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CLIMATE EMERGENCY SCIENCE LAW

Written Representation: 27th January 2026
Deadline D1 / Part A

Climate Change

EN0100166 Connah's Quay Low Carbon Power

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 F.

2 This submission (Part A of my deadline D1 Written Representation) provides my submissions on Climate Change. I thank the ExA for agreeing to schedule an ISH on Climate Change[1] in the week commencing March 16th.

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[2] on the use of AI is provided at Section G.

4 This submission has <u>three</u> in-document short appendices A, B and C provided as further background information directly related to the submission content. In addition, <u>six</u> full documents have been submitted to the examination library, as noted in the footnote[3].

<u>D1 / Part A / Section A</u> Background: Flexibilities and Uncertainties in EIA

A.1 Reasonable worst-cases and the Rochdale Envelope

5 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 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.

6 The applicant has set out its approach to the Rochdale Envelope in EIA Chapter 20 "Climate Change" [APP-058] at sections 20.3.16 - 20.3.18. The setting of design parameters using the Rochdale Envelope approach is described in Chapter 2: Assessment Methodology [APP-040] which itself refers to Planning Inspectorate's Advice Note Nine ("Advice Note Nine") on the

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[1] Noted as ISH4 on March 18th

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

[3] 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) Dispatchable Power Agreement (Net Zero Teesside Power).

Rochdale Envelope[4]. APP-058/2.3.16 provides references to where the maximum parameters for the principal components of the Connah's Quay Low Carbon Power (CQLCP) project are set out as design principles, work plans and parameter plans.

7 The Rochdale Envelope is not confined to spatial dimensions or layout flexibility[5], 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[6] 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. In the context of climate change assessment, assumptions that mathematically determine the scale of greenhouse gas emissions—such as upstream emission factors and capture-rate assumptions—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 (also construction or decommissioning), 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.

8 In addition to the parameters in APP-040, the applicant provides assumptions made in the description and assessment of the greenhouse gas emissions (GHGs) associated with the development. EIA Chapter 20 "Climate Change" sign posts these at APP-058/20.3.21 (under "Assessment Assumptions and Limitations"):

> *"As is typical practice, a series of assumptions have also been made where specific data sets are not available to conduct a robust assessment of the likely impacts of the Proposed Development on climate change. Assumptions used to assess the likely impact of GHG emissions across the construction, operational, and decommissioning phases have been detailed in paragraphs 20.6.3, 20.6.20, and 20.6.70 of this chapter respectively."*

A.2 Uncertainties in the ES for GHGs

9 The 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 CQLCP operational phase:

(A) the conversion factor (or emission factor) for the Scope 3 upstream emissions of the project; and

(B) the CCS capture rate for Scope 1 gas combustion emissions.

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[4] 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

[5] Where an Environmental Statement relies on quantified non-physical assumptions that drive the assessment of significant effects—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.

[6] 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

10 These assumptions, referred to as (A) and (B), are bounded at certain numerical thresholds in the EIA:

- Assumption (A) is set by an emission factors ratio of 0.165[7]. The derivation of this ratio will be fully explained later and in Appendix B; and
- Assumption (B) is set at 95%[8].

11 These are each parameters to the Rochdale Envelope for the project's EIA GHG assessment, along with the principal components and other assumptions [APP-058, sections 2.3.16 – 2.3.21] of the CQLCP. They also specify how the maximum assessed environmental effects have been capped in the Rochdale Envelope for the EIA.

12 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. CESL submits that there is significant evidence, to be provided in this submission, that the development would not always operate within the bounds on these assumptions. To understand this requires sensitivity analysis of operational GHG emissions against the available evidence of how the natural gas supply chain and carbon capture technology would operate in the real world. The applicant has not provided this sensitivity analysis.

13 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 proof, 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.

14 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.

15 CESL is submitting that the reasonable worst-case assessment in the EIA 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.

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[7] As specified at 20.6.23 [APP-058]

[8] As specified at Table 20-8, footnote a [APP-058]

<u>D1 / Part A / Section B</u> Uncertainties in GHG Forecasting Methodologies

16 At 20.6.23 of EIA Chapter 20 [APP-058], the applicant states how it derives the upstream emissions factor for the Scope 3 GHG emissions for natural gas supply: this is taken forward as a fixed assumption for the EIA. The emission factor is derived from the published DESNZ 2025 emissions factors (Ref 20-37 in APP-058), see later for an expanded explanation.

17 At 20.6.32 of EIA Chapter 20 [APP-058], the applicant states that each of the three operating cases is specified "*with an approximate 95% carbon capture rate*": this is taken forward as a fixed assumption for the EIA. Footnote a under APP-058/Table 20-8 (reproduced later) also says "*assuming a 95% carbon capture rate*".

18 The following sub-sections introduce <u>four uncertainties</u> in the forecasting of GHGs associated with developments such as CQLCP:

- Issues (i) and (ii) below relate to the uncertainties in deriving emission factors for the natural gas supply chain (ie uncertainties relating to assumption (A) introduced in the previous "Uncertainties in the ES for GHGs" section);

- Issue (iii) relates to the uncertainties in the carbon capture rate (ie uncertainties relating to assumption (B) introduced in the previous "Uncertainties in the ES for GHGs" section);

- Issue (iv) relates to T&S unavailability emissions; the CQLCP EIA does provide a maximum bound for this of 5%. Whilst retaining the possibility of submissions on this issue later, I do not address it further in this submission.

19 The ES/EIA lacks any sensitivity analysis of the associated operational lifecycle GHG emissions associated with the uncertainties with assumptions (A) and (B), as described below as issues (i), (ii) and (iii). 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 four uncertainties in forecasting operational GHG emissions in Power CCS projects

20 Some further expansion from the related recent scientific literature is given for issues (i) and (ii) below in Appendix C.

B.2 <u>Issue (i):</u> 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

21 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[9], November 2025, provided as a stand-alone Appendix in the examination library).

[9] 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

22 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[10]. These imports are associated with the very high Scope 3 upstream emissions which were not present in the UK system a decade ago.

23 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 LNG filling more of the gap. As a result, incremental gas demand associated with CCGT operation may be met at the system margin, which in certain periods is cleared by LNG imports[11] rather than by additional pipeline supply.

24 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 2035 and 2065 corresponding to the project lifetime for which there are many uncertainties.

25 However, DESNZ's December 2023 report "The role of gas storage and other forms of flexibility in security of supply"[12], did suggest a forecasted peak of UK gas imports in 2045, indicating that LNG imports would grow for the first 10 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

26 Turning to the emissions in the future UK gas supply chains after 2035, 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.

27 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 2065. 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.

28 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

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[10] 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

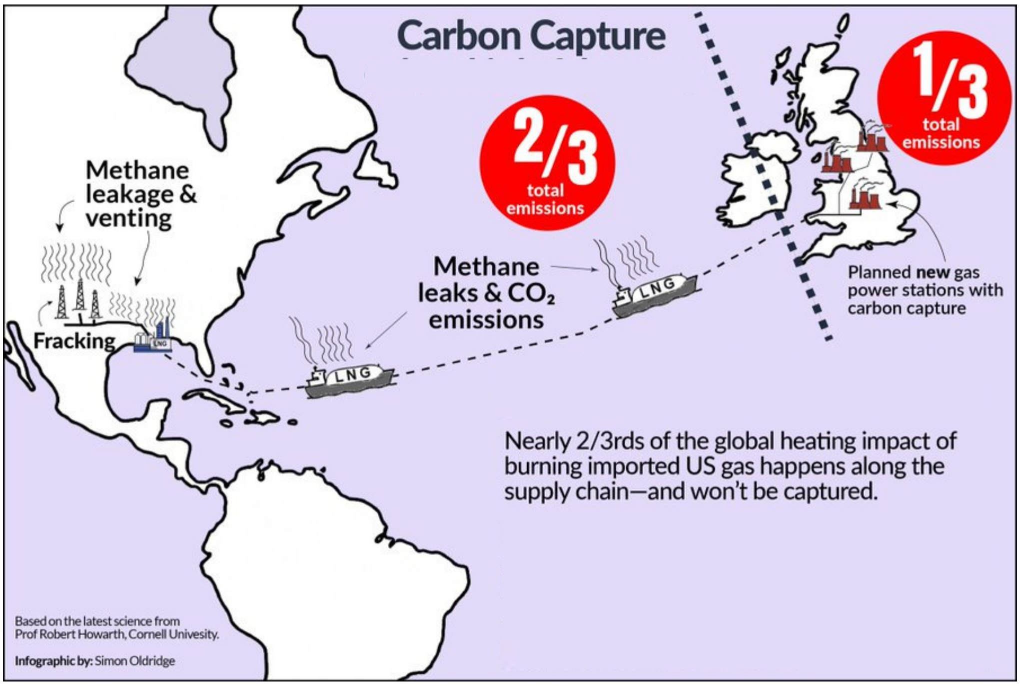
[11] Pipeline gas supplies are constrained by production and contractual limits and have limited short-run elasticity, whereas LNG functions as a globally traded, price-responsive balancing supply whose volumes and routing can adjust over days to weeks in response to demand signals, making it the marginal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

[12] 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

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.

29 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[13], this study is chosen for this 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.

30 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), ~<u>⅔ occur upstream and are uncapturable</u>.



Figure[14] 1: Upstream LNG emissions in US-UK supply chain

[13] 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)" 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

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

B.4 DESNZ Emission factors

31 The introduction of Scope 3 emissions into the UK Government conversion tables (ie the DESNZ emission factors referred to here) were based on self-reported industry data from before 2015 and assumptions stretching back decades (<u>see Appendix C</u>). 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 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.

32 Thus CQLCP, 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.

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

34 The Applicant states that it selected the DESNZ conversion factors "in the absence of suitable data" [APP-058/20.6.23]. 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 2065—are bounded within the Rochdale Envelope for the project.

35 CESL submits that its indicative sensitivity analysis shown later (in Section C) provides evidence that the CQLCP 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 <u>Issue (ii):</u> Uncertainty from the high-impact short-term impacts of supply chain methane.

36 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 CQLCP project lifetime to 2065.

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 extreme 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.

37 The combined impacts of issues (i) and (ii) give rise to considerable uncertainty in 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.

B.6 Issue (iii) Uncertainty in CO_2 capture rates

38 There is no evidence that any commercial CCS project has ever achieved a 90% CO_2 capture rate, nor a 95% CO_2 capture rate. This is evidenced by the Institute of Energy Economics and Financial Analysis (IEEFA) which have recently researched the CCS market and reviewed existing commercial projects[15], as shown graphically below:

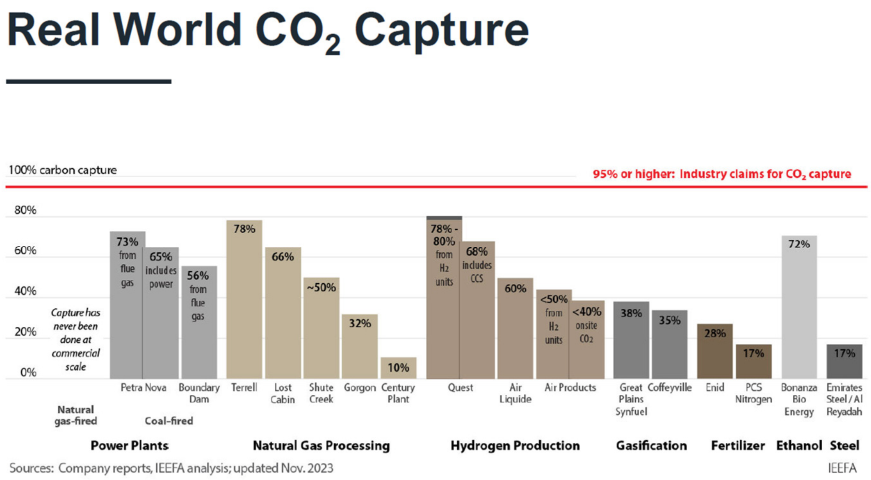


Figure 2: IEEFA: Real World CO_2 Capture (2024)

39 The evidence leads to the conclusion, that as no commercial gas-CCS plant like CQLCP, has ever been built world-wide, that there is still considerable uncertainty as to the capture rates that will be delivered in operation.

40 The applicant has provided no evidence that CQLCP could achieve the assumed 95% capture rate, nor any sensitivity analysis on it.

41 Further, the Environmental Statement proceeds on the basis of headline capture rates materially above the minimum level contractually tolerated under the Dispatchable Power Agreement ("DPA"). A recently completed DPA for the Net Zero Teesside power station defines a "Minimum CO_2 Capture Rate" of 70% (as an Achieved-and-Declared average), with under-performance below that level capable of persisting for multiple months under the breach and cure regime, and with payment suspension only engaged where capture performance falls below 50%[16]. A 70% capture rate is therefore not a failure mode, but a legally permitted operating condition supported by public subsidy.

42 Separate submissions at Deadline D1 Part B address, on a without-prejudice basis, how any capture-rate assumptions (ie the 95% capture rate) relied upon in the Environmental Statement would need to be secured in the Development Consent Order if those assumptions are to be treated as defining the consented development.

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[15] Institute of Energy Economics and Financial Analysis (IEEFA), Morrison, K, "The Good, the Bad, and the Ugly reality about CCS (Carbon Capture and Storage)", slide 12, https://ieefa.org/sites/default/files/2024-03/CCSpresentation4-MPCMarch24_CK.pdf

[16] Dispatchable Power Agreement (Net Zero Teesside Power), See "22. GENERATOR UNDERTAKING: MINIMUM CO2 CAPTURE RATE", Page 249 of https://lcc-web-production-eu-west-2-files20230703161747904200000001.s3.amazonaws.com/documents/DPA-NZT-2T1_Contract_Redacted_-_amended.pdf Failure to achieve the "Minimum CO_2 Capture Rate" (70%) gives rise to breach and cure mechanisms, with termination only following continued non-compliance; sustained performance below the "Suspension CO_2 Capture Rate" (50%) engages the payment suspension power.

43 Applying Rochdale Envelope principles, this minimum capture performance constitutes a non-spatial but physical and legally operative parameter of the development and must be treated as defining the reasonable worst-case for operational greenhouse gas emissions. 70% is a permitted and subsidised operating condition, and therefore it must be considered in worst-case bounding.

44 An assessment framed around aspirational or design-intent capture rates (e.g. ~95%) understates the likely maximum environmental effects and fails to assess the impacts of a contractually sanctioned lower-capture operating state. The EIA is therefore incomplete unless it assesses operational emissions, carbon-budget effects, and climate impacts on the basis of a 70% capture scenario (and the associated uncaptured Scope 1 and upstream emissions), rather than relying solely on best-case assumptions.

45 Later, CESL generates an indicative sensitivity analysis of the uncertainty of the capture rate, using the 70% capture rate[17].

Issue (iv): ***Uncertainties in CO_2 T&S infrastructure and CO_2 venting***

46 Maintenance and CO_2 transport and storage (T&S) downtime can cause substantial venting, reported as downstream Scope 3 emissions. As CCS is at an early stage of commercial development there is uncertainty as to the scale of T&S unavailability. The EIA for the CQLCP application has T&S unavailability modelled at 5%. I reserve comment on this.

D1 / Part A / Section C Indicative-only sensitivity analysis of the uncertainties in the EIA forecast operational GHG emissions

47 At 20.6.23 of EIA Chapter 20 [APP-058], the applicant states how it derives the upstream emissions factor for the Scope 3 GHG emissions for natural gas supply. The emission factor is derived from the published DESNZ 2025 emissions factors (Ref 20-37 in APP-058), see below for an explanation of how the emission factor is used.

48 A key argument in this submission is that CQLCP may give rise to greenhouse gas emissions materially in excess of those assessed in the EIA, based on the DESNZ 2025 emissions factor[18] 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.

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

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[17] Even though DPA payments for operation are not suspended until the plant capture CO2 at less than a 50% capture rate

[18] Also referred to as “conversion factors”

C.1 Applicant's derivation of upstream emission factors (natural gas and diesel)

50 At 20.6.23 of EIA Chapter 20 [APP-058] the applicant says:

> *"In the absence of suitable data, WTT emissions from the upstream natural gas supply chain have been estimated by applying a ratio (0.165) to the gross unabated CO_2 emissions from the HMB tables (above). This accounts for emissions from upstream activities including venting, flaring, and fugitive emissions. This ratio has been derived from published DESNZ 2025 emissions factors (Ref 20-37) for direct (Scope 1) and indirect (Scope 3) emissions from natural gas. These are emissions over which the undertaker has no control".*

51 The applicant further explains the meaning of the emission factor ratio, so obtained, as estimating the "*emissions in the upstream natural gas supply chain"* at Footnote 3 of Chapter 20 [APP-058]:

> *"The ratio so derived is 0.165, meaning that for every tonne of CO_2 directly emitted to the atmosphere in the unabated power station's flue gases, a further 0.165 tonnes will have been emitted through venting, flaring and fugitive emissions in the upstream natural gas supply chain."*

52 Ref 20-37 is given as "*DESNZ (2025). Greenhouse Gas Reporting: Conversion Factors 2025. [online]. Available at: https://www.gov.uk/government/collections/government-conversionfactors-for-company-reporting (Accessed 25/06/2025)*". And for completeness, and for the ExA's assistance, I have reproduced the relevant sections of the spreadsheet at *Ref 20-37* in Appendix B which confirms this derivation method for natural gas.

53 At 20.6.23 of EIA Chapter 20 [APP-058], the applicant addresses diesel emissions from the operation of CQLCP:

> *"… diesel consumption is assumed to be 50 tonnes/year, in line with requirements from a similar CCGT CCP project. Diesel is assumed to be used in the emergency generator and fire suppression system (including testing). Total diesel requirements across operation have been multiped [sic, in the original ES] by a DESNZ 2025 (Ref 20-37) emissions factor for liquid diesel. This calculation included WTT emissions associated with the extraction, refining, and transportation of raw fuels."*

54 I have also reproduced the data for "Diesel (100% mineral diesel)" from *Ref 20-37* in Appendix B. I obtain a similar emission factor ratio for this type of diesel as 0.2347. The applicant has not made clear that "Diesel (100% mineral diesel)" is the fuel type here in the DESNZ data. Although diesel is significantly less than 1% of the operational emissions, and do not significantly affect the calculations shown below, it would be helpful if the applicant could clarify the fuel type to the examination. (And I will correct my calculations if necessary although as diesel emissions are a very small portion on the total, it will not affect the main conclusions).

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

55 For the indicative sensitivity test, 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 an annotated extract from Supplementary Table B of the Howarth (2024) paper.

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

57 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.

58 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, in each of 4 cases (based on different LNG Tanker vessel type), an emission factor ratio. This is a direct comparator to the emission factor ratio derived by the applicant based on the DESNZ data.

Emission Factors Ratios (Howarth Supplementary Table B)				
Howarth data in units of gCO_2e/kg	Combustion	Upstream	Total	Factor = Upstream / Combustion
Steam-turbine tankers powered by LNG	2,750	4,695	7,445	1.71
4-stroke engine tankers powered by LNG	2,750	4,841	7,591	1.76
2-stroke engine tankers powered by LNG	2,750	4,661	7,411	1.69491
Diesel-powered tankers	2,750	4,471	7,221	1.63

Table 1: Emission factor ratio calculation from scientific literature

59 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 ratio of 1.69491[19] 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 that could have been chosen.

60 This ratio is a comparable ratio, for the purpose of forecasting calculations, to the 0.165 ratio derived from the DESNZ data and used by the applicant.

61 This ratio of 1.69491 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.

62 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.

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

63 Such an indicative sensitivity test using the data described above and in Appendix A is now presented. A second indicative sensitivity test is made on the CO_2 capture rate.

C.3 Sensitivity tests of operational GHG emissions (reference case)

64 The applicant's Table 20-8 is reproduced below. We are only concerned here with the row "Fuel Usage (CCGT emissions and other fuels)" and the ringed numbers.

Connah's Quay Low Carbon Power
EN010166/APP/6.2.20

Environmental Statement Volume II
Chapter 20: Climate Change

Table 20-8: Operational GHG Emissions (Reference Case)

Project activity/ Emission source	Emissions (tCO_2e) over 30-year operation period				Percentage of total
	Scope 1[7]	Scope 2[8]	Scope 3[9]	Total	
Grid Electricity Use	n/a	2,332,359	788,232	**3,120,591**	7%
Fuel Usage (CCGT emissions and other fuels)	6,653,318[a]	n/a	31,590,077[b]	**38,243,395**	90%
Waste Disposal	n/a	n/a	6,456	**6,456**	<1%
Worker Commuting	n/a	n/a	7,556	**7,556**	<1%
Raw Material Demand	n/a	n/a	1,270,383	**1,270,383**	3%
Raw Material Transport	n/a	n/a	5,813	**5,813**	<1%
Water Consumption	n/a	n/a	402	**402**	<1%
Total GHG emissions over operation period (tCO_2e)				42,654,595	
Average annualised GHG emissions during operation (based on 30-year life) (tCO_2e/year)				**1,421,820**	

a. Accounts for the direct emissions from on-site combustion of natural gas (assuming a 95% carbon capture rate) and diesel.
b. Accounts for the indirect emissions attributed to the natural gas and diesel supply chains, and the unavailability of the T&S system.

Figure 3: Applicant's Table 20-8

65 This data (for the "Fuel Usage (CCGT emissions and other fuels)" row) in Table 20-8 above is carried forward into the Table below.

66 In the Table below[20], the development's 30-year "Fuel Usage (CCGT emissions and other fuels)" operational emissions in tCO_2e are forecast for:

- (A) the application (ie reproducing the data in Table 20-8);
- (B) a sensitivity test (ST1) for the upstream emission factor; and
- (C) a sensitivity test (ST2) for the CO_2 capture rate.

67 For (A) the application, I have precisely stepwise calculated the ringed figures from Table 20-8 above in column 1 of the Table below. I found that a capture rate parameter – highlighted blue in the Table below – of 95.2367% (as opposed to 95.0%) was required to exactly reproduce the applicant's figures. I have shown my workings below in full as the applicant has not shown the calculation steps underneath Table 20-8. It would be helpful if the applicant could clarify its calculation steps to the examination.

68 For (B) a sensitivity test (ST1) for the upstream emission factor, the emission factor ratio based on the DESNZ conversion factors is replaced with the emission factor ratio calculated from the Howarth paper above in column 3 of the Table below (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 outputs for ST1 are highlighted yellow.

69 For (C) sensitivity test (ST2), the 95.2367% capture rate in the EIA is replaced with 70% in column 4 of the Table below (again, the sole input change from column 1 is highlighted green). This provides a sensitivity test which for the carbon capture plant is operating at the minimum sustained rate for which subsidies may be claimed by the operator (i.e. a capture rate of 70%) , as previously described. The only different forecast outputs for ST2 are highlighted yellow.

70 For each row, the calculation formulae are given in the left hand column of the Table below.

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

Emissions (tCO_2e) over 30-year operation period "Fuel Usage (CCGT emissions and other fuels)" (only)					
	Application		Evolving nature of natural gas supplies		Lower than 95% capture rate
	Column 1 (Table 20-8)	**Column 2 Description**	**Column 3 (ST1)**		**Column 4 (ST2)**
A	146,925,347	**Scope 1 : unabated natural gas combustion**	146,925,347		146,925,347
B	5%	**T&S Unavailability = 5%**	5%		5%
C=A*B	7,346,267	**Scope 3: emissions to atmosphere (T&S unavailability)**	7,346,267		7,346,267
D=A-C	139,579,079	**Remaining emissions available for CCS**	139,579,079		139,579,079
E	95.2367%	**Capture rate parameter**	95.2367%		70%
F=D*E	132,930,567	**Captured emissions**	132,930,567		97,705,356
G=D-F	6,648,512	**Scope 1: Natural Gas : Non-captured emission**	6,648,512		41,873,724
H	0.165	**Emission factor ratio: Upstream natural gas supply chain emissions**	1.69491		0.165
J=A*H	24,242,682	**Scope 3: Upstream natural gas supply chain emissions**	249,025,106		24,242,682
K	4806	**Scope 1: Diesel: 50tonnes/yr, 30 years (EF=3203.9/1000)**	4806		4,806
L	1128	**Scope 3: Diesel (EF ratio = 0.2347)**	1128		1,128
M=G+K	6,653,318	**Total Scope 1 "Fuel Usage (CCGT emissions and other fuels)"**	6,653,318		41,878,530
N=J+L+C	31,590,077	**Total Scope 3 "Fuel Usage (CCGT emissions and other fuels)"**	256,372,501		31,590,077
P=M+N	38,243,395	**Total Scope 1 & 3 "Fuel Usage (CCGT emissions and other fuels)"**	263,025,819		73,468,607
Q=A+J+K+L	171,173,963	**Total unabated Scope 1 and Scope 3 fuel emissions**	395,956,386		171,173,963
R=F	132,930,567	**Theoretical maximum captured and stored emissions**	132,930,567		97,705,356
S=R/Q	77.7%	**Percentage theoretical maximum captured and stored emissions**	33.6%		57.1%

Table 2: Sensitivity test on "Fuel Usage (CCGT emissions and other fuels)" – Indicative sensitivity tests of uncertainties of GHG forecasting (for bounding purposes only; not a substitute ES)

71 In this indicative sensitivity analysis, the forecasts in the Table provide reasonable worst-cases for the upper-bound of the uncertainty for the EIA assumptions on upstream supply chain emissions and CO_2 capture rate.

72 The table shows that when the high impacts from the future evolution of the natural gas supply chain are included (ST1, column 3), CQLCP may give rise to greenhouse gas emissions materially in excess of those assessed (Application. Column 1).

73 CQLCP may also give rise to greenhouse gas emissions materially in excess of those assessed (Application. Column 1) when the operators are receiving subsidies and the uncertainties for the CO_2 capture rates are included (ST2, column 4).

74 The final three rows of the Table above calculate the theoretical maximum capture and storage of CO2 with the "Fuel Usage (CCGT emissions and other fuels)" operational emissions. This calculation shows the theoretical maximum CO_2 stored against the emissions that would be generated with no CCS (which is the total of Scope 1 combustion emissions and the upstream Scope 3 supply chain emissions for the fuels before the effects of capture are calculated) for each of the Application, ST1 and ST2.

C.4 Significance assessment

75 The above indicative sensitivity analysis suggests the scale of how the CQLCP power station may give rise to greenhouse gas emissions materially in excess of those assessed is such that the operational emissions significance assessment (APP-058, 20.6.48 - 20.6.69) cannot be valid. For this reason, CESL makes no submissions on these sections of the application yet.

D1 / Part A / Section D Legal Considerations

76 CESL has submitted evidence that CQLCP may give rise to greenhouse gas emissions materially in excess of those described and assessed as the reasonable worst-case, based on the sections 20.3.16-20.3.18 under “Rochdale Envelope” [APP-058], and the assumptions on the upstream emissions factor and the CO_2 capture rate in the EIA. 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, and the physical timings of near-term warming impact of methane have not been accounted for in the applicant’s assumptions and forecasting.

77 A secondary factor is that the assumed capture rate of 95% is unproven. For this issue, the uncertainty of the capture rate may give rise to greenhouse gas emissions materially in excess of those described and assessed in the EIA to a smaller, but still substantive, numerical extent.

78 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.

79 Advice Note Nine[21] 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.

80 Even if the upstream emission and capture rate 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 CO_2 capture rates, and the absence of any sensitivity testing of these higher-impact scenarios.

81 The applicant suggests that the proposed CQLCP plant would replace an existing unabated gas-fired power station 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 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

[21] 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

assessment of the project's own impacts. In any event, the claimed replacement benefit is critically dependent on assumptions regarding upstream methane emissions and CO_2 capture performance; 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 CQLCP's own lifecycle emissions.

82 The Rochdale Envelope principle reflects the long-standing interpretation within the UK of the EIA regime derived from the EU EIA Directive[22]. 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.

83 In these circumstances, the EIA also does not satisfy the legal tests articulated in the recent UK *Finch*[23] and *Whitehaven*[24] 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.

84 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.

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[22] 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.

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

[24] 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 / Part A / Section E Conclusion

85 CESL is respectfully grateful in advance for any clarification by the applicant of its EIA GHG forecasting calculations as noted in the submission[25].

86 In light of this submission, CESL respectfully requests that the Examining Authority:

1) Directs the applicant to provide a sensitivity analysis of operational lifecycle GHG emissions using an upstream emission factor representative of a likely future high-LNG supply scenario;

2) Directs the applicant to provide a sensitivity analysis of the impact on assessed emissions using a GWP20 metric for methane, to understand the project's near-term climate forcing;

3) Directs the applicant to provide the detailed evidence base supporting the assumption of a sustained 95% CO_2 capture rate, and to provide a sensitivity analysis and reasonable worst-case based on such a delivery rate not being deliverable;

4) Finds that the current ES Chapter 20 lacks robustness on these key issues and cannot be relied upon for decision-making until these analyses are provided and considered.

87 I look forward to the ISH on Climate Change in the week commencing March 16th to assist the ExA on the issues raised in this submission in any way that I can.

[25] (1) whether “Diesel (100% mineral diesel)” is the correct fuel type used in the modelling (2) the calculation steps necessary to generate the data in Table 20-8.

<u>D1 / Part A / Section F</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 / Part A / Section G   Statement on the use of Artificial Intelligence

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

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

90 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.

91 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.

92 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.

93 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.

94 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.

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

96 No images[26], video, or visual material have been created, altered, or enhanced using artificial intelligence in this submission.

97 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.

[26] 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 / Part A / Section H   Appendix A

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

98 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)”.

99 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.”*

100 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.

	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**

A typographical error, this should read GWP_{20}

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%)	Ex-UK Scope 3 GHGs
Liquefaction	362 (4.8%)	3.7	303 (4.0%)	665 (8.8%)	Ex-UK Scope 3 GHGs
Emissions from tanker	126 (1.7%)	2.9	242 (3.2%)	367 (4.8%)	Ex-UK Scope 3 GHGs
Final transmission & distribution	0 (0%)	3.2	264 (3.5%)	264 (3.5%)	UK Scope 3 GHGs
Combustion by final consumer	2,750 (36%)	0	0 (0%)	2,750 (36%)	UK Scope 1 GHGs
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**

110 The following have been snapshot[27] from Tab in the spreadsheet at EIA Chapter 20 Ref 20-37 which is "*DESNZ (2025). Greenhouse Gas Reporting: Conversion Factors 2025. [online]. Available at: https://www.gov.uk/government/collections/government-conversionfactors-for-company-reporting …*". 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, and diesel, are highlighted in yellow.

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	

22	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
38	Gaseous fuels		kWh (Gross CV)	0.21450	0.21419	0.00019	0.00012
39		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			tonnes	2603.30441	2598.26000	3.85280	1.19161
75		Diesel (100% mineral diesel)	tonnes	3203.91143	3164.33000	0.34720	39.23423
76			litres	2.66155	2.62818	0.00029	0.03308
77			kWh (Net CV)	0.26808	0.26475	0.00003	0.00330
78			kWh (Gross CV)	0.25199	0.24887	0.00002	0.00309

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

111 The figures below in red have been calculated within a copy of the Government spreadsheet by CESL – in each they are the ratio the Scope 3 “WTT-fuels” figure divided by the Scope 1 “Fuels” relevant figure as highlighted in yellow on the previous page.

112 The first 4 red figures confirm the applicant’s calculation of a ratio of 0.165 [Footnote 3 of Chapter 20 [APP-058]].

113 By the same method, CESL generates a similar emission factor ratio of 0.2347 for diesel.

WTT- fuels

Index

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

Row	Activity	Fuel	Unit	kg CO_2e	
38	Gaseous fuels	Natural gas	tonnes	423.16368	0.1643
39		Natural gas	cubic metres	0.33660	0.1629
40		Natural gas	kWh (Net CV)	0.03347	0.1651
41		Natural gas	kWh (Gross CV)	0.03021	0.1651
74		Diesel (100% mineral diesel)	tonnes	752.02760	0.2347
75		Diesel (100% mineral diesel)	litres	0.62409	0.2345
76		Diesel (100% mineral diesel)	kWh (Net CV)	0.06291	0.2347
77		Diesel (100% mineral diesel)	kWh (Gross CV)	0.05913	0.2347

D1 / Part A / Section J   Appendix C

J.1 FURTHER SCIENTIFIC CONSIDERATIONS ON SUPPLY CHAIN EMISSION UNCERTAINITIES

114 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. No new arguments are advanced in this Appendix.

Upstream emission factors

115 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 CO2 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.

116 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)[28], Howarth (2024)[29]). Carbon Tracker[30] also produced a 2024 report which consolidated its conclusions from a considerable array of science papers.

117 The October 2024 paper by Professor Robert Howarth[31] 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 gas-CCS or 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[32] in January 2024.

118 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

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

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

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

[31] Howarth, "The greenhouse gas footprint of liquefied natural gas (LNG) exported from the United States", Energy Science & Engineering, October 2024, https://scijournals.onlinelibrary.wiley.com/doi/10.1002/ese3.1934

[32] 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/

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*[33] *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.

119 The DESNZ emission factors for upstream emissions are mostly based on a 2015 report from Exergia[34]. 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.

120 Although minor changes are made to the DESNZ emission factors annually[35], it is clear from examination of the data since 2015 that no major review has been made against the latest science described above[36].

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[33] 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

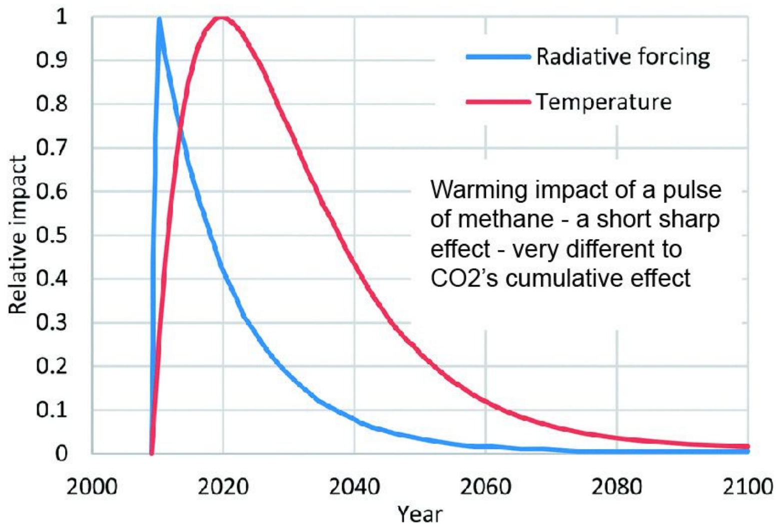
[34] https://energy.ec.europa.eu/system/files/2015-08/Study%2520on%2520Actual%2520GHG%2520Data%2520Oil%2520Gas%2520Final%2520Report_0.pdf

[35] 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.*" https://questions-statements.parliament.uk/written-questions/detail/2025-07-21/69533/

[36] 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 reference Ref 20-37 from Chapter 20 Climate Change is to the latest 2025 tables at this page "*DESNZ (2025). Greenhouse Gas Reporting: Conversion Factors 2025. [online]. Available at: https://www.gov.uk/government/collections/government-conversionfactors-for-company-reporting (Accessed 25/06/2025)*".

J.2 Methane emissions and their impact on the global climate

121 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[37] 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 4: The rapid impact of methane emissions

122 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[38].

123 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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[37] 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

[38] 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.

124 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[39] 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° C of the total global warming to date since the late 1800s, compared to 0.75° 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)."*

<END-OF-DOCUMENT>

[39] "The greenhouse gas footprint of liquefied natural gas (LNG) exported from the United States", Energy Science & Engineering, October 2024, https://scijournals.onlinelibrary.wiley.com/doi/10.1002/ese3.1934