On behalf of the Claimant

G MUTTITT

Date: 6 August 2021

IN THE HIGH COURT OF JUSTICE **CO/3206/2020**

QUEEN'S BENCH DIVISION

ADMINISTRATIVE COURT

BETWEEN:

FRIENDS OF THE EARTH LIMITED

Claimant

-and-

SECRETARY OF STATE FOR INTERNATIONAL TRADE & PRESIDENT OF THE BOARD OF TRADE

First Defendant

-and-

CHANCELLOR OF THE EXCHEQUER

Second Defendant

-and-

TOTAL E&P MOZAMBIQUE AREA 1 LIMITADA

Interested Party

-and-

MOZ LNG1 FINANCING COMPANY LIMITED

Interested Party

WITNESS STATEMENT OF GREG MUTTITT

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I, Greg Muttitt, will say as follows:

Qualifications and experience

1. I am an energy economist specialising in upstream oil and gas economics in the context of climate change. I am employed as Senior Policy Adviser at the International Institute for Sustainable Development ("IISD"). Over the last 20 years I have researched and written on oil and gas policy, investments and markets in Azerbaijan, Canada, Iraq, Kazakhstan, Norway, Russia, Saudi Arabia, Turkey, the United Kingdom and the United States.

2. My current work focuses on the pace at which oil and gas production should decline consistent with the Paris Agreement goals, while ensuring a just transition for those who rely on fossil fuels. Several of my publications are directly relevant to this case. I am lead author of the IISD report *Step Off the Gas: International public finance, natural gas and clean alternatives in the Global South*, published in June 2021.[1] I am a co-author of the annual *Production Gap Report*, co-published with Stockholm Environment Institute, the United Nations Environment Programme and others.[2] I co-authored a 2020 paper in the journal *Climate Policy* on how to address climate equity in phasing out fossil fuel extraction, including meeting the needs of the poorest countries.[3] I have written extensively and advised governments and investors on the meaning and limitations of scenarios published by the International Energy Agency (IEA).[4] I am currently working on two papers for the peer reviewed literature, one on the respective phaseout pace of coal, oil and gas in integrated assessment models, and one estimating the committed emissions from existing fossil fuel production assets. I gave oral evidence as an expert witness at the Environmental Audit Committee's 2019 inquiry into UK Export Finance's (UKEF's) support for the energy industry.[5]

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[1] Muttitt et al. (2021) https://www.iisd.org/publications/natural-gas-finance-clean-alternatives-global-south
[2] SEI et al. (2020) https://productiongap.org/
[3] Muttitt and Kartha (2020) https://doi.org/10.1080/14693062.2020.1763900
[4] Muttitt (2018a) http://priceofoil.org/2018/04/04/off-track-the-iea-and-climate-change/
Muttitt (2018b) http://priceofoil.org/2018/04/04/off-track-iea-briefing-for-investors/
Muttitt (2019) http://priceofoil.org/2019/02/07/the-international-energy-agency-and-the-paris-goals-qa-for-investors/
[5] House of Commons (2019)
https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/1804/1804.pdf

Outline

3. My instructions to prepare this statement, which are material to the opinions expressed below and upon which such opinions are based, related to UKEF's decision in July 2020 ("the Decision") to provide loans and guarantees to support the Liquefied Natural Gas (LNG) project being developed by Total S.A. in Mozambique ("the Project"), and specifically: (i) the background to climate science of greenhouse gas (GHG) impacts of liquefied natural gas ("LNG"); (ii) in this context, the requirements of the Paris Agreement; and (iii) the methodology for: (a) quantifying prospective gas emissions and (b) assessing compatibility with Paris. Those instructions were received by me between 9 July 2021 and the date of this statement. A list of the material provided to me with my instructions is set out in Appendix 1 to this statement. In particular, I was instructed to read and comment on: the Wood Mackenzie Report; the Climate Change Report; and the witness statements of Maxwell Griffin and Dr Adam Hawkes. Otherwise, where I have relied on further sources of information, these have been referenced in the statement. This statement is my independent expert opinion. All views contained within this statement are attributed to me, the author, and do not necessarily represent the views of IISD.

Summary of conclusions

4. A summary of my conclusions from this statement is as follows:

    a. Scope 3 GHG emissions of the project are a straightforward and fundamental part of any meaningful climate assessment, but were not assessed for the Decision. Instead, the climate change assessments that were used in the Decision focused on "avoided emissions", which is a methodologically flawed concept, inappropriate to assessing consistency with the Paris agreement;

    b. Scope 3 carbon dioxide (CO_2) emissions may be estimated at 29.3 $MtCO_2$ per year, equivalent to 7.4 coal power plants. Scope 3 methane emissions depend on the degree of leakage from gas infrastructure; a mid-range estimate is an additional 6.2 $MtCO_2e$ per year (range 1.8 to 21.2 $MtCO_2e$)

over a 100-year timeframe, and 19.2 $MtCO_2e$ (5.4 to 65.0 $MtCO_2e$) over a 20-year timeframe;

c. The climate impacts of any fossil fuel producing project should be considered in terms of the role of those fossil fuels within energy pathways aligned with the Paris goals. Pathways aligned with the 1.5°C goal generally see gas production and use decline at around 3-4% per year, which is equal to the natural decline in production from existing fields. Given carbon lock-in, this means that new oil and gas production is not consistent with the Paris goals, a conclusion reinforced by the International Energy Agency in its recent Net Zero Emissions scenario;

d. It is incorrect to consider gas a "transition fuel", also because alternatives are available and commonly cheaper than gas for most of its uses. In power generation, gas is more likely to impede than enable expansion of renewable energy. A climate change assessment should consider the effect of carbon lock-in, creating economic, political and social inertias that make it harder to transition to clean energy; and

e. Under the Paris Agreement, developing countries should also begin to decarbonise their economies, but given climate equity – captured in the concept of "common but differentiated responsibilities and respective capabilities" – they may do so more slowly than wealthy countries, and will need financial and other support to enable them to do so. In contrast, additional fossil fuels will expose Mozambique's economy to risks from the global energy transition, and potentially hold back the country's development.

The Wood Mackenzie Report

5. I understand that the project lenders commissioned Wood Mackenzie to assess the climate impact of the Project, in order to inform their decisions on whether to provide finance.[6] I have read the report, dated March 2020.[7]

[6] Griffin paras 37-39
[7] Exhibit MG/12

6. As a piece of climate change analysis, the Wood Mackenzie report is without merit, in my judgment. The report does not address the basic questions about the climate impact of the Project, and does not use any of the methodologies available to assess alignment with the Paris Agreement. It does not cite – and shows no evidence of having even read – any of the important literature, not even the reports of the Intergovernmental Panel on Climate Change (IPCC), which represent the accepted consensus overview of the science, including on energy pathways.

7. Wood Mackenzie is well known as a specialist in advising on oil and gas markets and investments. To my knowledge, Wood Mackenzie has no expertise on climate change, and I have never seen Wood Mackenzie cited in any climate change literature. Even on areas of Wood Mackenzie's expertise – energy markets – there are some striking errors and inaccuracies in its report. I am surprised that UKEF considered the report to be of sufficient quality to inform the Decision.

8. The Wood Mackenzie report makes the following arguments:

    a. There is continued demand for gas, including additional LNG, in the IEA's Sustainable Development Scenario (SDS), which is "*widely seen as the global community's accepted limitation of temperature growth to avoid significant and potentially catastrophic changes*".[8]

    b. We do not know how the gas will be used, "*and so we can't say what the emissions impact will be*". That said, "*There appears to be particular scope for MZLNG volumes to displace coal in power generation in China, India and Indonesia*", which could avoid over half a million tonnes of carbon emissions per TWh of electric power generated.[9]

9. Both arguments are partially or wholly incorrect. Specifically, as further detailed below:

    a. The SDS does not reflect the globally agreed ambition of the Paris goals. Wood Mackenzie does not consider any scenario aligned with limiting

[8] Wood Mackenzie report pp.3-6
[9] Wood Mackenzie report pp.8-13

warming to 1.5°C, which would inevitably involve less gas production and use.

b. The assessment of emissions impact is wrong in three respects:

   i. The notion of "avoided emissions" through displacement of other fuels is a methodologically flawed approach to considering the emissions impact of a project.

   ii. It is highly unlikely that Mozambique LNG will displace coal from power generation in India or Indonesia; it is more possible that it may do so in China, though still somewhat unlikely.

   iii. In assessing the lifecycle emissions of LNG, Wood Mackenzie has failed to consider leakage of methane from natural gas systems.

The Sustainable Development Scenario is not aligned with Paris Agreement goals

10. Contrary to Wood Mackenzie's assertion, there is not global acceptance of a 2°C target for temperature increase. Whilst that target was agreed at the Cancún climate summit in 2010, subsequent scientific evidence has led 2°C to be seen as a highly dangerous level of warming. This evolving understanding was summarised in 2015 by a two-year review within the United Nations Framework Convention on Climate Change (UNFCCC), based on inputs from scientists and other experts:[10] "*The 'guardrail' concept, in which up to 2°C of warming is considered safe, is inadequate and would therefore be better seen as an upper limit, a defence line that needs to be stringently defended, while less warming would be preferable*." It is for this reason that the Paris Agreement in 2015 set a more ambitious goals of keeping warming ***well below*** 2°C, and pursuing efforts to limit it to 1.5°C.

11. During the years immediately following the Paris Agreement, policy and investment discussions mainly focused on the upper limit of the Paris goals, namely keeping warming well below 2°C. This changed with the publication in 2018 of the IPCC's *Special Report on Warming of 1.5°C (SR15)*, which found that climate impacts at 2°C would be significantly worse than at 1.5°C, including

[10] UNFCCC (2015) https://unfccc.int/resource/docs/2015/sb/eng/inf01.pdf

impeding sustainable development, disrupting food supplies, damaging human health and causing irreversible change in natural systems.[11] Since that report, policy and investment discussions have focused primarily on how to limit warming to 1.5°C. This has led, for instance, to the emergence since 2019 of *government and company targets to reach net-zero emissions by 2050. 1.5°C scenarios generally reach net-zero emissions around 2050, whereas 2°C scenarios generally do so around 2070.*[12]

12. *The IEA's annual World Energy Outlook is an influential projection of future trends in energy systems*. Recent editions have focused on two scenarios: the Stated Policies Scenario, in which no additional climate policies are introduced, and the Sustainable Development Scenario (SDS), which aims to limit warming to well below 2°C and to achieve other energy-related Sustainable Development Goals.

13. The SDS has been widely criticised for failing to match the ambition of the Paris goals. This criticism was well known at the time the Wood Mackenzie report was completed in March 2020. For example, a series of letters in 2019 and 2020 from leading climate scientists, diplomats and major investors warned, "*The ambition of the SDS must be increased to present a reasonable probability of reaching net-zero emissions by 2050 (not 2070) and limiting warming to 1.5ºC (not 1.8ºC)*".[13] Joeri Rogelj, a lead author of the IPCC's *SR15*, said the SDS would lead to "a world warming beyond a level science considers compatible with *sustainable development of poor and vulnerable populations*".[14] These criticisms were also well reported in the media.[15]

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[11] IPCC (2018) https://www.ipcc.ch/sr15/
[12] Rogelj et al. (2015) https://doi.org/10.1038/nclimate2572
[13] Abogabir et al. (2020/2019) https://web.archive.org/web/20200817162253/https://mission2020.global/letter-to-iea/
[14] Farand (2019) https://www.climatechangenews.com/2019/11/13/iea-world-energy-outlook-outlines-1-5c-scenario/
[15] Rathi and Roston (2020) https://www.bloomberg.com/news/articles/2020-05-29/iea-s-world-energy-outlook-needs-a-1-5-c-climate-change-scenario
Green (2020) https://www.reuters.com/article/uk-climate-change-energy-idUKKBN2351UO
Watts (2018) https://www.theguardian.com/environment/2018/apr/05/iea-accused-of-undermining-global-shift-from-fossil-fuels

14. It was in this context that in May 2021, the IEA published a 1.5°C-aligned Net Zero Emissions (NZE) scenario, which the IEA has said will play an integral role in the 2021 edition of the *World Energy Outlook*. While this scenario was not available at the time of the Decision, best practice at that time was already to also consider use more ambitious IEA scenarios to test policies and investments, such as the Beyond 2 Degrees Scenario.[16]

15. For these reasons, the SDS is not a good yardstick for measuring consistency with agreed climate limits, and certainly not to indicate an upper limit of ambition, as Wood Mackenzie appears to imply when it says, "*Even in the IEA SDS scenario…, there is a continued and significant role for gas and LNG… Achieving the targets in the SDS will be challenging, meaning that there is likely upside for LNG*".[17]

Assessing "avoided emissions" is a methodologically flawed approach

16. Wood Mackenzie's assessment of the emissions impact of the Project is based entirely on assumed displacement of other fuels by the produced LNG. This approach is an unsuitable means to assess climate impacts, for two main reasons:

    a. As the climate crisis has grown more urgent, it is no longer appropriate to measure mitigation incrementally in terms of emissions reductions compared to a business-as-usual counterfactual; instead the focus of mitigation should be on *transformation* of energy systems to zero-carbon; relative to this goal, any additional fossil fuels should be considered problematic.

    b. It is impossible to meaningfully define such a counterfactual, as it is entirely assumption-dependent, and open to "gaming" through project proponents' selection of baselines with which to compare.

[16] E.g. World Aluminium (2021) https://www.world-aluminium.org/media/filer_public/2021/03/16/iai_ghg_pathways_data_calculation.pdf
Carbon Tracker and UNPRI (2018) https://carbontracker.org/reports/2-degrees-of-separation-update/
AIGCC et al. (2020) https://igcc.org.au/wp-content/uploads/2020/12/Climate-Action-100-2020-Progress-Report_Final.pdf
[17] Wood Mackenzie p.15

17. In the early stages of climate policy in the 1990s, policies commonly focused on reduction of emissions relative to business-as-usual baselines, as any incremental improvement could help start to bend the curve. Since those early days, thinking and practice on climate mitigation have moved on. One important advance came when the IPCC's Fifth Assessment Report in 2013/14 reported that temperature rise is approximately proportional to *cumulative* emissions of carbon dioxide (CO_2), and hence that stabilising temperatures at any level entails a finite cumulative amount that may be emitted, known as the carbon budget.[18] In other words, as long as CO_2 is emitted, temperatures will continue to rise. This is the scientific basis of the emergence of net-zero policy targets. As such, the emissions impact of projects should be considered in relation to what emissions they add (compared to no project), rather than in relation to what they avoid (compared to business-as-usual).

18. In addition to this evolved understanding of the carbon cycle, scientific advances have indicated that most impacts of climate change are worse at any given temperature than previously thought, leading to the 1.5°C target (as outlined above, at paragraph 10). Conversely, global emissions have continued to grow, meaning that energy systems must be rapidly transformed in order to avoid very dangerous (and potentially catastrophic) climate change. To illustrate this urgency, the carbon budget for a 50% probability of limiting warming to 1.5°C is just 460 Gt of CO_2 as at start of 2021, equivalent to just 11.5 years of annual emissions.[19] The incremental notion of avoided emissions is not appropriate to this urgency, which can be met only through transformational approaches.

19. Even if the approach were appropriate, it is methodologically impossible to apply in practice, because it relies on comparison with a counterfactual, the choice of which is inherently values-based. To illustrate, the IEA's Stated Policies Scenario is one such business-as-usual putative future, based on modelling of how energy markets may evolve if the policy environment is frozen in its current state. Such scenarios might usefully inform judgments about where the world is currently

[18] IPCC (2013), pp.1108ff http://ipcc.ch/pdf/assessmentreport/ar5/wg1/WG1AR5_Chapter12_FINAL.pdf
[19] IPCC (2018), Table 2.2.
Friedlingstein et al (2020) https://doi.org/10.5194/essd-12-3269-2020

headed (in that case, 2.7°C of warming) and how off-track policies are from where they need to be.[20] But it is not meaningful to measure a project against this, precisely because policies will not be frozen: they will change in response to events and political currents. To take the specific example considered by Wood Mackenzie, China's power generation mix will be strongly shaped by policies of the Chinese government, which change over time.

20. The controversy around "avoided emissions" was illustrated when former Bank of England Governor Mark Carney claimed Brookfield Asset Management, where he is now vice chair, has achieved net-zero GHG emissions, based on deducting emissions avoided through its renewable energy from its Scope 3 investments in fossil fuels. Following criticism from scientists and investors, he withdrew the claim.[21]

21. Business-as-usual counterfactuals have also been widely criticised for being subject to "gaming": advocates of any project can choose assumptions and baselines that involve higher emissions than their favoured project.[22] The problem has been most researched in relation to avoided deforestation, which has been part of climate policy debates since the 1990s, and is institutionalised in the framework of Reducing Deforestation and Forest Degradation (REDD+), on which there has been extensive scholarly research.[23]

22. This is not just an issue of abuse of accounting systems. As researcher Larry Lohmann observes, "*If baselines are indeed unverifiable, then there can be no distinction between 'fraud' and 'nonfraud'*".[24]

Implausible assessment of likely markets

23. Wood Mackenzie rightly states that it is impossible to know where much of the Project's LNG will be consumed, because of flexibility in the offtake agreements,

[20] IEA (2020) https://www.iea.org/reports/world-energy-model/stated-policies-scenario
[21] FT (2021) https://www.ft.com/content/2d96502f-c34d-4150-aa36-9dc16ffdcad2
Shankleman and Rathi (2021) https://www.bloomberg.com/news/articles/2021-02-25/mark-carney-s-brookfield-net-zero-claim-confounds-climate-experts
[22] Drew and Drew (2010) https://doi.org/10.1108/10309611011092574
[23] E.g. Gifford (2020) https://doi.org/10.1007/s10584-020-02653-1
Gupta et al. (2012) https://doi.org/10.1016/j.cosust.2012.10.004
[24] Lang (2016) https://redd-monitor.org/2016/10/18/larry-lohmann-the-problem-is-not-bad-baselines-but-the-concept-of-counterfactual-baselines-itself/

and because demands will change over time. In light of this recognition, it is surprising that Wood Mackenzie selected this methodology for assessing climate impact.

24. Wood Mackenzie states however, "*That said, there appears to be particular scope for MZLNG volumes to displace coal in power generation in China, India and Indonesia*". The report gives no reasons for judging there to be "particular scope" for this. In fact, while all three countries use coal extensively in their power systems, imported gas is unlikely to displace it.

25. In India, gas power generation is considerably more expensive than either coal or renewables (wind and solar). As a result, renewables are the primary competition with coal power, and more than half of India's gas generation capacity sits idle. Gas imports are rising, but for use in residential, industrial and transport applications, where they will largely be additional to existing energy use.[25]

26. In China too, onshore wind and solar are cheaper than gas (they have a levelized cost of around USD 60/MWh, compared to USD 100/MWh for gas),[26] and so are now the primary competitors with coal. This competition can be seen from the fact that while coal accounted for 47% of China's growth in power generation from 2010 to 2019, wind and solar accounted for 18% of the growth and gas just 5% (also behind hydro and nuclear).[27] While policy incentives have driven gas expansion in some provinces, gas is not an important competitor because it is too expensive.

27. Indonesia is a net gas exporter – both by pipeline and as LNG – and so is unlikely to import Mozambique LNG. Indonesia currently exports about one third of its

[25] Muttitt et al. (2021) https://www.iisd.org/publications/natural-gas-finance-clean-alternatives-global-south
[26] Smart Energy International (2020) https://www.smart-energy.com/renewable-energy/renewables-will-be-cheaper-than-coal-by-2026-in-china-study/
[27] IEA World Energy Statistics 2020

gas production,[28] and is not expected to become a net importer before at least the mid-2030s.[29]

28. The Wood Mackenzie report compares LNG with four alternatives used for power generation in China: coal from Australia (sub-critical), coal from Australia (super-critical), gas oil from the Middle East and fuel oil from the Middle East. This is an inappropriate selection of comparators. Oil products such as gas oil and fuel oil account for just 0.1% of power generation in China[30] (oil products are no longer significantly used in power generation worldwide because of their inefficiency, except in older power stations in some poor countries and in major oil producing countries). The primary generation fuel in China is coal (68%), but 98% of China's coal supplies are mined domestically rather than imported.[31] While these comparators do not reflect the Chinese power generation mix (nor its likely future), they are the generation sources worldwide that lead to the highest emissions per TWh generated.[32]

29. China's other generation fuels/technologies are hydro (18%), solar and wind (6%), nuclear (4%), gas (3%) and biofuels (1%).[33] Wood Mackenzie did not include any zero-carbon power sources in its comparison, nor domestic gas.

30. While any assessment of uses of the gas will be necessarily uncertain, Wood Mackenzie is wrong to assert that no such assessment is possible. The question of displacement – and hence net impact on emissions – can be examined through models of the energy system, and if Wood Mackenzie or UKEF were serious about answering this question, they could have conducted or commissioned such modelling. Indeed, studies that have done this modelling reach the opposite conclusion to Wood Mackenzie: that displacement of

[28] BP (2021) https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html
[29] Fulwood et al. (2020) https://www.oxfordenergy.org/publications/emerging-asia-lng-demand/ pp.30-39
[30] IEA World Energy Balances 2019
[31] BP Statistical Review 2021 https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html
[32] Only one fuel is less efficient in emissions terms than these, namely lignite.
[33] IEA World Energy Balances 2019

renewables offsets displacement of coal, leading to no net environmental benefit.[34]

Failure to consider fugitive methane in lifecycle emissions assessment

31. Wood Mackenzie's estimate of the life cycle emissions of LNG, although expressed as CO_2-equivalent, appears not to have considered leakage of methane ("fugitive methane") from gas production, distribution and consumption systems. Leakage is not anywhere explicitly mentioned (including which Global Warming Potential (GWP) basis is being used, which would be normal when considering methane as well as CO_2); judging from the size of Wood Mackenzie's numbers, I expect that they are either neglecting fugitive methane or assuming very low leakage rates.

32. Methane – which constitutes around 95% of processed natural gas – leaks from gas infrastructure at every stage of the supply chain, and some recent studies have found that leakage is far greater than previously thought.[35]

33. Methane is a highly potent GHG. Since it persists in the atmosphere only for 12 years on average (compared to hundreds of years for CO_2), its relative impact depends on the timescale one considers. Methane is 28 times more potent than CO_2 over a 100-year timescale and 86 times more potent over 20 years.[36]

34. Above a given "break-even" methane leakage rate (which varies between sectors and applications), gas will be no better for the climate than coal. Methane leakage has been observed to exceed these rates in some cases.[37]

35. A proper climate assessment of a gas development would be expected to consider likely and possible rates of leakage from gas infrastructure, either

[34] McJeon et al. (2014) http://doi.org/10.1038/nature13837
Zhang et al. (2016) http://dx.doi.org/10.1016/j.apenergy.2015.10.016
[35] Alvarez et al. (2018) http://doi.org/10.1126/science.aar7204
Hmiel et al. (2020) https://doi.org/10.1038/s41586-020-1991-8
Schwietzke et al. (2016) https://doi.org/10.1038/nature19797
[36] IPCC (2013) https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf p.714
[37] Howarth (2015) http://www.eeb.cornell.edu/howarth/publications/f_EECT-61539-perspectives-on-air-emissions-of-methane-and-climatic-warmin_100815_27470.pdf
Qin et al. (2017) https://doi.org/10.1021/acs.est.6b04072

globally or in likely target countries for sales of the gas (paragraph 48). Wood Mackenzie has not done this.

The Climate Change Report

36. I understand that UKEF compiled the Climate Change Report (CCR) to build on the Wood Mackenzie report and consider aspects not covered by Wood Mackenzie.[38] The CCR does not seek to address the shortcomings of Wood Mackenzie's report outlined above. In my judgment, it does not fill the most important gaps in Wood Mackenzie's assessment.

<u>The CCR does not contain the key elements of a climate change analysis</u>

37. An effort to systematically assess the climate impacts of a project, and that project's consistency with the Paris Agreement, should normally contain the following elements:

    a. Total project GHG emissions, broken into Scopes 1, 2 and 3.

    b. Analysis of whether those emissions, in combination with emissions from other existing or expected supply, exceed Paris-aligned energy pathways.

    c. Uses for the project, including positive and negative social impacts and the availability of alternatives.

    d. Influence of the project on evolution of the energy system, including carbon lock-in.

38. The CCR does not include the most important parts of any of these four elements, which are addressed in more detail below:

    a. The CCR quantifies only Scopes 1 and 2 emissions, even though it acknowledges that Scope 3 emissions "*will significantly exceed Scope 1 and Scope 2 emissions from the Project facilities, and will also likely significantly exceed 25,000 tonnes CO2e per year (the threshold set by the IFC for determining whether GHG emissions are considered*

[38] Griffin para 44

'significant')."[39] The CCR does not make any attempt to quantify Scope 3 emissions.

b. The CCR echoes Wood Mackenzie in arguing that gas will remain part of the energy mix, but does not consider 1.5°C scenarios and does not consider the role of the project in addition to other sources of supply.

c. The CCR states that it considers gas a "*transition fuel*" but does not unpack the meaning of this or its limitations, nor substantively consider the availability of alternatives to gas.

d. In considering carbon lock-in, the CCR suggests only a single methodology, and then states that it does not know how to apply it, thereby leaving the lock-in issue not substantively addressed.

39. As such, the CCR cannot be considered a meaningful assessment of the climate impacts of the project, because it has omitted the vital aspects of such an assessment. Furthermore, in considering alternatives to the project, the CCR only addresses the possibility of incremental improvements through technological, operational and design adjustments. It does not consider the climate impact of the project compared to not building the project at all, on grounds that not building the project would lose its economic and social benefits.[40] Yet this is the most important question on the climate impact of any project, especially in the context of post-Paris mitigation and the drive towards net-zero emissions: how does the project contribute to climate change, compared to not building it?

<u>The CCR fails to consider UKEF's and the UK's consistency with Article 2.1(c) of the Paris Agreement</u>

40. The CCR argues (without evidence) that if UKEF did not provide support, the Project would be likely to go ahead in any case, providing no climate benefit.[41] This is not a valid argument in light of Article 2.1(c) of the Paris Agreement, which establishes the goal – highly relevant to UKEF and the UK – of "*Making finance*

[39] CCR, p.30
[40] CCR, p.16
[41] CCR, pp.17-18

flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development". The reasonable interpretation of this is that all finance flows should be made consistent with low-emission pathways, regardless of what other financial flows do. UKEF's argument is also akin to any individual or country stating that there is no point in reducing their emissions, because others will continue to emit.

41. Furthermore, the CCR's claim is likely not factually correct. In respect of phasing out coal finance since 2009, and more recently phasing out oil and gas finance, international public financial institutions have influenced each other, with others following suit or leapfrogging when one adopts greater climate ambition.[42] It is likely therefore that withdrawal of UKEF from the Project, as a major member of the financial consortium, would influence others. Furthermore, public finance plays a key role in de-risking projects for private finance, so the withdrawal of UKEF and potentially others would deter private finance from the Project, by making it unattractive in terms of the balance of risk and reward.

The CCR's headline conclusion on emissions is not supported by any evidence

42. The CCR also compounds Wood Mackenzie's errors on avoided emissions. In its headline finding on the international impact of the Project, the CCR makes a stronger claim than Wood Mackenzie – without additional evidence – that *more likely than not*, the Project will displace more polluting fuels, and thus reduce overall emissions (Wood Mackenzie simply stated that it "*could*" displace them). This is a remarkable claim in the absence of evidence.

43. The CCR appears to justify the claim in two ways. First, based on Sales Purchase Agreements for the gas,[43] and second based on a simplistic argument that reality will lie somewhere between two extremes, namely where *all* the LNG displaces more polluting fuels and where *none* of it does. The first explanation is contradicted by the CCR itself, which notes that it is not known with confidence where the LNG will be used due to the flexibility of the SPAs.[44]

[42] Muttitt et al. (2021), pp.11-12 https://www.iisd.org/publications/natural-gas-finance-clean-alternatives-global-south
[43] "This is considered the most likely scenario for the use of the Project's LNG based on the SPAs" (CCR p.29)
[44] CCR, pp. 8, 31

44. Whilst likely true in a trivial sense, the second observation that "*some of the LNG will displace some … coal and oil*"[45] does not support the conclusion in the CCR summary that "*On balance, taking the three posited scenarios [all, none and some], it appears more likely than not that, over its operational life, the Project will at least result in some displacement of more polluting fuels, with a consequence of some net reduction in emissions*."[46] Even if one accepts the "avoided emissions" frame of analysis (which we should not – see paragraphs 16-22), the net reduction of emissions will only occur if that displacement effect outweighs the non-displacing, additional emissions from the remainder. This is a matter of quantitative comparison, and the CCR has done nothing to assess this.

Methodology for quantifying Scope 3 GHG emissions from this Project

45. A necessary first step in any serious climate analysis of a project should be to estimate the total emissions associated with a project. The large majority of the emissions from the Project will be Scope 3 emissions (from combustion of the sold LNG) rather than Scopes 1 or 2 emissions (from the operations of the project facilities), as the CCR acknowledges.[47]

46. The CCR asserts however that Scope 3 emissions cannot meaningfully be estimated, because "*The technology that will be used to process and combust the Project LNG is not known. It can vary widely, with more modern / efficient technology producing greater output (e.g. kWh of electricity) per tonne of carbon emissions*."[48] This is incorrect. The amount of energy generated is not relevant to an estimate of Scope 3 emissions: they are an absolute measure, not an intensity. CO_2 emissions are not significantly dependent on uses: they depend primarily on the carbon content of the LNG, which is known. The only, minor exception related to some of the LNG that goes to non-combustion uses, such as in petrochemicals. Only around 5% of global gas consumption is in non-

[45] CCR, p.29 (emphasis added)
[46] CCR, p.8 (emphasis added)
[47] CCR, p.30
[48] CCR, p.28

energy uses,[49] and much of the carbon in such uses still leads to CO_2 emissions (such as through incineration of plastics or decomposition of fertilisers).[50]

47. There are well-accepted methods for estimating GHG emissions.[51] For example, the IPCC *Guidelines for National Greenhouse Gas Inventories*[52] – which are used by states in calculating their GHG emissions as part of the UNFCCC process – give carbon content per energy content of these fuels, and energy content per volume or mass quantity. Combining these gives a carbon content for natural gas equivalent to 1,670 tCO_2 per bcm. Operating at full capacity of 12.88 mtpa, equivalent to 17.5 bcmpa, the two trains of the Project would have Scope 3 CO_2 emissions of 29.3 $MtCO_2$ per year. This is the equivalent of 7.4 coal power stations.[53]

48. To this CO_2 we need to add fugitive methane emissions. Unlike CO_2, methane emissions are indeed determined by the quality of infrastructure, specifically the extent of leakage. An appropriate approach would be to consider two or three scenarios, including high and low assumptions on rates of leakage: estimates of such rates are available in the literature.[54] Scope 3 methane emissions for the Project are estimated in the table below, using three scenarios of leakage rates across the whole supply chain[55] – low (0.5%), mid (2%) and high (6%) – with Global Warming Potential of 86 over 20 years and 28 over 100 years.[56] In the mid-case, total Scope 3 emissions are 48.5 $MtCO_2e$ per year using GWP_{20} and 35.5 $MtCO_2e$ per year using GWP_{100}.

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[49] IEA, *World Energy Balances 2019*
[50] CIEL et al. (2019) https://www.ciel.org/plasticandclimate/
[51] WRI and WBCSD (2013), p.118
https://ghgprotocol.org/sites/default/files/standards/Scope3_Calculation_Guidance_0.pdf
[52] IPCC (2006) https://www.ipcc-nggip.iges.or.jp/public/2006gl/
[53] EPA (n.d.) https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
[54] Estimates for leakage throughout the supply chain mostly range from 0.5% to 6%; they are commonly around 2% (though low and high outliers are 0.2% and 12%).
Research institute PSE Healthy Energy maintains a database of studies at
https://www.zotero.org/groups/248773/repository_for_oil_and_gas_energy_research_roger_-_pse_healthy_energy/collections/WEICK6IC/items/E9FMHN42/collection
[55] Total has targeted low methane leakage from its operations of 0.2% by 2025, which is part of Scope 1 GHG emissions. It will be seen during operation whether this target is actually achieved; however the weakness of regulatory institutions in Mozambique suggests it may be difficult to verify; actual fugitive methane emissions have significantly exceeded reported values even in countries with more established regulatory systems such as the United States. This target will not include Scope 3 methane emissions from leakage after the LNG leaves Total's facilities, in shipping, regasification, subsequent pipeline distribution and use.
[56] Assuming natural gas contains 95% methane with density 0.72 kgm^{-3} and no other GHGs

Leakage rate	Methane emissions, $MtCO_2e$ per year		Total Scope 3GHG emissions, $MtCO_2e$ per year	
	GWP_{20}	GWP_{100}	GWP_{20}	GWP_{100}
Low (0.5%)	5.4	1.8	34.7	31.1
Mid (2%)	19.2	6.2	48.5	35.5
High (6%)	65.0	21.2	94.3	50.5

49. The CCR confuses Scope 3 and "avoided emissions". In attempting to answer a question about Scope 3 emissions, the CCR instead assesses avoided emissions, in three scenarios of displacement.[57] Yet these are distinct concepts. Not only is assessing avoided emissions a methodologically flawed approach, it is incommensurate with Scope 3 assessment, which focuses specifically on the project's own production, not on wider market issues beyond the direct influence of the project. The GHG Protocol states that "*Any estimates of avoided emissions must be reported separately from a company's Scope 1, Scope 2, and Scope 3 emissions, rather than included or deducted from the Scope 3 inventory*".[58]

Carbon capture and storage

50. I have also read the witness statement of Adam Hawkes. Dr Hawkes argues that over the longer term, much of the CO_2 from combustion of Mozambican gas will be captured and stored. However, carbon capture and storage (CCS) is not relevant to estimation of Scope 3 emissions. I have never seen Scope 3 emissions estimates of any project that have assumed some of the future emissions will be abated with CCS, and the GHG Protocol does not suggest this as part of the assessment.

51. Furthermore, I believe Dr Hawkes' view of future CCS deployment is over-optimistic. While he is right that many energy models incorporate large amounts of CCS in 1.5°C and 2°C scenarios, it would be misinterpreting those models to

[57] CCR pp.27-29
[58] WRI and WBCSD (2013), p.107
https://ghgprotocol.org/sites/default/files/standards/Scope3_Calculation_Guidance_0.pdf

infer therefore that CCS is more likely to be delivered in practice: those models show futures that would be economically optimal (based on a number of assumptions), and not those that would be likely in the real world, or even necessarily realistic.[59]

52. Carbon capture and storage (CCS) has been promoted since the 1990s as a means to maintain fossil fuel consumption while reducing emissions, and has made very little progress in either deployment or technical advancement. Costs of CCS have remained high compared to expectations, and after 30 years of attempts to commercialize CCS, there remain only 21 commercial-scale plants in existence worldwide, with capacity to capture 40 Mt/year (about 0.1% of total global CO_2 emissions). All but five of the plants are used for enhanced oil recovery rather than long-term CO_2 storage.[60]

53. Many analysts now consider that wind and solar power, which are proven technologies, are likely to remain cheaper than CCS, even as CCS technology improves.[61] Advocates and investors have pulled back from the technology in recent years.[62]

54. CCS also presents significant governance challenges.[63] To be an effective mitigation measure, it will be necessary to regulate CO_2 capture, transport and processing to verify it is accurately accounted for and minimize leakage; the integrity of geological and biological storage sites will have to be monitored for generations into the future. Across all of this, international institutions must be created to deliver incentives, funding and penalties. One of the largest uncertainties in the scalability of CCS is thus the extensive institutions that would be required, at a global level, and these would have to remain effective over the very long term.

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[59] Trutnevyte (2016) https://doi.org/10.1016/j.energy.2016.03.038
[60] IEA (2020) https://www.iea.org/reports/ccus-in-clean-energy-transitions
[61] E.g. Wynn (2017) http://energypost.eu/the-carbon-capture-dream-is-dying/
[62] For example, Francesco Starace, Chief Executive of the Italian utility Enel and chair of trade association Eurelectric, captured the view of many utilities when he said, "I think CCS has not been successful. It doesn't work, let's call it what it is – it is simply too expensive, too cumbersome, the technology didn't fly."
Simon (2017) https://www.euractiv.com/section/electricity/interview/eu-power-utility-boss-coal-is-finished-the-hard-question-now-is-gas/
[63] Zhou (2020) https://theicct.org/blog/staff/carbon-capture-storage-and-leakage
Amderson (2017) https://doi.org/10.1007/s11053-016-9303-6

55. In light of these challenges, and absent any concrete commitment that Mozambique LNG will specifically be used in facilities with CCS, the reasonable approach is to calculate Scope 3 emissions without an assumption of CCS.

Role of gas in Paris-aligned energy pathways

56. The CCR considers alignment with the Paris Agreement (under questions 11 and 14) only in relation to Mozambique's Nationally Determined Contribution (NDC), along with vague discussion of preferences for renewable energy.[64] It does not, consider the Project's overall compatibility with the Paris Agreement. Mozambique's first NDC – like those of other countries – relates to the period from 2020 to 2030.[65] The Project's operational life is intended to be from 2024 to 2049,[66] meaning that at best the NDC can serve as a benchmark for the Project's climate impact only in its first six years of operation.

57. The Paris Agreement (Article 4.3) specifies that countries' successive NDCs – covering later periods – will contain progressively greater ambition. This mechanism – often known as "ratcheting" – is the heart of the Paris Agreement, inherently recognising that Parties' initial pledges are insufficient to avoid dangerous climate change, but providing a mechanism to successively increase effort to meet the need. Thus, Mozambique's first NDC reflects only one small part of the Paris Agreement, and indeed understates the ultimate ambition of the country's contributions under the Paris Agreement during the Project's operation.

58. In terms of mitigation, there are two key elements of the Paris Agreement: the goals and the means of achieving them. Article 2 of the Agreement sets out the goals, including "*Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels*" (Article 2.1(a)) and "*Making finance flows consistent with a pathway towards low greenhouse gas*

[64] E.g. "Investment in renewable energy offers by far a more environmentally sustainable pathway for global community in meeting the requirements of the Paris Agreement" (CCR, p.31)
[65] Mozambique (n.d.) https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Mozambique%20First/MOZ_INDC_Final_Version.pdf
[66] CCR, p.24

emissions and climate-resilient development" (Article 2.1(c)). Article 4 and subsequent articles describe the means by which these goals are to be achieved.

59. Future ambition – especially for a long-lived project such as this – can be best assessed by reference to the long-term goals, which the ratcheting process is designed ultimately to meet. Therefore the Project should be assessed against energy scenarios consistent with limiting warming to 1.5°C. On this basis, there is compelling evidence that the Project is not consistent with the Paris goals.

60. Importantly, the question is not just whether there is demand for gas in these scenarios, but whether there is demand for gas from the Project in addition to gas that is already provided (or "committed" – see paragraph 82-83). It cannot simply be hoped that other gas projects will be closed to make room for the Project.

61. In its Net Zero Emissions scenario (NZE),[67] the IEA simulates an energy system consistent with 1.5°C of warming, finding that there is no need for additional oil or gas fields. This is because global demand for oil and gas decline at a rate equivalent to the natural decline of production from existing fields.[68] It also finds that there is no need for "*many of the liquefied natural gas (LNG) liquefaction facilities currently under construction*".[69]

62. Dr Hawkes suggests that since the NZE considers "existing" fields to be those developed before end of 2021, the gas fields in the Project are within that bracket and hence consistent with the scenario.[70] This is true only for the gasfields, not the LNG terminal, and only in quite a trivial sense, because it flows from an artefact of the scenario design. The IEA designed the scenario so as to minimise the stranding of upstream production assets,[71] which is why it selected that timeline for defining "existing" fields. Yet the scenario relies on a very large and extremely rapid deployment of CCS, of 1.7 Gt by 2030 and 7.6 Gt by 2050;[72] I

[67] IEA (2021) https://www.iea.org/reports/net-zero-by-2050
[68] Annual production from a developed conventional oil or gas field commonly declines at 3-5% per year as reservoir pressures decrease; historically the oil and gas industry has continually developed new fields in order to sustain and grow total production.
[69] IEA (2021), p.102 https://www.iea.org/reports/net-zero-by-2050
[70] Hawkes para 12
[71] IEA (2021), p.55 https://www.iea.org/reports/net-zero-by-2050
[72] IEA (2021), p.80 https://www.iea.org/reports/net-zero-by-2050

consider that 2030 quantity implausible (see paragraph 51-54), and the 2050 quantity uncertain at best, and the IEA itself notes that the amount of CCS is one of the largest uncertainties in the scenario.[73] If there were less reliance on CCS, gas (and oil) production would have to be correspondingly lower. Thus if the scenario had been published in 2019 (for example), it would very likely have found no room for new fields beyond those developed by 2019. While it is true that the scenario treats the gasfields associated with the Project as "existing" in a strictly literal sense, a broad interpretation of the scenario would be that there is no room for those fields either.

63. As for the IEA's second point about LNG terminals, Dr Hawkes states that because "*the Project appears to be very economically attractive*", it is unlikely to be one of the many under-construction terminals that are not needed.[74] This cannot be asserted without more detailed economic analysis. In the IEA scenario, LNG exports fall from a peak of around 500 bcm per year in 2025 to 300 bcm in 2035 and 200 bcm in 2045.[75] On Dr Hawkes' limited measure of relative economic robustness, the Project would have to be in the 40% lowest-cost terminals.

64. While the NZE was published after the Decision, several scenarios consistent with the Paris goals were available at the time of the Decision, in particular the scenario set published by the IPCC.[76] These are considered in Dr Hawkes' evidence, though not in the CCR.

65. Dr Hawkes is right to exclude "high overshoot" scenarios from this set,[77] but he should go further, to exclude scenarios that rely on carbon dioxide removal (negative emissions) to an extent greater than the IPCC report on 1.5°C

[73] IEA (2021), p.94 https://www.iea.org/reports/net-zero-by-2050
[74] Hawkes para 12
[75] IEA (2021), p.175 https://www.iea.org/reports/net-zero-by-2050
[76] Available at https://data.ene.iiasa.ac.at/iamc-1.5c-explorer/#/workspaces
[77] Hawkes para 10 and note 2

considers realistic.[78] The Production Gap Report and Climate Action Tracker both restrict the scenario set in this way, in order to achieve greater realism.[79]

66. In this set of more realistic IPCC scenarios, the Production Gap Report finds that global gas production declines by 3% per year between 2020 and 2030.[80] This is roughly equivalent to the natural decline rate of production from existing fields, echoing the IEA's conclusion that there is no room for additional oil and gas fields, this time as of 2020 (which is the base year for mitigation in the IPCC scenarios).

67. The relative cost of a project compared to competing sources of supply is a means of assessing economic and financial risk to a project – the more relatively expensive, the greater the risk. It is not a means of determining whether a project is consistent with the Paris goals. Thus, even if the Project were one of the cheapest producers, such that other producers face greater losses from Paris-aligned demand limits, it would not follow that the Project can fit within a global carbon budget consistent with the Paris Agreement. This is because projects tend to continue producing as long as the gas can be sold at a price greater than the *marginal* cost of producing it, even if making a loss on the sunk capital (because additional marginal production will reduce that loss). Furthermore, when projects make a loss, their operators commonly argue for regulatory or fiscal support to protect their investments and associated jobs. These effects are part of carbon lock-in.

68. If the Project is indeed economically superior to rivals, this may mean that the Project could make smaller losses on investment in a Paris-aligned world; the

[78] The IPCC reports that the maximum sustainable potential for bioenergy with carbon capture and storage (BECCS) is 5 $GtCO_2$ per year in 2050, and for land use-based removal is 3.6 $GtCO_2$ per year. *SR15* pp.343–345
Best practice is therefore to exclude scenarios whose reliance on CO_2 removal exceeds the upper end of those ranges, on average over the period 2040–2060.
Dr Hawkes might suggest this exclusion should not make any difference, based on his finding that cumulative CO_2 removal is uncorrelated with gas usage in IPCC scenarios. However, closer inspection reveals that the removal/gas-usage relationship shows significant heteroscedasticity: there is much greater variation at higher levels of removal, and this distorts the overall picture, masking correlation at lower levels of removal. Excluding the "unrealistic" scenarios reveals a (moderate) linear correlation between the same two variables Dr Hawkes examined, with R^2 of 0.28.
[79] SEI et al (2020) https://productiongap.org/2020report/
New Climate Institute et al. (2018) https://climateanalytics.org/media/cat_temp_upadate_dec2018.pdf
[80] SEI et al. (2020) https://productiongap.org/2020report/

quantity of gas produced would still exceed amounts the world could afford to consume while achieving the Paris goals.

69. These considerations significantly impact upon the economic benefit of the Project to Mozambique. The effect of too much gas supply will be to drive down commodity gas prices, reducing the revenue received by the Project. Since gas projects are structured economically to prioritise returns on the companies' invested capital before providing revenue to the Mozambique government: the government is not set to receive a significant share of revenues until well into the 2030s.[81] Reduced global demand driven by climate policy, combined with an excess of supply, will significantly impact overall revenues. Since flows to the companies are frontloaded, the government share bears the energy transition risk.[82] Whilst this may be good news for repaying UKEF, it fundamentally undermines the case for the Project driving Mozambique's socio-economic development.

Uses of gas, the "transition fuel" idea and mitigation in developing countries

70. The CCR describes gas as a "transition fuel" on grounds that it how lower emissions than coal or oil.[83] While the relative emissions are uncertain, depending on the degree of methane leakage (paragraph 34), it is not enough post-Paris to consider the incremental emissions: we must consider whether gas is actually needed before zero-carbon alternatives can be deployed. The CCR does not address this.

71. Dr Hawkes argues that "*the natural gas from the Project could be used to support the introduction of more wind and solar electricity than would otherwise be possible. This is because gas is a competitive option for balancing supply and demand in an electricity system that has a high penetration of intermittent technologies such as solar and wind-based systems*."[84]

[81] Mozambique (2018) http://www.inp.gov.mz/pt/content/download/1372/9256/version/1/file/Republic+of+Mozambique_Government+Revenues+from+Gas+Projects.pdf
[82] Fuhr and West (2014) https://www.project-syndicate.org/commentary/lili-fuhr-and-johnny-west-encourage-oil-producing-countries-to-prepare-for-more-robust-climate-policies
[83] CCR p.8
[84] Hawkes para 41

72. This claim is not generally correct, because the types of gas generation that could provide grid flexibility to balance renewables — flexible "peaker" units such as open cycle and reciprocating gas engines—are very costly per unit of energy due to their inefficiency and resulting high fuel consumption. The more efficient CCGT plants are not suited to providing grid balancing: they are designed for relatively constant use due to high upfront capital costs. If they are used for grid balancing (i.e., only part of the time), their capacity factor will be lower than optimal, and hence their cost will be high (Stockman et al., 2019, pp. 14–15).[85] In reality, gas is more often a competitor than a complement to renewables.

73. There are numerous ways to balance the variability of renewables more affordably and more effectively than with gas.[86] Integration of variable renewables is relatively straightforward at low levels of penetration, such as below 10%. Low-cost options at these levels include improved forecasting of supply and demand, more frequent and/or more sophisticated grid management, and improved power market design. As penetration increases, modest-cost options include enhancing the ramping characteristics of existing flexible power stations (to allow quicker response) and managing demand to better match supply, including through time-of-day pricing. More substantive physical investments need to be added only at higher penetration levels, such as strengthening transmission infrastructure and adding storage.

74. With near-instantaneous response times, batteries are better suited than gas to short-term grid balancing.[87] Lithium-ion battery costs are declining even faster than wind and solar costs, having fallen 75% between 2015 and 2020, and wind-plus-battery or solar-plus-battery systems are now cheaper than gas peaker

[85] CCGT plants have relatively high capital costs but (due to efficiency) lower fuel costs. Peakers are the other way round and so are suited to providing capacity that is often idle.
[86] Muttitt et al. (2021), pp.24-27 https://www.iisd.org/publications/natural-gas-finance-clean-alternatives-global-south
Cochran et al. (2014) https://www.nrel.gov/docs/fy14osti/61721.pdf
Denholm et al. (2010) https://www.nrel.gov/docs/fy10osti/47187.pdf
IEA (2019) https://www.iea.org/articles/should-grid-integration-be-a-concern-for-policy-makers-in-countries-with-low-wind-and-solar-deployment
IEA (2020) https://www.iea.org/articles/will-system-integration-of-renewables-be-a-major-challenge-by-2023
Lund et al. (2015) http://doi.org/10.1016/j.rser.2015.01.057
[87] Stockman (2019) http://priceofoil.org/2019/05/30/gas-is-not-a-bridge-fuel/

plants in much of the world.[88] The first gigawatt-scale battery was given regulatory approval in California in 2020.

75. In fact, the notion that gas can be a "transition fuel"[89] is now obsolete, for three reasons. First, after decades of continued rising global emissions, the climate crisis has become more urgent, and to avoid its worst impacts, cuts must be more rapid than fuel switching can deliver (see paragraphs 16-18); with net-zero emissions targeted for mid-century, new gas infrastructure is likely to lock in emissions beyond the time horizons for emissions reduction. Second, the costs of renewable energy have fallen dramatically, and renewables are now cheaper than fossil fuels in most of the world, and techniques and technologies have become available to balance variable supply; there are affordable alternatives for most uses of gas.[90] Third, recent studies have found that methane leakage is far greater than previously thought.[91]

76. While the CCR mentions that under the Paris Agreement, developing countries may reduce GHG emissions more slowly developed countries,[92] it does not follow that fossil fuel expansion in those countries is consistent with the goals of the Agreement. Indeed, as noted above, achieving the Paris goals will require rapid *global* reduction in gas production and use. The notion of "common but differentiated responsibility", at the heart of the UNFCCC and Paris Agreement, means that all countries have a common responsibility, but the way in which they meet it is differentiated between them. When it comes to fossil fuel extraction, this implies that all countries should begin a reduction, but the reduction should be fastest in wealthiest countries, and poorer countries should receive finance and support to enable their reduction.[93]

77. With the global energy transition unfolding over the coming decades, fossil fuel development is a very risky economic pathway for countries like Mozambique.

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[88] BNEF (2020) https://about.bnef.com/blog/scale-up-of-solar-and-wind-puts-existing-coal-gas-at-risk/
[89] E.g. Griffin paras 90-91
[90] Muttitt et al. (2021) https://www.iisd.org/publications/natural-gas-finance-clean-alternatives-global-south
[91] Alvarez et al. (2018) https://science.sciencemag.org/content/361/6398/186
Schwietzke et al. (2016) https://www.nature.com/articles/nature19797
Hmiel et al. (2020) https://www.nature.com/articles/s41586-020-1991-8
[92] CCR, p.8
[93] Muttitt and Kartha (2020) https://doi.org/10.1080/14693062.2020.1763900

There is a danger that these countries get left behind, locked into high-carbon infrastructure, stranded assets and costly liabilities as the rest of the world moves to cleaner and cheaper forms of energy.

78. The CCR argues that "*Investment in renewable energy would offer a more environmentally sustainable pathway for Mozambique's domestic energy needs and to meet the aims of the Paris Agreement, but it should be recognised that the same financial incentives do not exist to attract such investment into the renewables sector, and it is unlikely that Mozambique will attract significant international investment into the renewables sector without first being in receipt of financial resources from investment into sectors such as natural gas*."[94]

79. This argument strikes me as highly perverse: that expanded carbon-intensive infrastructure is necessary to enable investment in reducing carbon intensity. Indeed, on this argument, any revenue-generating project could be claimed to be consistent with the Paris agreement.

Carbon lock-in

80. Far from helping facilitate renewable energy, it is more likely that the opposite will be the case: new gas development will impede renewable energy.

81. One particular concern around new fossil fuel development is that it may cause carbon lock-in, meaning inertias in the system that make it harder to change course to a clean energy path.[95] These inertias can be economic, technological, political, social, cultural or behavioural.[96]

82. Carbon lock-in can relate either to the Project itself, preventing it from being closed early due to market pressures and/or evolving climate policy; or to the energy system of Mozambique as a whole (or the broader region or the world), creating societal inertias that lead to yet more gas development and dependence, making it harder to transition the whole system. In respect of the former, more limited lock-in of the Project itself, Committed Cumulative Carbon Emissions

[94] CCR, p.24
[95] Unruh (2000) https://doi.org/10.1016/S0301-4215(00)00070-7
Unruh (2002) https://doi.org/10.1016/S0301-4215(01)00098-2
[96] Seto et al. (2016) https://doi.org/10.1146/annurev-environ-110615-085934

(CCCE) would be an appropriate metric, as it assesses the lifetime emissions of the whole project, if it is not closed early.

83. The CCR states that "*UKEF's understanding is that the only area where research is advanced enough to undertake a near reliable assessment is in the power generation sector.*"[97] In fact, commitment accounting dates back at least to 2010,[98] and has been applied to diverse infrastructure,[99] including fossil fuel extraction.[100]

84. In fact, CCCE is very straightforward to calculate, by multiplying the annual Scope 3 emissions (calculated as above) by the lifetime of the Project. If the Project operates for its intended life of 25 years, the CCCE would be 735.2 $MtCO_2$. (This does not include methane, whose climate impact is non-cumulative). However, infrastructure projects often continue beyond their intended design life, if there is no incentive to close them. Thus, the CCCE should consider a range of operating lifetimes; for example, if it operates for 35 years, the CCCE would be 1,026 $MtCO_2$.

85. In respect of the wider effects on the national, regional or global energy system, the CCR does not make any assessment (even qualitative). There is strong evidence that fossil fuel development can lock in entire national economies to high-carbon pathways,[101] including by creating political pressures for fossil fuel subsidies and greater fossil fuel consumption.[102]

Statement of Truth

86. I am aware of my duties to the Court (as contained in Part 35 of the Civil Procedure Rules, Practice Direction 35 and the Guidance for the Instruction of Experts in Civil Claims 2014) with the overriding duty being to help the Court on

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[97] Presumably referring to Pfeiffer et al. (2016) https://doi.org/10.1016/j.apenergy.2016.02.093
[98] Davis et al. (2010) https://doi.org/10.1126/science.1188566
[99] E.g. Tong et al. (2019) https://doi.org/10.1038/s41586-019-1364-3
Smith et al. (2019) https://doi.org/10.1038/s41467-018-07999-w
[100] Matthews (2014) https://doi.org/10.1088/1748-9326/9/11/111001
Muttitt (2016) http://priceofoil.org/content/uploads/2016/09/OCI_the_skys_limit_2016_FINAL_2.pdf
[101] Friedrichs and Interwildi (2013) http://doi.org/10.1016/j.enpol.2013.07.076
[102] Gomes (2020) https://www.oxfordenergy.org/publications/the-dilemma-ofgas-importing-and-exporting-countries/
Also Muttitt et al. (2021) https://www.iisd.org/publications/natural-gas-finance-clean-alternatives-global-south

matters within my expertise, one which overrides any obligation I have to those instructing me to prepare this statement. I confirm that I have complied with those duties. I also confirm that I have made clear which facts and matters referred to in this statement are within my own knowledge and which are not. Those that are within my own knowledge, I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer. I understand that proceedings for contempt of court may be brought against anyone who makes, or causes to be made, a false statement in a document verified by a statement of truth without an honest belief in its truth.

Signed:

Greg Muttitt

Dated: 6 August 2021

Appendix 1

Documents provided with my instructions

Document	Date sent
Claim bundle including: 1. Claimant's original statement of facts and grounds 2. First witness statement of Kevin Anderson dated 8 September 2020 3. Witness Statement of Paul Balcombe dated 7 September 2020 4. Witness Statement of Ilham Rawoot dated 7 September 2020 5. First witness statement of Joshua Dimon dated 7 September 2020 6. Witness Statement of Adam McGibbon dated 7 September 2020 7. Witness Statement of Rowan Smith dated 8 September 2020 8. Witness Statement of Kim Bowden dated 7 September 2020 9. Supporting documents including extracts of: EIA (2014), Resettlement Action Plan (2016), Production Gap Report (2019), Emissions Gap Report (2019), CCC Net Zero Report (May 2019) 10. Relevant legislation and policies **Disclosure bundle** provided by Defendant on 30 September 2020 **Core renewal hearing bundle** including: 11. Second witness statement of Joshua Dimon dated 4 November 2020 12. Second witness statement of Kevin Anderson dated 9 November 2020 13. Claimant's Amended Statement of Facts and Grounds 14. Defendant's Acknowledgment of Service and Summary Grounds 15. Interested Parties' Acknowledgment of Service and Summary Grounds 16. Claimant's Reply **Supplementary renewal hearing bundle**	12 July 2021

Defendant and Interested Parties' DGR and evidence: 17. Defendant's Detailed Grounds of Resistance 18. Defendant's Witness Statement of Louis Taylor dated 25 June 2021 and exhibit 19. Defendant's Witness Statement of Maxwell Griffin dated 25 June 2021 and exhibit 20. Interested Parties' Detailed Grounds of Resistance 21. Interested Parties' Witness Statement of Ronan Bescond dated 25 June 2021 and exhibit 22. Interested Parties' Expert Witness Statement of Dr Hawkes dated 25 June 2021	
Greenhouse Gas Protocol - Technical Guidance for Calculating Scope 3 Emissions	21 July 2021