "Construction, maintenance & decommissioning GHG emissions (tCO_2e)" as 162,229 tCO_2e. This is added into the column "Direct lifecycle GHG emissions (tCO_2e)" under "Scope 1 operation, construction, maintenance and decommissioning emissions". It is not added into the column "Total Lifecycle GHG emissions (tCO_2e)" under "Scope 1 + Scope 3 operational, and construction, maintenance and decommissioning emissions".

L.4 Emission intensities

207 CESL estimates the emission intensity of the “Scope 3 operational GHG emissions (tCO_2e) – operational fuel supply” for scenario-A in Table 18.10 (7,027,112 tCO_2e) as follows:

Intensity = ((7,027,112 [tCO_2e] / 95,580,000 [MWh]) * 1000) / 3,600,000 = 20.42 gCO_2e/MJ

208 This is close to, but slightly in excess of the LCHS threshold of 20 gCO_2e/MJ (LHV).

209 The applicant gives the emission intensity as 119 tCO_2e/GWh. To convert the units, I used this factor, (10^6 g / 3.6×10^6 MJ) = 0.27778. Then 119 tCO_2e/GWh = 33.06 gCO_2e/MJ. This is >50% greater than the LCHS threshold of 20 gCO_2e/MJ (LHV), and my calculation which closely reproduces the LCHS threshold.

106 CESL believes that all the GHG emission intensities on Table 18.10 are similarly mis-scaled with respect to the reported GHG figures in tCO_2e, and the assumed operational output 95,580,000 MWh, based the applicant’s stated assumptions.

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