Climate Change Committee

The UK's independent adviser on tackling climate change

The Rt Hon Kwasi Kwarteng MP
Secretary of State, Department for Business, Energy & Industrial Strategy
1 Victoria Street SW1H 0ET
31st March 2021

Climate Change Committee
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London SW1W 9SZ

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Dear Kwasi,

The Climate Change Committee is required by the Infrastructure Act to provide advice to the UK Government on compatibility of onshore petroleum[1] with UK carbon budgets, every five years.

The present moratorium on hydraulic fracturing ('fracking') for onshore oil and gas, due to the risk of earthquakes,[2] means this advice may not carry any immediate implications. Nevertheless, our advice is provided to fulfil our statutory duty, and to address the potential case in which concerns over seismicity are overcome at a future date.

Context for onshore petroleum production in the UK

Since our previous advice in 2016,[3] the context on compatibility of onshore petroleum with UK climate targets has changed with the introduction of a new statutory Net Zero target in 2019. This is a more substantive factor than any new evidence on the emissions footprint of shale developments in the UK:

- **Net Zero UK greenhouse gas emissions.** The adoption of the Net Zero target for 2050 represents a more stringent context in which to consider any impact of onshore petroleum on UK GHG emissions. The Committee's recent advice on the Sixth Carbon Budget[4] recommended a reduction in UK emissions of 78% on 1990 by 2035, reaching almost the same level of emissions reduction as the previous 2050 target, 15 years earlier.

- **UK evidence.** The estimates for the greenhouse gas (GHG) footprint of UK shale developments made in our 2016 advice remain valid in the absence of new evidence on the productivity of UK geology.

[1] The sources of onshore petroleum covered by our advice are those relevant to the UK, which are conventional oil and gas, shale gas, shale oil and coal bed methane.

[2] https://www.gov.uk/government/news/government-ends-support-for-fracking

[3] CCC (2016) *Onshore Petroleum – The compatibility of UK onshore petroleum with meeting the UK's carbon budgets.*

[4] CCC (2020) *The Sixth Carbon Budget – The UK's path to Net Zero.*

The emissions per unit of energy produced depend strongly on the amount of energy produced per well, for which there remains a weak evidence base in a UK context.

Our 2016 advice focused primarily on shale gas, and set out three tests for the compatibility of exploitation of this resource with UK carbon budgets:

- **Test 1: Well development, production and decommissioning emissions must be strictly limited.** Greenhouse gas emissions must be tightly regulated and closely monitored in order to ensure rapid action to address leaks.

- **Test 2: Consumption – gas consumption must remain in line with carbon budgets requirements.** UK unabated fossil energy consumption must be reduced over time within levels we have advised to be consistent with the carbon budgets.

- **Test 3: Accommodating shale gas production emissions within carbon budgets.** Additional production emissions from shale gas wells will need to be offset through reductions elsewhere in the UK economy, such that overall effort to reduce emissions is sufficient to meet carbon budgets.

These tests remain valid, but the greater stringency of the UK's increased climate ambition will make them more difficult to achieve.

Fossil fuel consumption on the path to Net Zero

Onshore petroleum is another source of fossil fuels, the consumption of which must fall sharply on the path to Net Zero. The Committee's Balanced Net Zero Pathway requires reductions in oil consumption of 47% by 2035 and 77% by 2050 and in unabated fossil gas combustion of 65% by 2035 and 99% by 2050 (see Annex). These are larger drops in demand than that identified as part of our Fifth Carbon Budget advice in 2015.

Fossil gas may have a role in combination with carbon capture and storage (CCS), for example in hydrogen production and electricity generation. However, gas with CCS faces multiple challenges:

- Use of fossil gas with CCS is not zero-emissions (e.g. saving up to 85% vs. unabated fossil gas on a lifecycle basis). It would increase dependence on large amounts of CCS infrastructure and potentially increase reliance on fossil gas imports. Its use should be limited in order to minimise upstream emissions from fossil gas supply, and focused where it complements the role of zero-emission energy generation.

- So far, deployment of CCS has made relatively little progress in the UK and internationally, repeatedly falling behind roadmaps and stated intentions. Given its role in greenhouse gas removals, industrial decarbonisation and energy generation, it is important that more rapid progress is made on CCS deployment. Failure to do so will reduce further the scope for fossil fuel consumption on the path to Net Zero.

- Exploitation of UK shale resources is unpopular. Only 10% of the public supported fracking at the time when the moratorium was introduced; 41% were opposed.[5] Domestic shale gas production therefore presents a risk to the acceptance of hydrogen if they are closely linked in the public's perception, even with CCS. Given the value of hydrogen as a new low-carbon energy vector this risk is material.

[5] BEIS (2020) *BEIS Public Attitudes Tracker: Wave 32*. Subsequent surveys have shown a modest increase in support, but this may be due to the absence of active exploration.

Even if fossil fuel consumption falls in line with our recommended path, there will be a challenge to meet the UK's fossil fuel demand, given the decline in North Sea production. Projections of North Sea fossil gas production by the Oil and Gas Authority (OGA), together with gradually declining pipeline imports from Norway, suggest that the UK will continue to require additional gas supplies beyond these two sources until 2045 and potentially beyond 2050.

For fossil gas, the choice at the margin to fill this gap is likely to be between shale gas and imported liquefied natural gas (LNG), some of which may come from shale gas produced elsewhere in the world. We judge, therefore, that LNG is the appropriate comparator for UK onshore shale gas production when considering the implications for GHG emissions. The implications of UK onshore petroleum development for greenhouse emissions depend on the lens through which they are viewed:

- **UK territorial emissions.** Producing fossil fuels leads to GHG emissions wherever it occurs, so production within the UK would lead to higher territorial emissions. By contrast, emissions from LNG supply occur predominantly outside the UK and are therefore outside the scope of the UK's carbon budgets. Although UK territorial emissions are used under the UK carbon budgets, in the case of highly-traded goods it is not the metric that best reflects the impact of UK activity on the climate.

- **UK consumption emissions.** When considering the impact of UK energy consumption on global GHG emissions, a fairer comparison is to consider the emissions from fossil fuel supply regardless of where in the world they occur. This is represented by the lifecycle GHG footprint of different sources of fossil fuels:

    - Current evidence on the GHG footprint of LNG and UK shale gas is not definitive, but available estimates indicate that emissions from LNG supply are likely to be higher than those that would arise from commercial UK shale gas production and could be much higher. Uncertainty over the GHG footprint of each source means that the difference in their footprints is highly uncertain. The emissions footprint of LNG could be very similar to that of UK shale gas or higher by up to 63 gCO_2e per kWh of gas consumed, equivalent to around a third of the emissions released by fossil gas combustion (see Annex).[6]

    - Combining this assessment of the emissions intensity of fossil gas supply with estimates of the relevant potential volumes of UK fossil gas demand (105-180 TWh in 2035, falling to 0-100 TWh by 2050 – see Annex), we can estimate the potential impact on annual consumption emissions. At the higher end of LNG emissions footprint, UK consumption emissions could be 6.7-11.5 $MtCO_2e$ higher in 2035 and up to 6.3 $MtCO_2e$ higher in 2050 if the UK relies on LNG to fill the portion of the supply gap that could otherwise be met by shale gas.

- **Overall global emissions.** UK shale gas production risks increasing the global consumption of fossil gas, unless new UK production is matched by equivalent reductions in overseas supply. The impact on aggregate global GHG emissions will depend on wider developments in energy consumption:

    - The UNEP Production Gap report[7] has shown that some new fossil fuel production is required, even under decarbonisation pathways consistent with the Paris Agreement, but that current plans internationally for fossil fuel exploration and production are already well in excess of what is required.

[6] When also including the CO_2 that arises from burning the gas, these extra emissions mean that the overall GHG footprint of fossil gas from LNG could be up to 29% higher than that of UK shale gas.

[7] https://www.unep.org/resources/report/production-gap-2020

– The addition of UK production to the market for fossil gas could lead to higher fossil gas consumption through displacement of low-carbon energy and/or an increase in energy consumption. Should extra UK fossil gas production lead to higher gas consumption globally, especially in the likely case that this is without CCS, this would push up global emissions. In the absence of any change in coal consumption (see below), the lifecycle emissions savings of UK shale gas over LNG imports would be counteracted if global unabated fossil gas consumption increases by a mere 7% of the extra UK production.[8]

– It is also conceivable that, due to displacement of coal consumption, an increase in fossil gas consumption globally could lead to lower overall GHG emissions. However, scenarios for global decarbonisation that achieve a 1.5°C limit on global temperature rise tend to have lower consumption of both coal and fossil gas than those consistent with a rise of 'well below 2°C'. Therefore, pursuit of efforts towards 1.5°C, as required by the Paris Agreement, suggests little if any room for increased fossil gas consumption to lower overall global emissions.

In practice, it is not possible to predict with certainty how these factors will interact in a dynamic international energy market in the context of international climate action, nor how the UK might control these effects.

The Committee therefore makes the following recommendations to ensure that any fossil fuels supplied to the UK are compatible with our climate commitments:

- Policies must be put in place to reduce direct emissions from fossil fuel consumption across the UK energy system, consistent with the path to Net Zero set out in our Sixth Carbon Budget advice. These policies must drive substantial improvements in energy efficiency, strong deployment of zero-carbon energy sources and electrification where this is feasible, together with rapid development and deployment of hydrogen and CCS to tackle those activities that can't be electrified.

- Regardless of choices over where the UK gets its fossil fuels at the margin, the UK should adopt a policy to limit the greenhouse gas emissions from the production/supply of fossil fuels consumed in the UK, irrespective of where the emissions occur. This could be achieved through implementation of minimum standards or border carbon tariffs on imports. Such a framework would help deliver around 10% of the economy-wide emissions reduction required to meet the NDC[9] for 2030 and drive the 75% reduction in UK fossil fuel supply emissions from 2018 to 2035 that we have recommended in our Sixth Carbon Budget advice, without biasing consumption towards imports with a higher emissions footprint.

- If concerns are overcome regarding seismicity, the moratorium on UK shale production should not be lifted without an in-depth independent review of the evidence on the climate impact:

  – This review should be undertaken in the context of the Government's Net Zero Strategy, and international plans on decarbonisation and fossil fuel production.

  – It would need to undertake a proper assessment of the lifecycle emissions of UK unconventional fossil fuel production and alternative sources of supply.

[8] Within a range of 1-22%.

[9] Our Balanced Net Zero Pathway has emissions from fossil fuel supply reducing from 39 $MtCO_2e$ in 2018 to 18 Mt in 2030, around 10% of the required economy-wide emissions reduction from 494 Mt in 2018 to 276 Mt in 2030.

- It should take into account progress in deployment and costs of zero-carbon (e.g. renewable) hydrogen and carbon capture and storage (CCS), as well as the CO_2 capture rate of CCS.
- It should also consider the implications of fracking for public acceptance of the energy transition on the path to Net Zero, and the risk of lock-in to fossil fuel infrastructure.

Reducing emissions from offshore oil and gas production

We have noted the publication of the new North Sea Transition Deal,[10] which commits to reduce the GHG footprint of UK offshore oil and gas production by 50% by 2030, relative to 2018 levels.[11] This reduction is significantly lower than the recommendation in our Sixth Carbon Budget advice.

Offshore production is in decline and given the opportunities to electrify offshore platforms[12] and reduce methane emissions and flaring, we would expect outturn emissions to be well below the Transition Deal's ambition. A stronger policy on reducing the emissions footprint of fossil fuels consumed in the UK should therefore be adopted. Weak policies towards domestic oil and gas emissions will hinder the achievement of Net Zero and risk damaging the UK's authority as COP President.

We welcome the planned 'Climate compatibility checkpoint' reviews before each licensing round and we would be happy to engage with BEIS in these reviews. Given the issues we have raised in this letter around compatibility of new fossil fuel production with the UK's climate commitments, these reviews will need to present a transparent and coherent case to justify proceeding with licensing rounds.

The Annex to this letter sets out our analysis in more detail.

Yours

Lord Deben
Chairman

[10] https://www.gov.uk/government/publications/north-sea-transition-deal

[11] The Committee's Balanced Net Zero Pathway, on which the advice on the level of the Sixth Carbon Budget is based, entails a 68% reduction in emissions from production and processing of North Sea oil and gas by 2030 compared to 2018 levels, from 19.2 to 6.1 $MtCO_2e$. The North Sea Transition Deal committed to a 50% reduction by 2030.

[12] The Oil and Gas Authority has set out significant potential for electrification of offshore platforms at reasonable cost, in Oil and Gas Authority (2020) *UKCS Energy Integration – Final Report – Annex 1 – Offshore Electrification*

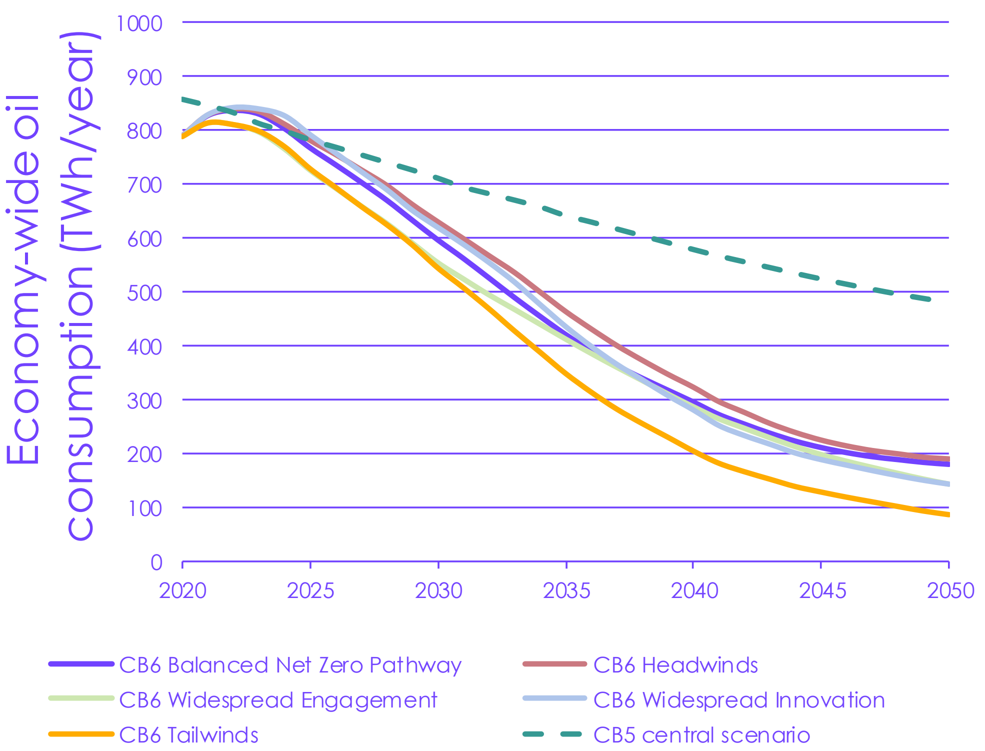
Annex

Fossil fuel consumption on the path to Net Zero

The UK's committed climate ambition for 2030 and 2050, together with the Committee's recent advice on the Sixth Carbon Budget (which centres around 2035), imply major reductions in unabated fossil fuel consumption and in use overall use of fossil fuels for energy, beyond those previously identified by our analysis. Reducing this consumption must be the over-riding priority:

- The decarbonisation of transport means that oil consumption must fall by 46-62% by 2035 and 85-98% by 2050. Any remaining liquid fuel consumption by that date is expected to be dominated by aviation and use as a chemical feedstock (Figure 1). In order to achieve Net Zero, emissions in its use must be balanced by use of greenhouse gas removals.

Figure 1 Oil demand under the Sixth Carbon Budget scenarios to 2050



Source: CCC analysis; BEIS (2021) *Energy Trends: March 2021*
Notes: CB5 and CB6 are the pieces of CCC advice on the Fifth and Sixth Carbon Budgets respectively. The Sixth Carbon Budget level was recommended on the basis of the Balanced Net Zero Pathway. Projected consumption includes non-energy use kept constant at 2019 levels (75 TWh/year).

- Similarly, decarbonisation pathways for sectors such as buildings, manufacturing and electricity generation mean that unabated consumption of fossil gas (i.e. use without CCS) will need to fall by around 65% by 2035 and be virtually eliminated by 2050 (Figure 2).

- While there is a potentially important further role for fossil gas to contribute in conjunction with use of carbon capture and storage (CCS) (e.g. in hydrogen production and electricity generation), this should be limited in order to minimise upstream emissions from fossil gas supply, as well as reliance on CCS in meeting Net Zero and a potential need for gas imports and/or new domestic production:

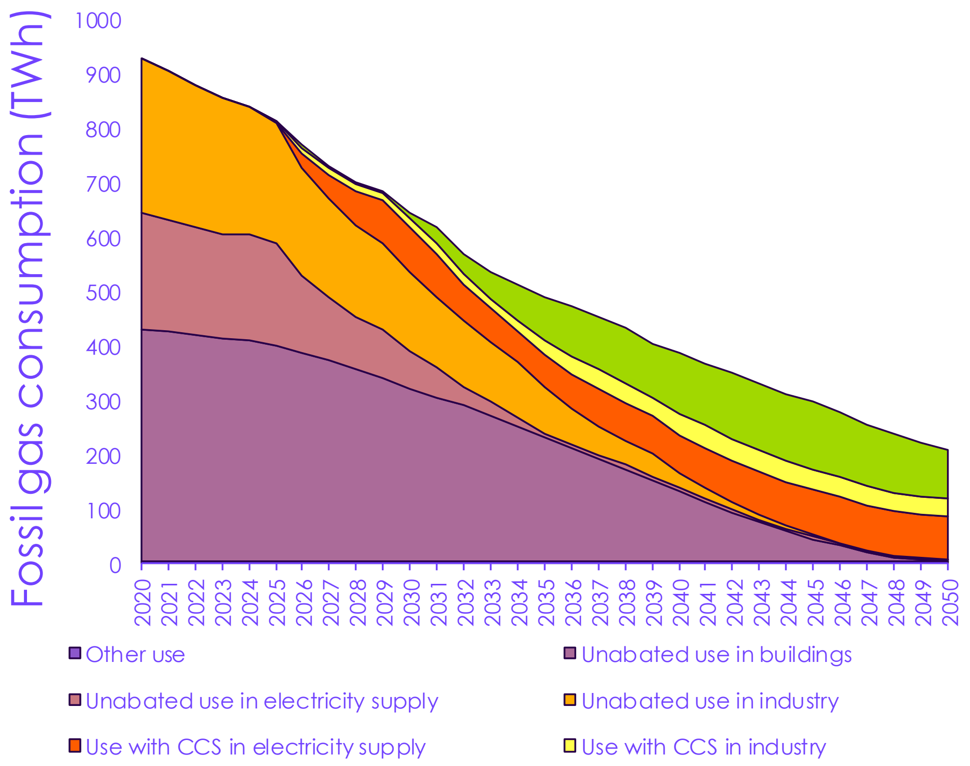
– Use of gas with CCS is not zero-carbon and at best can be regarded as low-carbon (e.g. saving up to 85% compared to unabated fossil gas). It reduces emissions by less than non-hydrocarbon energy (e.g. wind, solar, nuclear), which have much lower lifecycle emissions. It also remains unclear how much CCS infrastructure can feasibly be deployed by 2050.

– Use of fossil fuels with CCS should therefore be limited to areas that cannot be decarbonised through renewables/nuclear (e.g. as back-up capacity to support an electricity system with a high share of zero-carbon generation). Where fossil CCS is used, CO_2 capture rates will need to be at least 90% and ideally 95% or higher.

– Given likely constraints on non-fossil hydrogen supply (e.g. electrolysis based on renewables/nuclear), it is also likely that hydrogen supply at the margin will need to be from fossil gas with CCS. Where feasible, electrification (e.g. of transport, buildings and manufacturing) is strategically preferable to use of hydrogen, which is better prioritised for areas that cannot be electrified.

– However, some hydrogen production from fossil gas with CCS is likely to be necessary in order to scale up hydrogen use at the necessary rate, given constraints on production volumes from other routes.

Figure 2 Fossil gas consumption under the Balanced Net Zero Pathway to 2050

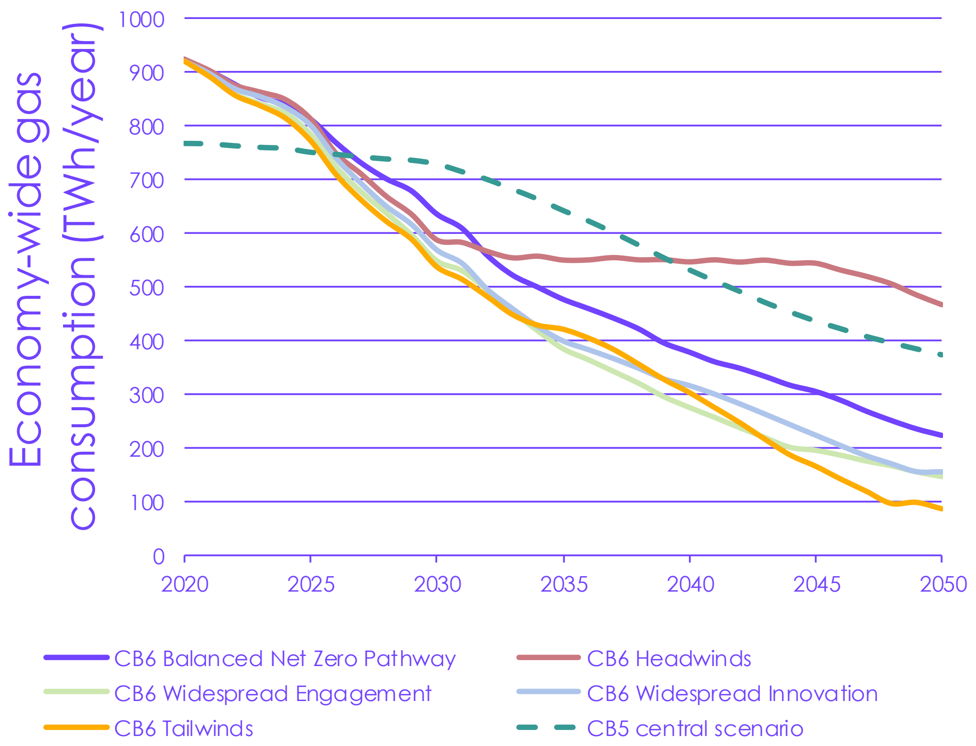


Source: CCC analysis; BEIS (2021) *Energy Trends: March 2021* .
Notes: Other use includes small amounts of consumption in agriculture and shipping, plus non-energy use kept constant at 2019 levels.

- Should technology costs fall fast enough, it is possible that zero-carbon energy can be used to displace fossil kerosene in aviation and to reduce the need for fossil gas with CCS. For example, a further halving of renewables costs (as in our Widespread Innovation scenario) could enable greater contributions from renewable-based hydrogen and/or production of synthetic jet fuel. However, these reductions are uncertain, and it is possible that a greater reliance on fossil fuels may undermine innovation in this area.

- The Committee has developed a range of illustrative pathways for achieving Net Zero, by 2050 or earlier. The quantity of fossil gas consumption with CCS varies widely across these, depending on technology costs as well as the level and nature of future energy demands (e.g. on the balance between hydrogen and electrification in heating buildings). Overall fossil gas consumption across these scenarios falls by 40-60% by 2035 and 50-90% by 2050 (Figure 3).

Figure 3 Fossil gas demand under the Sixth Carbon Budget scenarios to 2050



Source: CCC analysis; BEIS (2021) *Energy Trends: March 2021*
Notes: CB5 and CB6 are the pieces of CCC advice on the Fifth and Sixth Carbon Budgets respectively. The Sixth Carbon Budget level was recommended on the basis of the Balanced Net Zero Pathway. Projected consumption includes non-energy use kept constant at 2019 levels (4.5 TWh/year).

UK fossil fuel supply

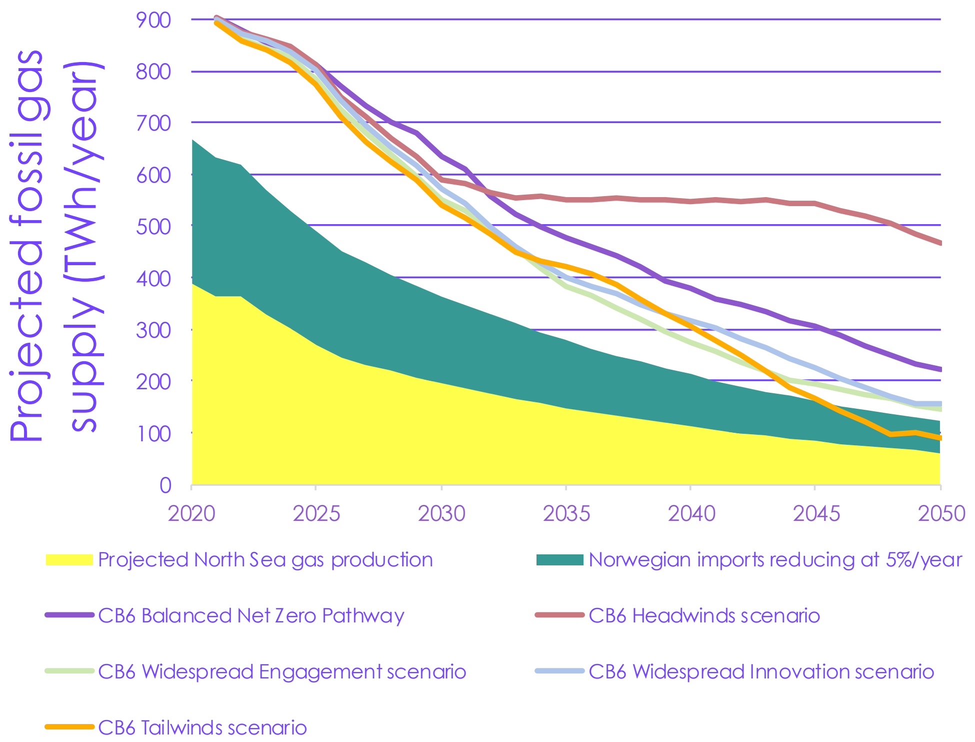
Despite this necessary fall in fossil fuel consumption, there will continue to be a challenge to meet the UK's fossil fuel demand given the decline in North Sea production. For fossil gas, the choice at the margin is likely to be between shale gas and imported liquefied natural gas (LNG).

The UK is currently a net importer of oil and gas. Despite projected reductions in demand for oil and gas in the UK, North Sea oil and gas production is unlikely to be sufficient to meet future UK needs, given the gradual decline in offshore production that is anticipated. Although pipeline imports of fossil gas (e.g. from Norway) are likely to continue, this is also unlikely to fill the supply gap entirely.

The Oil and Gas Authority's projection of North Sea fossil gas production, together with an assumption of gradually declining pipeline imports from Norway, suggest that even under our scenarios there will continue to be a need for additional gas supplies beyond these two sources at least until 2045 and potentially beyond 2050 (Figure 4).

In the absence of UK onshore production, it is likely, therefore, that there would also be a significant contribution from LNG. LNG is therefore the appropriate comparator for UK onshore shale gas production when considering the implications for GHG emissions.

Figure 4 Projected fossil gas supply from the North Sea and Norway compared to CCC demand scenarios



Source: CCC analysis, OGA (2021) *OGA oil and gas production projections and BEIS and CCC demand projections - February 2021*
Notes: CB6 lines are the consumption under the five scenarios presented in the CCC advice on the Sixth Carbon Budget. The Sixth Carbon Budget level was recommended on the basis of the Balanced Net Zero Pathway. Projected consumption includes non-energy use at 2019 levels (4.5 TWh/year). It is assumed that Norwegian gas imports decline at 5% per annum.

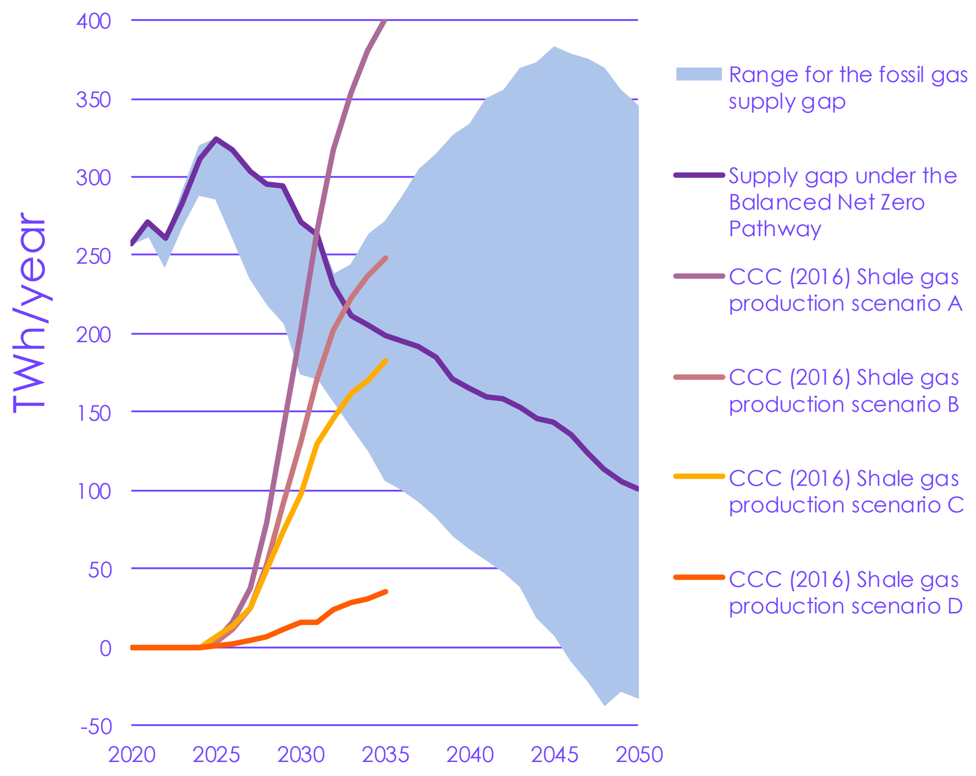
The gap between fossil gas consumption under the CCC scenarios and the supply from the North Sea and Norwegian pipeline imports varies across scenarios, from 350 TWh in 2050 to below zero (implying a lesser need for Norwegian gas). Under the Balanced Net Zero Pathway, there is a supply gap all the way to 2050, by which time it falls to 100 TWh.

UK shale gas has the potential to fill some or all of this supply gap. Using the scenarios for UK shale gas production developed for the Committee's 2016 advice but pushed back in time by five years, the supply gap could be filled by shale gas under some scenarios by the early 2030s (Figure 5). However, some scenarios for shale gas supply exceed the supply gap under some or all decarbonisation scenarios.

Under the Committee's Tailwinds scenario, which achieves Net Zero in 2042, fossil gas consumption falls to a point in 2045 where supplies from the North Sea and Norway are sufficient to meet all fossil gas demand.

For the purposes of assessing the potential role for shale gas in the UK supply mix, our analysis assumes that the supply gap could be between that in the Balanced Net Zero Pathway and that in the Tailwinds scenario.

Figure 5 Projected supply gap and scenarios for UK shale gas production



Source: CCC analysis, CCC (2016) *Onshore Petroleum - The compability of UK onshore petroleum with meeting the UK's carbon budgets.*
Notes: Supply gap defined as the difference between projected consumption and the sum of North Sea production plus Norwegian pipeline imports shown in Figure 4. The range for the supply gap reflects that under the Tailwinds (low) and Headwinds (high) scenarios. The four shale gas production scenarios are taken from the CCC's Onshore Petroleum advice in 2016, shifted forward in time five years.

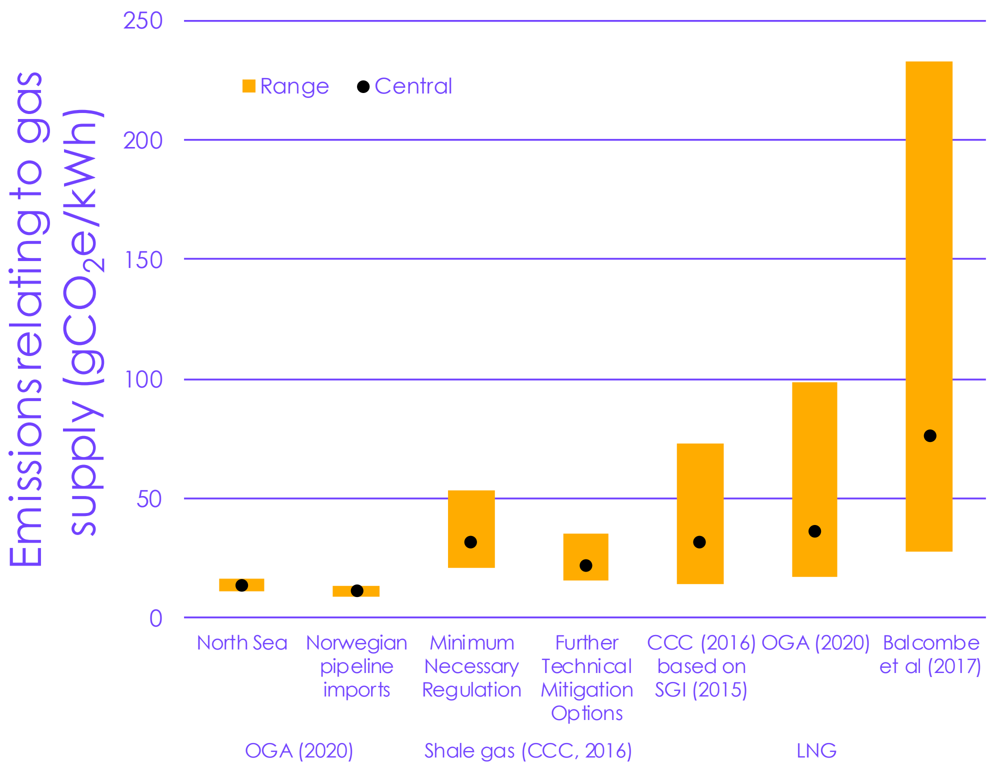
Lifecycle emissions

When considering the impact of fossil fuel consumption on global GHG emissions, it is necessary to consider the emissions implications of UK consumption, regardless of where in the world those emissions occur. Accepting the need to reduce fossil fuel consumption rapidly, as set out above, this effectively becomes a matter of the lifecycle GHG footprint of fossil fuel production and supply to the UK energy system:

- Current evidence on the GHG footprint of LNG and UK shale gas is not definitive, but available estimates indicate that emissions from LNG supply are likely to be higher than those that would arise from strongly regulated commercial UK shale gas production and could be much higher (Figure 6). Uncertainty over the GHG footprint of each source means that emissions associated with use of LNG could be higher than through use of UK shale gas by 2-63 gCO_2e per kWh of gas consumed.[13]

- Combining this assessment of the emissions intensity of fossil gas supply with the range of potential volumes of shale gas compatible with the Balanced Net Zero Pathway and the Tailwinds scenario (105-180 TWh in 2035, falling to 0-100 TWh by 2050), this suggests that UK consumption emissions could be 6.7-11.5 $MtCO_2e$ higher in 2035 and 0-6.3 $MtCO_2e$ higher in 2050 if the UK relies on LNG to fill the portion of the supply gap that could otherwise be met by shale gas.

Figure 6 Estimated ranges for upstream emissions from fossil gas production/supply



Sources: OGA (2020) Natural gas carbon footprint analysis; CCC (2016) *Onshore Petroleum - The compability of UK onshore petroleum with meeting the UK's carbon budgets* ; Sustainable Gas Institute (*2015) White Paper 1: Methane and CO2 emissions from the natural gas supply chain* ; Balcombe et al (2017) *The Natural Gas Supply Chain: The Importance of Methane and Carbon Dioxide Emissions* .
Notes: The range cited for OGA estimates of emissions from LNG supply covers the central estimates from the lowest-emitting source of LNG (Norway) to the highest-emitting (US). All estimates presented using a GWP100 of 34, with adjustments where necessary. All estimates are for current emissions, except for the CCC estimates for future UK shale gas - for those, estimates are based on what emissions might be with implementation of certain required technologies and techniques to reduce emissions.

[13] When also including the CO_2 that arises from burning the gas, these extra emissions mean that the overall GHG footprint of fossil gas from LNG could be 1-29% higher than that of UK shale gas.

Global emissions

When considering the impact of additional fossil gas consumption on global emissions, it is instructive to look at the ranges for fossil fuel consumption under pathways consistent with limiting warming to 1.5°C and well below 2°C.

In particular, it is important to consider whether there is potential globally for additional fossil gas consumption to displace coal consumption, thereby lowering global emissions:

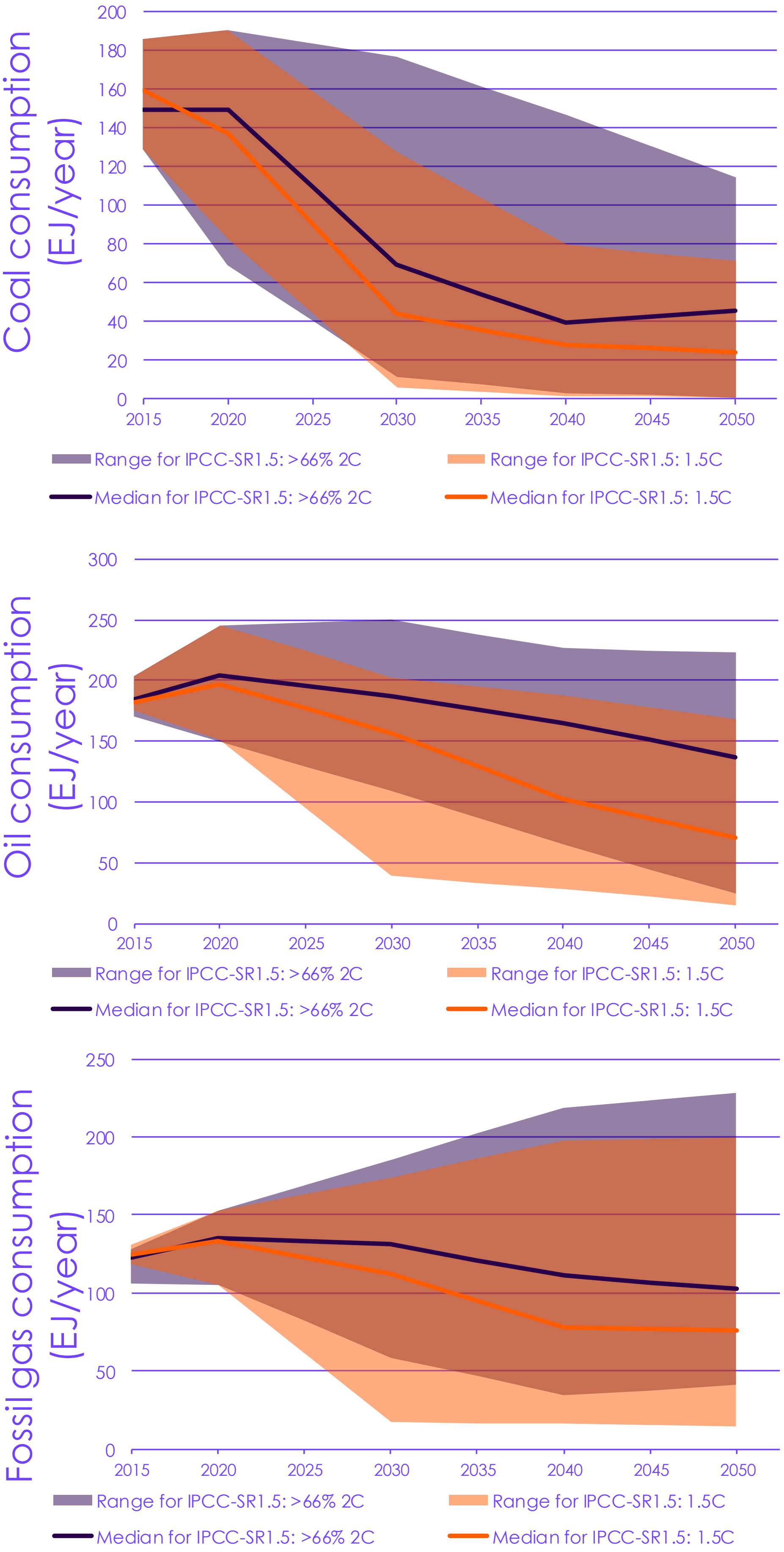
- TIAM modelling for the Committee in 2016 in a 'well below 2°C' case for global climate action[14] indicated that the downward impact on overall global emissions through substituting gas for coal might be similar in magnitude to the upward impact due to fossil gas displacing low-carbon energy and higher overall energy consumption, leaving global GHG emissions largely unchanged.[15]

- More recent modelling indicates that in a 1.5°C case (Figure 7), consumption of both coal and fossil gas are likely to need to be significantly below that in the 'well below 2°C' case. This indicates less potential for an increase in fossil gas supply to displace coal, as both need to be reducing strongly and largely replaced by non-emitting forms of energy.

[14] https://www.theccc.org.uk/publication/imperial-college-grantham-institute-shale-gas-analysis-for-the-ccc/

[15] See Chapter 5 of https://www.theccc.org.uk/publication/scottish-unconventional-oil-and-gas-compatibility-with-scottish-emissions-targets/

Figure 7 Global fossil fuel consumption in Paris-compatible decarbonisation scenarios



Source: IPCC (2018) *Special Report on Global Warming of 15C.*
Notes: The chart presents the range and median level for coal, oil and fossil gas consumption in model runs presented in the IPCC Special Report on Global Warming of 15C, for each of a 66% chance of keeping global temperature rise below 2C and for a 50% chance of keeping warming below 15C. The shaded range in the middle is the overlap between the two ranges.