Committee on Climate Change

Independent advice to government on building a low-carbon economy and preparing for climate change

The Sixth Carbon Budget and Welsh emissions targets – Call for Evidence

Background to the UK's sixth carbon budget

The UK Government and Parliament have adopted the Committee on Climate Change's (CCC) recommendation to target net-zero emissions of greenhouse gases (GHGs) in the UK by 2050 (i.e. at least a 100% reduction in emissions from 1990).

The Climate Change Act (2008, 'the Act') requires the Committee to provide advice to the Government about the appropriate level for each carbon budget (sequential five-year caps on GHGs) on the path to the long-term target. To date, in line with advice from the Committee, five carbon budgets have been legislated covering the period out to 2032.

The Committee must provide advice on the level of the sixth carbon budget (covering the period from 2033-37) before the end of 2020. The Committee intends to publish its advice early, in September 2020. This advice will set the path to net-zero GHG emissions for the UK, as the first time a carbon budget is set in law following that commitment.

Both the 2050 target and the carbon budgets guide the setting of policies to cut emissions across the economy (for example, as set out most recently in the 2017 Clean Growth Strategy).

The Act also specifies other factors the Committee must consider in our advice on carbon budgets – the advice should be based on the path to the UK's long-term target objective, consistent with international commitments and take into account considerations such as social circumstances (including fuel poverty), competitiveness, energy security and the Government's fiscal position.

The CCC will advise based on these considerations and a thorough assessment of the relevant evidence. This Call for Evidence will contribute to that advice.

Background to the Welsh third carbon budget and interim targets

Under the Environment (Wales) Act 2016, there is a duty on Welsh Ministers to set a maximum total amount for net Welsh greenhouse gas emissions (Welsh carbon budgets). The first budgetary period is 2016-20, and the remaining budgetary periods are each succeeding period of five years, ending with 2046-50.

The Committee is due to provide advice to the Welsh Government on the level of the third Welsh carbon budget (covering 2026-30) in 2020, and to provide updated advice on the levels of the second carbon budget (2021-25) and the interim targets for 2030 and 2040. Section D of this Call for Evidence (covering questions on Scotland, Wales and Northern Ireland) includes a set of questions to inform the Committee's advice to the Welsh Government.

Question and answer form

When responding, please provide answers that are as specific and evidence-based as possible, providing data and references to the extent possible.

Please limit your answers to 400 words per question and provide supporting evidence (e.g. academic literature, market assessments, policy reports, etc.) along with your responses.

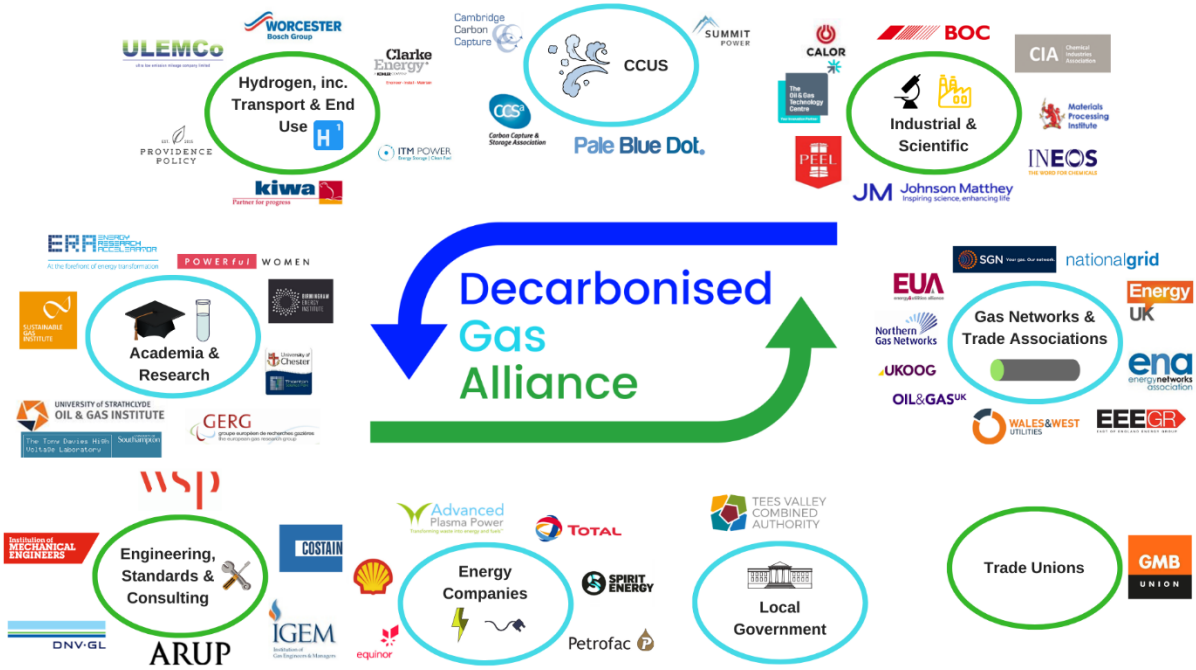
Introduction

The Decarbonised Gas Alliance (DGA) is an alliance of 50 gas producers, transporters, suppliers and users, hydrogen and carbon capture experts, alongside R&D, supply chain, trade union and local government specialists whose knowledge and expertise will be vital in decarbonising the UK's gas system and improving poor air quality.

Our aim is to work with all levels of government and with other expert organisations to use the gas system as a whole to help deliver our emission reduction and air quality goals. We believe that decarbonising gas – including biogases and hydrogen from a variety of low carbon methods – would make best use of our existing infrastructure and lower the overall costs of decarbonisation.

The DGA is a broad-based alliance, established in late 2016, and has now expanded to 50 signatory organisations, which are listed in full in the diagram below. The DGA secretariat is managed by DNV GL, a global specialist firm which provides advisory, certification and other technical assurance solutions covering a range of energy sources.

We welcome the opportunity to provide evidence to the Sixth Carbon Budget Call for Evidence, and we are happy to provide further detail, if this would be useful to the Committee. Please note that we do not answer all questions.



A. Climate science and international circumstances

Question 1: The climate science considered in the CCC's 2019 Net Zero report, based on the IPCC Special Report on Global Warming of 1.5°C, will form the basis of this advice. What additional evidence on climate science, aside from the most recent IPCC Special Reports on Land and the Oceans and Cryosphere, should the CCC consider in setting the level of the sixth carbon budget?

ANSWER:

Question 2: How relevant are estimates of the remaining global cumulative CO_2 budgets (consistent with the Paris Agreement long-term temperature goal) for constraining UK cumulative emissions on the pathway to reaching net-zero GHGs by 2050?

ANSWER:

We support a target of net zero emissions in the UK in 2050, and believe that it is a stretching target, requiring, amongst other things, changing the heating systems in almost 1 million existing homes a year between now and 2050 (there were 27.8 million households in the UK in 2019).[1]

Therefore, ensuring that the Sixth Carbon Budget is compatible with a cost-effective and achievable pathway to net zero by 2050 is paramount. If UK carbon budgets in 2035 were to be restricted by more than a cost-effective pathway to 2050 would imply, the level of change in all sectors would need to increase correspondingly. Given that a) domestic heating decarbonisation is currently running at very low levels, and b) decisions have yet to be made about using 100% hydrogen in homes, we cannot see how a target of more than 1 million homes a year before 2035 is practically achievable.

[1] Office for National Statistics Families and households in the UK: 2019 https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2019

Question 3: How should emerging updated international commitments to reduce emissions by 2030 impact on the level of the sixth carbon budget for the UK? Are there other actions the UK should be taking alongside setting the sixth carbon budget, and taking the actions necessary to meet it, to support the global effort to implement the Paris Agreement?

ANSWER:

Firstly, we note that the EU Commission has proposed a net zero target for the EU for 2050, and the UK aligning its decarbonisation trajectory with the EU is a sensible approach. If the UK progresses much faster, there is a risk of carbon leakage to the rest of the EU (assuming a zero-tariff free trade deal is agreed post-Brexit).

Secondly, it is also worth noting that the European Green Deal document itself highlights the risk of carbon leakage, and suggests that a carbon border tax may be needed to counter it:[2]

"As long as many international partners do not share the same ambition as the EU, there is a risk of carbon leakage, either because production is transferred from the EU to other countries with lower ambition for emission reduction, or because EU products are replaced by more carbon-intensive imports. If this risk materialises, there will be no reduction in global emissions, and this will frustrate the efforts of the EU and its industries to meet the global climate objectives of the Paris Agreement.

"Should differences in levels of ambition worldwide persist, as the EU increases its climate ambition, the Commission will propose a carbon border adjustment mechanism, for selected sectors, to reduce the risk of carbon leakage. This would ensure that the price of imports reflect more accurately their carbon content. This measure will be designed to comply with World Trade Organization rules and other international obligations of the EU. It would be an alternative to the measures that address the risk of carbon leakage in the EU's Emissions Trading System."

UK policy needs to bear this in mind, including whether the UK would want to take part in any EU carbon border tax in future – if we do not, then UK industry may be disadvantaged. However, if the UK does join an EU mechanism, then post-Brexit trade deals with other parts of the world will be more difficult to agree.

Thirdly, in order to support meaningful global agreement on strengthened action to reduce emissions during the UK's hosting of the COP at the end of 2020, policies must be put in place in the UK to support decarbonisation in the hard-to-decarbonise sectors. This should include mechanisms to support the development of hydrogen, biomethane and CCS.

Finally, a replacement for Horizon Europe, the EU's R&D programme that will run from 2021-27 with a €100 billion budget, will be needed in the UK. Practical applied scientific R&D funding will need to be targeted towards making a significant reduction in the cost of hydrogen production and CCS.

[2] EU Commission, The European Green Deal, December 2019 https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF

Question 4: What is the international signalling value of a revised and strengthened UK NDC (for the period around 2030) as part of a package of action which includes setting the level of the sixth carbon budget?

ANSWER:

Firstly, it is worth emphasising that the UK is currently off track to meet the existing Fourth and Fifth Carbon Budgets, so the most important action is to put policies in place to meet those targets and to put the UK on a cost-effective trajectory to 2050.

While a strengthened commitment in 2030 would be a welcome signal, there is a risk that, if it is not backed up by policies, it will be seen as an empty gesture and potentially discourage other countries from putting in place policies to meet their own targets.

The strongest signal that can be given internationally is a set of policies that will drive material decarbonisation in the heavy transport, industrial and domestic heating sectors.

Secondly, a commitment to avoid carbon leakage is essential. Our answer to Question 3 highlights the need to consider the potential imposition of a European carbon border tax, and the particular difficulties of the UK implementing one post-Brexit, given the need to agree trade deals with other parts of the world.

That said, carbon leakage is a particularly acute problem for the UK:[3]

- Consumption emissions peaked in 2007, and only fell to 1990 levels in 2014;
- Net imports of CO2 are 4 tonnes per person, the highest level in the world;
- The UK has net imports of CO2 from all major trading partners, including 82 million tonnes from China, 45 million tonnes from the EU, 24 million tonnes from the US, 21 million tonnes from Russia and 19 million tonnes from India. The UK therefore has a broadly-based and consistent carbon leakage problem.

Whatever the practicalities of a carbon border tax, we think it is important to signal that the UK is committed to reducing emissions within the UK, and not through industrial activity shifting to other countries.

It's also important to stress that this includes energy production. There will be a continuing need for natural gas for some time to come, including for the production of hydrogen (alongside hydrogen production from electrolysis), as the Committee's Net Zero report points out. It is therefore important to ensure that the UK continues to produce gas, with production emissions minimised, and also that production emissions are kept as low as possible from imported sources.

[3] Office for National Statistics, The decoupling of economic growth from carbon emissions: UK evidence https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/compendium/economicreview/october2019/thedecouplingofeconomicgrowthfromcarbonemissionsukevidence

B. The path to the 2050 target

Question 5: How big a role can consumer, individual or household behaviour play in delivering emissions reductions? How can this be credibly assessed and incentivised?

ANSWER:

Firstly, looking at a regional level is important. In certain regions, biomethane and hybrid heating systems may have the potential to play a large role. In others, hydrogen in the home may be a more effective way to decarbonise. Understanding the potential for different behavioural changes in different regions is therefore important.

Secondly, it is worth noting that consumers are buying new gas boilers at a rate of well over 1 million a year[4]; indeed, in 2019, a record 1.67 million gas boilers were sold.[5] By contrast, only 53,000 heat pumps have been installed in to date.[6] Therefore, changes that go with the grain of consumer behaviour – such as a switch to hydrogen heating – may be more successful.

Thirdly, we think that detailed public opinion research is needed to assess the extent to which consumers will change their behaviour, and the cost incentives that would be needed. For example, we suspect that many consumers are very price sensitive and unwilling to pay a lot more for decarbonised heat, and we also wonder whether people would be happy having certain decisions made for them, as with the town gas to natural gas switch in the 1970s. But this needs to be tested properly.

Fourthly, there are different options to encourage behaviour change. For example:

- A low carbon industrial product mark would provide public sector and other larger consumers with the information to make greener procurement choices.
- A regulation requiring all new boilers to be hydrogen ready would see rapid uptake, at a rate of over 1 million a year. Since condensing boilers were mandated in 2005, uptake has averaged 1.2 million per annum.[7] This would make a future hydrogen switchover – with or without hybrid heat pumps – far easier.

[4] English Housing Survey 2017-18, Annex Table 2.10 https://www.gov.uk/government/statistics/english-housing-survey-2017-to-2018-headline-report
[5] Energy and Utilities Alliance data, see https://www.eua.org.uk/record-boiler-sales-show-how-decarbonisation-will-work/
[6] Energy and Utilities Alliance, Economic Report, October 2019
[7] English Housing Survey 2017-18, Annex Table 2.10 https://www.gov.uk/government/statistics/english-housing-survey-2017-to-2018-headline-report

Question 6: What are the most important uncertainties that policy needs to take into account in thinking about achieving Net Zero? How can government develop a strategy that helps to retain robustness to those uncertainties, for example low-regrets options and approaches that maintain optionality?

ANSWER:

There are a number of key uncertainties for net zero policy, including:

- Consumer responsiveness to incentives for changes in transport and the home. For example, what is the elasticity of demand for hybrid heating systems in response to a change in gas prices?
- Consumer acceptance of decarbonised heating systems, including 100% hydrogen in the home.
- The ability of the UK's planning system to approve the huge number of applications for low carbon development in a timely manner. This aspect of decarbonisation is rarely considered, but it takes around 3 years for a DCO approval for nationally significant infrastructure, and a Town and Country Planning application can take at least a year from start to finish. Around half of onshore wind planning applications between 2005 and 2015 were either refused or withdrawn.[8] There is therefore no guarantee that the required level of e.g. anaerobic digesters, onshore CO2 pipelines, and new industrial facilities can actually be given planning permission in time.
- For industry, there is uncertainty on cross-chain solutions. For example, a CO2 pipeline needs the captured CO2, and CO2 capture needs the pipeline. Wind developers need to know that their electricity can get to market, and that the periods when wind output is curtailed are minimised.
- We also note that there is a lack of regulation for the use of underground geothermal energy for heat.[9]

A net zero target also reduces uncertainty because all sectors need to decarbonise. There is no longer any place to hide in the 20%, as there was under the previous 2050 target. The issue is whether regulation and policy can deliver, but there is clarity that low regrets actions need to be carried out.

To tackle uncertainties, we would highlight:

- It is often said, but silos between government departments need to be broken down, so that energy, transport, planning, housing and environmental policy is better co-ordinated. A minister for net zero may be a sensible approach, and the support of the Treasury is clearly essential – the cancellation of the CCS competition in late-2015 is a cautionary tale of the risks of not having Treasury support.
- We know that negative emissions are needed to achieve net zero, which requires CCS to be developed, regardless of the extent of CCS in power, industry or hydrogen production. Negative emissions can provide a level of insurance against other decarbonisation measures during the sixth carbon budget. Whilst negative emissions technologies should not replace required mitigation measures, they can be deployed from the late 2020s to help meet future carbon budgets and the net-zero 2050 target.

[8] BEIS, Renewable Energy Planning Database, December 2019
https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract
[9] This point has been made in more detail by the British Geological Survey

Question 7: The fourth and fifth carbon budgets (covering the periods of 2023-27 and 2028-32 respectively) have been set on the basis of the previous long-term target (at least 80% reduction in GHGs by 2050, relative to 1990 levels). Should the CCC revisit the level of these budgets in light of the net-zero target?

ANSWER:

We would refer to our answer to Question 4. The UK is currently off track to meet the existing Fourth and Fifth Carbon Budgets, so the most important action is to put policies in place to meet those targets and to put the UK on a cost-effective trajectory to 2050 – whatever the level of the next two carbon budgets.

However, if the Fourth and Fifth Carbon Budgets are updated with more ambitious reduction targets, it would have two beneficial effects:

- It would push government to recognise that the UK is currently off track to meet net zero and that faster progress is needed.
- It would make it more difficult for the carbon budgets to be met by carrying forward overachievement from the earlier carbon budgets – and therefore require government to implement necessary policies.

Question 8: What evidence do you have of the co-benefits of acting on climate change compatible with achieving Net Zero by 2050? What do these co-benefits mean for which emissions abatement should be prioritised and why?

ANSWER:

Firstly, the potential global market in low carbon industrial goods and services could be very large:

- The Hydrogen Council roadmap envisages the global hydrogen market reaching £1.9 trillion a year by 2050, creating jobs for 30 million people, with global demand for hydrogen increasing tenfold to almost 80 EJ (over 20,000 TWh).[10]
- The future global CCS market is estimated to be around £100bn/year,[11] with 11Gt CO2 needing to be permanently stored by 2060 to meet Paris Agreement emissions reduction targets.
- The estimated European electrolyser market (dependent on Brexit outcome) is £3.7 billion in 2017-2025, which could represent around £0.8 billion to the UK by 2025.[12]
- The EU bio economy is already worth £1.7 trillion today.

The UK will have an opportunity to earn export revenue from manufacturing hydrogen technologies, including appliances, electrolysers and gas reformers; storing CO2 on behalf of other countries and/or through capturing and storing CO2 from industrial processes and then exporting the low carbon products; and exporting renewable hydrogen.

Secondly, many of the jobs in these sectors would be in less affluent regions, including in the main industrial clusters in the North West, North East, Humber, South Wales and parts of Scotland. A recent Summit Power report found that developing a network of CCS projects along the East Coast of the UK, capturing 75 million tonnes of CO_2 per year, would provide £163 billion of economic benefits and 225,000 jobs, cumulatively, through to 2060.[13]

Although we do not yet have hard evidence for this, the UK may become more attractive to investors given recent announcements from major investors on the shift to green investment.

Thirdly, there are significant air quality benefits from biomethane and hydrogen in heavy transport, with hydrogen emitting only water and biomethane CNG delivering particulate emissions savings of 96% compared with Euro VI diesel.[14]

[10] Hydrogen Council, Hydrogen scaling up, November 2017, p.8 and p.20 http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-Scaling-up_Hydrogen-Council_2017.compressed.pdf
[11] HM Government, Clean Growth Strategy, October 2017, p.69 https://www.gov.uk/government/publications/clean-growth-strategy
[12] Tractebel and Hinicio, Study on early business cases for h2 in energy storage and more broadly power to h2 applications, June 2017, p.2 https://www.fch.europa.eu/sites/default/files/P2H_Full_Study_FCHJU.pdf
[13] Summit Power, Clean Air – Clean Industry – Clean Growth: How Carbon Capture Will Boost the UK Economy: East Coast UK Carbon Capture and Storage Investment Study, October 2017 http://www.ccsassociation.org/news-and-events/reports-and-publications/clean-air-clean-industry-clean-growth/
[14] Department for Transport, Emissions Testing of Gas-Powered Commercial Vehicles, Prepared by Low Carbon Vehicle Partnership, January 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/581859/emissions-testing-of-gas-powered-commercial-vehicles.pdf. Also see http://www.eua.org.uk/ngv-network-calls-on-new-metro-mayors-to-tackle-air-pollution/

C. Delivering carbon budgets

Question 9: Carbon targets are only credible if they are accompanied by policy action. We set out a range of delivery challenges/priorities for the 2050 net-zero target in our Net Zero advice. What else is important for the period out to 2030/2035?

ANSWER:

We would highlight six key issues:

Infrastructure: Sufficient infrastructure will need to be built to encourage behaviour change. For example, a national network of biomethane CNG or hydrogen fuelling stations will need to be comprehensive enough to give owners of truck fleets the confidence to switch from diesel.

Regulator and government co-ordination: Ofgem and BEIS will need to be consistent to ensure that government policy on heat decarbonisation is facilitated and not constrained by the actions of the regulator. This will include network innovation funding and network price controls more widely.

Affordability and security: Fuel poverty is already too high, and should not be exacerbated by a move to net zero. A household in England is 50% more likely to be in fuel poverty if it does not have a gas grid connection,[15] and in Scotland, a household is almost twice as likely to be in fuel poverty if it is off the gas grid.[16]

Scale up: Whichever solutions to the hard-to-decarbonise sectors are developed during the 2020s, they need to be able to scale up rapidly in the 2030s. For instance, a target of 10 million tonnes of CO2 captured and stored annually by 2030 implies a growth of 2 million tonnes of capacity per annum from 2025. To meet the Committee's Further Ambition scenario of 75-175 million tonnes captured and stored per annum in 2050, CCS capacity growth would need to expand to 3.25-8.35 million tonnes per annum after 2030.

Energy literacy: An improvement in energy literacy amongst both policymakers and the general public is essential. Understanding the difference between energy and electricity, the volume of energy transported and used through the gas system, and the opportunities for sector coupling between the gas and electricity sectors, is of particular importance.

Policy support: The majority of decarbonisation will require policy support to implement. There is a risk that the government may be slow to introduce the policies necessary to reach both a 2050 and 2030/35 target.

[15] In England, 10.4% of households with a gas grid connection are fuel poor, compared with 15.5% of households without a gas grid connection. BEIS, Fuel poverty statistics: Detailed tables 2016, Published June 2018, Table 10 https://www.gov.uk/government/statistics/fuel-poverty-detailed-tables-2018

[16] In Scotland, 22% of households on the gas grid are fuel poor, compared with 38% of households off the gas grid. Scottish house condition survey: 2017, Table 36 https://www.gov.scot/publications/scottish-house-condition-survey-2017-key-findings/pages/6/

Question 10: How should the Committee take into account targets/ambitions of UK local areas, cities, etc. in its advice on the sixth carbon budget?

ANSWER:

Firstly, the roadmaps for cluster decarbonisation funded by the Industrial Decarbonisation Challenge will set out pathways for the major industrial clusters. The largest emitters in the main industrial clusters alone account for over 33 million tonnes of CO2 annually.[17] So the Committee must take into account these cluster roadmaps, which will be in progress (but not completed) as the Sixth Carbon Budget is put together.

Secondly, there is likely to be significant difference across regions. For example:

- We envisage that rural regions such as Cornwall could see major development of biomethane, that could be used in hybrid heating systems, for CNG buses and trucks, and potentially for flexible power generation.
- In Northern regions, hydrogen is likely to be a major contributor to decarbonisation, with significant production from natural gas with CCS and from electrolysis using offshore wind energy, and with usage across industrial, heavy transport and domestic heating sectors.
- The recent gas decarbonisation pathways report for the Energy Networks Association provided an in-depth view of the potential for hydrogen and biomethane in different regions.[18]

Thirdly, there will still need to be a national view, as infrastructure will need to cross county and city-region boundaries. This would be likely to include:

- Networks of biomethane CNG and hydrogen fulling stations;
- Hydrogen pipelines, both high pressure transmission and lower pressure distribution;
- CO2 pipelines;
- Ensuring sufficient production of natural gas and offshore wind in the UK to ensure a reliable and cost-effective hydrogen supply.

[17] BEIS, Industrial Clusters Mission https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/803086/industrial-clusters-mission-infographic-2019.pdf

[18] Energy Networks Association, Pathways to Net-Zero: Decarbonising the Gas Networks in Great Britain, October 2019, pp.46-49 http://www.energynetworks.org/assets/files/gas/Navigant%20Pathways%20to%20Net-Zero.pdf

Question 11: Can impacts on competitiveness, the fiscal balance, fuel poverty and security of supply be managed regardless of the level of a budget, depending on how policy is designed and funded? What are the critical elements of policy design (including funding and delivery) which can help to manage these impacts?

ANSWER:

We have to recognise from the outset that there are tough trade-offs between all of these areas. To the extent that decarbonising costs more than not decarbonising (excluding any carbon price), there are only a limited number of ways to pay:

- Consumers – domestic and/or industrial;
- Taxpayers;
- Government borrowing i.e. future taxpayers;
- Reducing other areas of public spending.

Nor are CO2 prices and regulatory mandates easy ways around this problem. CO2 prices will increase prices of energy and goods for consumers, risk carbon leakage if they are much higher than in other countries, and will be passed through to domestic consumers even if they are only levied on industry. Regulatory mandates are also likely to require more expensive solutions.

We also need to avoid a situation where the long-term costs of decarbonisation in all sectors are placed on energy consumers. Such an approach risks exacerbating fuel poverty issues.

Whichever sectors and technologies are targeted, and whichever the desired ways of paying, there are four critical elements of policy design that can help to minimise cost increases:

- **Incentivising cost reduction:** CfD auctions have helped to deliver impressive offshore wind cost reductions.
- **Ensuring budgets are not siloed:** The £170 million Industrial Decarbonisation Challenge, the £315 million Industrial Energy Transformation Fund and the £100 million Low Carbon Hydrogen Production Fund are all very welcome and important funding sources. However, a cluster project is likely to need elements of all three funds, and will therefore have to make three bids, with the risk that one element is not funded. It would be far better for the three funds to have one application process, enabling major cluster projects to progress with confidence.
- **Lower abatement costs:** The cost per tonne of CO2 abatement, now and potentially in the future, together with the abatement potential, are useful metrics to gauge where limited funding should be best targeted to ensure maximum abatement for a given level of investment.
- **Wider benefits:** Wider benefits of emission reduction policies should also be a relevant factor, for instance the air quality benefits of heavy transport decarbonisation and the job creation potential of industrial decarbonisation.

We also believe there is an important trade off between government and private sector-led investment:

- A government-owned entity would be able to set out a strategic plan for levels of infrastructure in each region, and would benefit from a lower cost of capital than the private sector. It would also mitigate the risk of insufficient private investment.
- Private sector entities would introduce competition, and hence would have a greater incentive to reduce costs.

Question 12: How can a just transition to Net Zero be delivered that fairly shares the costs and benefits between different income groups, industries and parts of the UK, and protects vulnerable workers and consumers?

ANSWER:

Households:

- The key objective is to minimise costs and disruption to households. Many households are severely capital-constrained, and therefore solutions with a high upfront cost, even if cheaper over a 20-year lifetime, are simply out of reach for many people – 18.9 million households (69% of the total) have less than £10,000 in savings, and of these, 12.6 million have no or less than £1,500 of savings.[19]
- A Just Transition needs to consider the annual heating bill, the upfront cost of low carbon heating equipment, how these will be paid for, and the associated disruption. For example, a hydrogen-ready boiler would cost around £50 more than a regular gas boiler,[20] so would meet the upfront cost challenge. Hydrogen will cost more as a fuel than natural gas, but if costs are socialised across all gas consumers, and if the Iron Mains Replacement Programme funding is continued, it may be affordable – the H21 North of England report concluded that bill increases would be £53 per annum.[21] A hydrogen-ready boiler could be converted by an engineer in about one hour.

Energy intensive industry:

- Energy intensive industries contribute £140 billion in economic value added and employ over 1.1 million people.[22] They are often located in less affluent regions and are the largest employer in the area. Their products are key to other industries – for example, the UK's successful pharmaceutical industry depends on products made by the chemical industry, which in turn depends on natural gas as a feedstock; the UK's agriculture relies on fertiliser made in plants such as Ince; and the UK's water industry relies on chlorine made in Runcorn.
- A Just Transition needs these foundation industries to stay in the UK, not only to protect jobs in those industries but also to support other sectors, as highlighted above, who would likely see costs rise if they had to rely solely on imports. As noted earlier, a carbon border tax would help, but would be difficult to implement post-Brexit.

Oil and gas industry

- A Just Transition is also essential to protect the 250,000 jobs that rely on oil and gas production,[23] through, for example, ensuring sufficient natural gas production to provide hydrogen at scale, and through energy integration programmes that bring together oil and gas assets with offshore wind, hydrogen and CO2 transport and storage.[24]

Residual emitters

- As recognised by the Committee in the Net-Zero report, some residual emissions will be difficult if not impossible to remove entirely or will be prohibitively expensive. Negative emissions will therefore be needed to help ensure that a just transition can be achieved for these sectors.

[19] The Money Charity, The Money Statistics, December 2019 https://themoneycharity.org.uk/media/December-2019-Money-Statistics.pdf
[20] See https://www.bbc.co.uk/news/science-environment-50873047
[21] H21 North of England, 2018 https://www.northerngasnetworks.co.uk/event/h21-launches-national/
[22] BEIS analysis using the ONS Annual Business Survey
[23] Oil & Gas UK, Economic Report, 2019 https://oilandgasuk.co.uk/wp-content/uploads/2019/09/Economic-Report-2019-OGUK.pdf ,
[24] Oil and Gas Authority, UKCS Energy Integration: Interim findings, December 2019 https://www.ogauthority.co.uk/news-publications/publications/2019/ukcs-energy-integration-interim-findings/

D. Scotland, Wales and Northern Ireland

Question 13: What specific circumstances need to be considered when recommending an emissions pathway or emissions reduction targets for Scotland, Wales and/or Northern Ireland, and how could these be reflected in our advice on the UK-wide sixth carbon budget?

ANSWER:

The EU's Net Zero Strategy *"A Clean Planet for all – a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy"*, highlights that the North East of Scotland has by far the greatest regional exposure to employment sectors at risk during the energy transition. The jobs of 11.3% of the working-age population in North East Scotland depend on fossil fuel extraction and mining. This is twice the exposure of the second highest region in Europe, the coal mining region of Silesia in Poland, and six times that of the third, Sud-Vest Oltenia in Romania, again a region highly dependent on the coal industry.

We provide our views on the oil and gas sector in our answers to Question 12 and Question 24.

Question 14: The Environment (Wales) Act 2016 includes a requirement that its targets and carbon budgets are set with regard to:

- The most recent report under section 8 on the State of Natural Resources in relation to Wales;
- The most recent Future Trends report under section 11 of the Well-Being of Future Generations (Wales) Act 2015;
- The most recent report (if any) under section 23 of that Act (Future Generations report).

a) What evidence should the Committee draw on in assessing impacts on sustainable management of natural resources, as assessed in the state of natural resources report?

b) What evidence do you have of the impact of acting on climate change on well-being? What are the opportunities to improve people's well-being, or potential risks, associated with activities to reduce emissions in Wales?

c) What evidence regarding future trends as identified and analysed in the future trends report should the Committee draw on in assessing the impacts of the targets?

d) Question 12 asks how a just transition to Net Zero can be achieved across the UK. Do you have any evidence on how delivery mechanisms to help meet the UK and Welsh targets may affect workers and consumers in Wales, and how to ensure the costs and benefits of this transition are fairly distributed?

ANSWER:

Question 15: Do you have any further evidence on the appropriate level of Wales' third carbon budget (2026-30) and interim targets for 2030 and 2040, on the path to a reduction of at least 95% by 2050?
ANSWER:

Question 16: Do you have any evidence on the appropriate level of Scotland's interim emissions reduction targets in 2030 and 2040?
ANSWER:

Question 17: In what particular respects do devolved and UK decision making need to be coordinated? How can devolved and UK decision making be coordinated effectively to achieve the best outcomes for the UK as a whole?

ANSWER:

Effective coordination between devolved and UK decision-making is essential in many areas, including but not limited to:

- **CO2 shipping:** Given that the South Wales cluster does not have nearby offshore CO2 storage facilities, shipping of CO2 to other clusters in the UK, for example the North West of England, will be essential. Coordination of CCS policy will therefore be needed.

- **Hydrogen:** Hydrogen produced in the HyNet scheme in the North West of England could be used in industry in the North East of Wales, and potentially for domestic heating as well. Coordination of hydrogen policy will also be needed.

- **Nuclear:** There is also a need for coordination on nuclear policy, with the potential to use nuclear heat from the proposed new Wylfa nuclear power station in Anglesey to produce hydrogen.

- **Transport:** For truck's carrying goods across the UK, consistency on biomethane CNG and hydrogen refuelling stations will be important to enable nationwide journeys to be made. It would not make sense, for instance, for only CNG fuelling stations to be built in Wales, and only hydrogen fuelling stations in England. In reality, we believe that both will be needed.

- **Carbon prices:** Northern Ireland is not subject to the UK's Carbon Price Floor, which leads to inefficiencies in cross-border electricity flows.

- **Scotland:** We see that UK decisions on CCS and wind are critical to the development of hydrogen and the transition of the oil and gas industry in Scotland.

UK-wide support schemes for biomethane, hydrogen and CCS are necessary to underpin devolved decision-making on the precise roles of the various decarbonised gas technologies, based on local circumstances. The UK-wide support schemes for offshore wind and other renewable technologies, for ensuring firm capacity, and for encouraging coal off the generation mix through the Carbon Price Floor, have been successful in delivering the progressive decarbonisation of electricity generation in each nation of the UK. There is no reason why a similar approach cannot work for decarbonising the gas system.

E. Sector-specific questions

Question 18 (Surface transport): As laid out in Chapter 5 of the Net Zero Technical Report (see page 149), the CCC's Further Ambition scenario for transport assumed 10% of car miles could be shifted to walking, cycling and public transport by 2050 (corresponding to over 30% of trips in total):

a) What percentage of trips nationwide could be avoided (e.g. through car sharing, working from home etc.) or shifted to walking, cycling (including e-bikes) and public transport by 2030/35 and by 2050? What proportion of total UK car mileage does this correspond to?

b) What policies, measures or investment could incentivise this transition?

ANSWER:

Question 19 (Surface transport): What could the potential impact of autonomous vehicles be on transport demand?

ANSWER:

Question 20 (Surface transport): The CCC recommended in our Net Zero advice that the phase out of conventional car sales should occur by 2035 at the latest. What are the barriers to phasing out sales of conventional vehicles by 2030? How could these be addressed? Are the supply chains well placed to scale up? What might be the adverse consequences of a phase-out of conventional vehicles by 2030 and how could these be mitigated?

ANSWER:

The key barrier to phasing out conventional car sales by 2030 is whether sufficient materials exist for batteries:

- Global reserves of Cobalt, 52% of which are in the Democratic Republic of Congo, are 6.6 million tonnes, which is equal to 42 years of 2018 global production.[25] But Cobalt production for EVs will expand rapidly.
- A recent EU Commission report concluded: *"Worldwide, demand is already perceived to exceed supply in 2020 and such a loss making trend is expected to become more consistent from 2025 on. In the EU, although the capacity to meet rising demand is projected to increase through mining and recycling activities, there is an increasing gap between endogenous supply and demand."*[26] Cobalt availability may therefore affect the pace of EV rollout.

In addition, impacts on the electricity network of widespread EV ownership will be very dependent on the successful roll out of smart charging.

To address these barriers, developing infrastructure for hydrogen and biomethane refuelling can help to manage pressures on materials availability and electricity networks, by ensuring a balanced roll out of low and zero emission vehicles.

[25] BP, Statistical Review of World Energy, 2019 https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html
[26] EU Commission, Cobalt: demand-supply balances in the transition to electric mobility, 2018 https://publications.jrc.ec.europa.eu/repository/bitstream/JRC112285/jrc112285_cobalt.pdf

Question 21 (Surface transport): In our Net Zero advice, the CCC identified three potential options to switch to zero emission HGVs – hydrogen, electrification with very fast chargers and electrification with overhead wires on motorways. What evidence and steps would be required to enable an operator to switch their fleets to one of these options? How could this transition be facilitated?

ANSWER:

Firstly, we would emphasise that biomethane CNG should be considered a viable decarbonisation option, with the latest Euro VI trial showing that well-to-wheel savings are at least 76% compared to diesel,[27] and with a choice of CNG trucks available now. We therefore include biomethane CNG in our considerations on this question.

A number of pieces of evidence will be needed for operators to switch fleets (see our answers to Question 9 and Question 17 as well), including:

- Cost of fuel and cost of vehicles compared to diesel (Total Cost of Ownership);
- Availability of biomethane CNG and hydrogen fuel when needed;
- Number and location of fuelling stations, particularly considering freight routes and HGV range;
- Tax incentives on either vehicle purchase or fuel duty, and the certainty that these will be continued;
- Regulatory requirements over time on HGV fleets, and the certainty that the trajectory will be maintained;
- Certification guaranteeing that the CNG or hydrogen fuel is low-carbon.

To facilitate the transition, investment for the construction of biomethane CNG and hydrogen fuelling stations will need to be supported by gas network and/or on-site electrolyser or anaerobic digester investment to ensure a reliable fuel supply. The gas network investment needs to be supported through Ofgem price controls, which must be consistent with BEIS and DfT policy on transport decarbonisation.

Finally, infrastructure investment will need to run slightly ahead of usage – no freight company can risk not being able to make deliveries, so fleets will only be switched over when reliable infrastructure is in place.

[27] Cenex, Dedicated to Gas project (part of the Low Emission Freight and Logistics Trial), November 2019 https://www.cenex.co.uk/case-studies/dedicated-to-gas/

Question 22 (Industry): What policy mechanisms should be implemented to support decarbonisation of the sectors below? Please provide evidence to support this over alternative mechanisms.

a) Manufacturing sectors at risk of carbon leakage

b) Manufacturing sectors not at risk of carbon leakage

c) Fossil fuel production sectors

d) Off-road mobile machinery

ANSWER: *(NB: This answer is longer than 400 words given the subsections to the question.)*

The first point to note is that there has not been a considerable degree of deep decarbonisation of industry (beyond switching from coal to gas and improving energy efficiency), and so evidence on which policies are best for industrial deep decarbonisation is limited. Examples from other sectors can therefore be useful, and our answer to Question 23 is also relevant. We would also highlight the business model options reviewed in the BEIS CCUS business models consultation.

Secondly, for all of the sectors highlighted in the question, there are no UK policies to support operational expenditure and roll-out, beyond pilot schemes. The policy focus must be on how best to support deployment, if meaningful emissions reduction is to be achieved. And just as Renewable Obligations evolved into CfDs, initial industrial decarbonisation schemes are likely to evolve over time.

Thirdly, many of the cluster decarbonisation projects will have relevance for more than one of the above sectors. It is imperative that all of the main cluster projects are progressed, and at this early stage, we cannot see any benefit from competition between clusters – decarbonising Humberside will not decarbonise Teesside.

Fourthly, post-Brexit, we are not clear what will replace the EU ETS, and so carbon pricing in a UK context remains uncertain. Also, as stated in our answers to Question 3 and Question 4, we believe the UK will find it difficult to implement a carbon border tax.

a) For these sectors, a carbon price significantly higher than in other countries will not be helpful; instead, these sectors must be supported financially to decarbonise, at least in the early years. Options include:
   - Tax credits or subsidies per tonne of CO2 abated, to cover the additional cost over the Carbon Price Floor, possibly through a CfD auction.
   - Enhanced capital allowances for low carbon equipment.
   - Regulated Asset Base (RAB) financing for supporting infrastructure, including CO2 transport and storage and hydrogen transport.
   - Subsidies for hydrogen production, possibly through a CfD auction, to cover the additional cost over natural gas.

In combination, these policies could be quite effective. For example, a CfD for CO2 capture on a manufacturing plant, supported by a RAB for the CO2 transport and storage infrastructure. Or a CfD for hydrogen production in combination with enhanced capital allowances for new industrial hydrogen burners.

b) For these sectors, there is much more rationale for a higher carbon price. Although the carbon price will be passed onto consumers, revenue from a carbon tax in these

Question 22 (Industry): What policy mechanisms should be implemented to support decarbonisation of the sectors below? Please provide evidence to support this over alternative mechanisms.

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sectors could be used to help fund decarbonisation measures in the sectors at risk of leakage, reducing the overall cost to the taxpayer. The Energy Transitions Commission recommended differentiated carbon prices on products that are not internationally traded e.g. cement.[28]

c) It is worth noting that considerable carbon leakage will occur if UK oil and gas production is replaced by imports. UKCS gas has pre-combustion emissions estimated at 9-17 gCO2/kWh, compared with LNG pre-combustion emissions estimated at 38-89 gCO2/kWh.[29]

[28] Energy Transitions Commission, Mission Possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century, November 2018 http://www.energy-transitions.org/mission-possible

[29] DECC, Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use, 2013, Tables A4 and A5 https://www.gov.uk/government/publications/potential-greenhouse-gas-emissions-associated-with-shale-gas-production-and-use

Question 23 (Industry): What would you highlight as international examples of good policy/practice on decarbonisation of manufacturing and fossil fuel supply emissions? Is there evidence to suggest that these policies or practices created economic opportunities (e.g. increased market shares, job creation) for the manufacturing and fossil fuel supply sectors?

ANSWER:

As mentioned in our answer to Question 22, evidence on effectiveness is limited at this stage, but there are a number of policy initiatives that are worth highlighting:

CfDs for offshore wind: This is not an overseas example, but we should not forget to consider successful UK examples, and the evidence on offshore wind cost reductions is well known. Key to this has been a falling cost of capital, as investors became more comfortable with the risks – the same is possible in industry.

US – 45Q and production tax credit: The 45Q tax credit will rise to $50 per tonne by 2025 for dedicated geological storage, and is expected to bring non-Enhanced Oil Recovery (EOR) projects online.[30] The US Production Tax Credit has also successfully supported wind and solar development. It is worth noting, however, that a tax credit approach is more common in the US, and that CCS is not an add-on to the oil and gas sector, but needs to be developed in other industries – most of the US CCS projects so far are for EOR.

Netherlands – CO2 abatement subsidy: Although the details are still to be finalised, the Netherlands is implementing an "SDE++" mechanism, which provides a guaranteed support amount per tonne of CO2 abated. The amount varies by industry:[31]

- €139 EUR/tonne: Refineries
- €91 EUR/tonne: Waste to energy
- €67 EUR/tonne: Steel, fertilizers,
- €35 EUR/tonne: Ethanol production

This is potentially a very powerful way of accelerating carbon emissions reduction.

Northern Lights Project: The Norwegian Government has provided support for CCS as part of the full-scale CCS project in Norway.[32] If the project is realized, the Norwegian state has agreed to provide the industry partners with subsidies for capturing, transporting and storing CO2. Both CAPEX and OPEX will be subsidised. There will be cost and risk sharing between industry and government (subject to ongoing industrial-governmental negotiations).

Domestic energy production: Finally, it is worth noting that, properly accounted for, fossil fuel supply emissions will fall if domestic production rises at the expense of LNG imports, given that UKCS gas has pre-combustion emissions considerably lower than LNG imports – estimated at 9-17 gCO2/kWh, compared with 38-89 gCO2/kWh for LNG.[33]

[30] See https://www.iea.org/commentaries/us-budget-bill-may-help-carbon-capture-get-back-on-track
[31] Netherlands Enterprise Agency, SDE++: CCS Deployment Stimulus
[32] See https://ccsnorway.com/public-and-private-cooperation/
[33] DECC, Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use, 2013, Tables A4 and A5 https://www.gov.uk/government/publications/potential-greenhouse-gas-emissions-associated-with-shale-gas-production-and-use

Question 24 (Industry): How can the UK achieve a just transition in the fossil fuel supply sectors?

ANSWER:

As noted in our answer to Question 12, a Just Transition is essential to protect the 250,000 jobs that rely on oil and gas production.[34] There are a number of ways to achieve this:

CCS:

- A recent Summit Power report found that developing a network of CCS projects along the East Coast of the UK, capturing 75 million tonnes of CO_2 per year, would provide £163 billion of economic benefits and 225,000 jobs, cumulatively, through to 2060.[35]
- The UK has more than 100 years' of CO_2 storage capacity,[36] and can make use of oil and gas industry expertise, and its supply chain and innovation system.
- The future global CCS market is estimated to be around £100bn/year,[37] with 11Gt CO2 needing to be permanently stored by 2060 to meet Paris Agreement emissions reduction targets. The UK can also create jobs through storing CO2 on behalf of other countries and/or through capturing and storing CO2 from industrial processes and then exporting the low carbon products.

Hydrogen:

- Offshore hydrogen production from wind, piping the hydrogen to shore, and from production of hydrogen from methane by the coast, with the resulting CO2 emissions transported and stored, are both viable options.
- The Hydrogen Council roadmap envisages the global hydrogen market reaching £1.9 trillion a year by 2050, creating jobs for 30 million people.[38] Scale-up will be the biggest driver of cost reduction, but there is scope for technological breakthroughs in both the production and transport of hydrogen.

Energy integration

- Overall, considerable work is underway to investigate the potential for offshore energy integration programmes that bring together oil and gas assets with offshore wind, hydrogen and CO2 transport and storage.[39] This work is extremely important for all offshore sectors.
- Finally, as stated previously, ensuring sufficient natural gas and offshore wind production to provide cost-effective hydrogen at scale will also be essential.

[34] Oil & Gas UK, Economic Report, 2019 https://oilandgasuk.co.uk/wp-content/uploads/2019/09/Economic-Report-2019-OGUK.pdf ,
[35] Summit Power, Clean Air – Clean Industry – Clean Growth: How Carbon Capture Will Boost the UK Economy: East Coast UK Carbon Capture and Storage Investment Study, October 2017 http://www.ccsassociation.org/news-and-events/reports-and-publications/clean-air-clean-industry-clean-growth/
[36] The North Sea has ample CO_2 storage opportunities, estimated to be around 78 billion tonnes. Simply utilising the top 15% of this storage capacity would be enough to meet entire UK needs for 100 years. Energy Technologies Institute, Pale Blue Dot, Costain and Axis, Progressing Development of the UK's Strategic Carbon Dioxide Storage Reserve: A Summary of Results from the Strategic UK CO_2 Storage Appraisal Project, April 2016 http://www.eti.co.uk/project/strategic-uk-ccs-storage-appraisal/
[37] HM Government, Clean Growth Strategy, October 2017, p.69 https://www.gov.uk/government/publications/clean-growth-strategy
[38] Hydrogen Council, Hydrogen scaling up, November 2017, p.8 and p.20 http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-Scaling-up_Hydrogen-Council_2017.compressed.pdf
[39] Oil and Gas Authority, UKCS Energy Integration: Interim findings, December 2019 https://www.ogauthority.co.uk/news-publications/publications/2019/ukcs-energy-integration-interim-findings/

Question 25 (Industry): In our Net Zero advice, the CCC identified a range of resource efficiency measures that can reduce emissions (see Chapter 4 of the Net Zero Technical Report, page 115), but found little evidence relating to the costs/savings of these measures. What evidence is there on the costs/savings of these and other resource efficiency measures (ideally on a £/tCO2e basis)?
ANSWER:

Question 26 (Buildings): For the majority of the housing stock in the CCC's Net Zero Further Ambition scenario, 2050 is assumed to be a realistic timeframe for full roll-out of energy efficiency and low-carbon heating.

a) What evidence can you point to about the potential for decarbonising heat in buildings more quickly?

b) What evidence do you have about the role behaviour change could play in driving forward more extensive decarbonisation of the building stock more quickly? What are the costs/levels of abatement that might be associated with a behaviour-led transition?

ANSWER:

a) As noted in our answer to Question 2, net zero requires the heating systems to be changed in almost 1 million existing homes a year between now and 2050 (there were 27.8 million households in the UK in 2019).[40] This is already a very stretching target to achieve:
   - Given that around 1.2 million condensing boilers have been installed each year since 2005,[41] mandating hydrogen-ready boilers would exceed an interim target of 1 million homes a year ready for decarbonisation (indeed, in 2019, a record 1.67 million gas boilers were sold[42]) – although they would still need connecting to a hydrogen supply.
   - The H21 North of England project provided a roadmap to decarbonise 3.8 million homes in the North of England, and a nationwide roll out covering 15 million homes by 2050. It is worth noting that the town gas to natural gas conversion at peak (1971-72) was converting 2.3 million homes a year.[43]
   - The Freedom Project demonstrated the ability of the gas and electricity sectors to work together to manage peak heating loads,[44] and would ensure that a given level of hydrogen and biomethane supply would reach more homes.
   - The H21 and Freedom projects are essential to achieving net zero in domestic heating in 2050.
   - We understand that the RHI may possible be removed for domestic hybrid heating upgrades. We think this would be retrograde step, making a low regrets option supported by the Committee more difficult to achieve in practice.

b) As stated above, mandating hydrogen-ready boilers would exceed the requirement for 1 million homes a year to be ready for decarbonisation, without requiring any behavioural change at all.

[40] Office for National Statistics Families and households in the UK: 2019 https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2019

[41] English Housing Survey 2017-18, Annex Table 2.10 https://www.gov.uk/government/statistics/english-housing-survey-2017-to-2018-headline-report

[42] Energy and Utilities Alliance data, see https://www.eua.org.uk/record-boiler-sales-show-how-decarbonisation-will-work/

[43] H21 North of England, 2018 https://www.northerngasnetworks.co.uk/event/h21-launches-national/

[44] Wales & West Utilities, Freedom Project: Final Report, October 2018 https://www.wwutilities.co.uk/media/2829/freedom-project-final-report-october-2018.pdf

Question 27 (Buildings): Do we currently have the right skills in place to enable widespread retrofit and build of low-carbon buildings? If not, where are skills lacking and what are the gaps in the current training framework? To what extent are existing skill sets readily transferable to low-carbon skills requirements?

ANSWER:

The H21 North of England report showed that a widespread conversion of homes to hydrogen would require over 3,000 gas engineers for a number of years, with additional management staff. To put this into context, the UK has 128,000 Gas Safe registered engineers.[45] The workforce would require hydrogen training, but the overall size of the workforce for a domestic hydrogen conversion would be manageable.

However, the gas workforce is ageing, and so recruitment, training and retention of younger gas engineers is critical. In our experience, decarbonisation is a strong motivator for young people, who value work that contributes positively to the environment – a hydrogen and hybrid heating roll out would, we believe, prove to be a strong motivator for young engineers.

We would also refer to the National Grid report, "Building the Net Zero Energy Workforce", which has just been published. We have not had time to review the report in detail, but it finds that 400,000 new recruits will be needed in the energy sector through to 2050.[46]

[45] H21 North of England, 2018, pp.284-285 https://northerngasnetworks.co.uk/h21-noe/H21-NoE-23Nov18-v1.0.pdf
[46] National Grid, Building the Net Zero Energy Workforce, 28 January 2020 https://www.nationalgrid.com/group/responsibility-and-sustainability/net-zero-energy-workforce

Question 28 (Buildings): How can local/regional and national decision making be coordinated effectively to achieve the best outcomes for the UK as a whole? Can you point to any case studies which illustrate successful local or regional governance models for decision making in heat decarbonisation?

ANSWER:

The town gas to natural gas conversion, together with the construction of the National Transmission System for gas, is an example of an effective national policy implemented locally. However, it was carried out in the context of a nationalised industry. A recent study for BEIS looked at the logistics of domestic hydrogen conversion with reference to the previous conversion from town gas.[47]

The important distinction to make is that a hydrogen conversion requires a definite decision to be made for a phased switchover in a region, together with the coupling of hydrogen production and transmission. This is likely to be necessary on an inter-regional or national basis, given that hydrogen production at scale is most likely to take place on the coast – to make use of gas pipelines, CO2 storage facilities and offshore wind assets – and hydrogen conversion will be needed in inland cities.

For every other solution, change can take place piecemeal, with a patchwork of different solutions and no requirement for a set of definite conversion dates.

[47] Frazer-Nash Consultancy, Logistics of Domestic Hydrogen Conversion, October 2018 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760508/hydrogen-logistics.pdf

Question 29 (Power): Think of a possible future power system without Government backed Contracts-for-Difference. What business models and/or policy instruments could be used to continue to decarbonise UK power emissions to close to zero by 2050, whilst minimising costs?

ANSWER:

We believe it may be too early to consider replacements for CfDs. They have proved successful in reducing renewable generation costs, and could be expanded to cover CCS, BECCs, or hydrogen power generation.

Considerable thought was given to business models for hydrogen and CCS in last year's BEIS CCUS business models consultation. In our response to that consultation, our preferences were for:[48]

- A **baseload CfD** to be provided for the first CCUS plants, providing greater certainty, including for transport and storage (T&S) developers. A baseload CfD would also be the best model for BECCS plants that provide negative emissions.
- A **flexible CfD with a capacity payment** to be introduced subsequently, which would allow CCUS plants to play a preferred role providing mid-merit generation. This would also provide time for technology to be improved to allow full CO_2 capture for short running periods, and for T&S infrastructure to have been established, and hence T&S risks to reduce. It would also allow time to establish with greater certainty the role that new nuclear is likely to play and the direction of heat decarbonisation.
- A **hybrid grant/CfD for hydrogen production**, with grants to cover capital outlays and the CfD covering operational costs. The reference price would be the natural gas price, plus a CO_2 price for those sectors that currently pay CO_2 prices on natural gas consumption.

However, if an alternative was required, we believe the recommendation made in the Cost of Energy Review for a unified equivalent firm power (EFP) capacity auction would be sensible.[49] It would ensure a level playing field for generation capacity from renewables plus storage, nuclear, CCS, and hydrogen. It would also encourage sector-coupling approaches, for example electrolysis hydrogen from excess renewables coupled with hydrogen generation.

Other alternatives include:

- A CO2 price, although the carbon leakage risk is still present in the power sector, with a growing level of interconnection, and there is an additional risk of carbon leakage if industrial electricity prices are too high;
- Enhanced capital allowances for e.g. CCS equipment;
- Tax credits for renewable and low carbon power generation, as in the US;
- Regulatory limits on emissions, as are being used to phase out coal-fired power stations.
-

[48] Business models for carbon capture, usage and storage: Decarbonised Gas Alliance response, September 2019 https://www.dgalliance.org/wp-content/uploads/2019/12/DGA-CCUS-business-models-consultation-response-vfinal.pdf

[49] Cost of Energy Review, October 2017 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/654902/Cost_of_Energy_Review.pdf

Question 30 (Power): In Chapter 2 of the Net Zero Technical Report we presented an illustrative power scenario for 2050 (see pages 40-41 in particular):

a) Which low-carbon technologies could play a greater/lesser role in the 2050 generation mix? What about in a generation mix in 2030/35?

b) Power from weather-dependent renewables is highly variable on both daily and seasonal scales. Modelling by Imperial College which informed the illustrative 2050 scenario suggested an important role for interconnection, battery storage and flexible demand in a future low-carbon power system:

i. What other technologies could play a role here?

ii. What evidence do you have for how much demand side flexibility might be realised?

ANSWER:

b) i) It is worth noting that there are periods of several days with little wind in winter. For example, from 22.35 on 18 January 2020 until 15.40 on 20 January, total wind generation remained below 6 GW. It then rose slightly above 6 GW (but less than 7 GW) until 22.25 on 20 January, before falling to a low of under 1.6 GW at 08.35 on 21 January. It then stayed below 3 GW until 23 January and below 4 GW until 25 January.[50] By contrast, at peak, wind generates over 12 GW. These periods where wind is at less – and often much less – than 50% of capacity are far longer than battery storage is able to handle and much longer than desirable for demand response. Therefore, flexible, fast-acting and long-lasting backup low carbon generation is a necessity:

- Gas-based CCS power is a credible option, including areas of new technology such as the Allam Cycle, which is being successfully tested at a 50 MW plant in Texas.
- Hydrogen generation may also be a good solution for flexible power. It would not face the issue of CO2 capture efficiency if used for short periods of a few hours at a time. And it could also make best use of offshore wind assets, with hydrogen produced by electrolysis during periods of excess renewable electricity, and then used to generate power when wind speeds are lower.
- Hydrogen also has the potential to offer large-scale energy storage to balance the inter-seasonal disparity between energy demand and supply. Analysis published by WindEurope highlighted that, while the UK is home to 40% of Europe's wind resource, the vast bulk of this resource is unlikely to be developed, especially in northern waters.[51] Green hydrogen production could harness this resource, coupled with geological hydrogen storage.
- BECCS plants would deliver negative emissions, which are needed to meet net zero, although they may be more suited to baseload operation.

All of the above options could also help to fill the gap if new nuclear is not developed at scale, with all existing nuclear plants except Sizewell set to close before 2030. They could also help meet a need for additional electricity generation capacity to the extent that heat decarbonisation follows an electric pathway – at the extreme end, if domestic heating was fully electrified, the recent Imperial College report on heat decarbonisation found that 79 GW of OCGT and 24 GW of hydrogen OCGT would be needed, together with 13 GW of CCGT and 23 GW of hydrogen CCGT.[52]

[50] Gridwatch data https://www.gridwatch.templar.co.uk/
[51] Wind Europe, Our energy, our future: How offshore wind will help Europe go carbon-neutral, December 2019 https://windeurope.org/about-wind/reports/our-energy-our-future/
[52] Imperial College London, Analysis of Alternative UK Heat Decarbonisation Pathways: For the Committee on Climate Change, August 2018, Figure E https://www.theccc.org.uk/wp-content/uploads/2018/06/Imperial-College-2018-Analysis-of-Alternative-UK-Heat-Decarbonisation-Pathways.pdf

Question 31 (Hydrogen): The Committee has recommended the Government support the delivery of at least one large-scale low-carbon hydrogen production facility in the 2020s. Beyond this initial facility, what mechanisms can be used to efficiently incentivise the production and use of low-carbon hydrogen? What are the most likely early applications for hydrogen?

ANSWER:

Firstly, more than one large scale low carbon hydrogen production facility will be needed by 2030. All of the major industrial clusters need to decarbonise, and indeed a number of cluster projects, including in Scotland, the North West and Humberside, envisage a major role for hydrogen. We would therefore consider it a failure if only one large scale low carbon hydrogen production facility was up and running by 2030.

Possible mechanisms to support hydrogen production were discussed in the BEIS CCUS business models consultation. Given the wide variety of possible uses for hydrogen, it may be most straightforward to establish a **hybrid grant/CfD for hydrogen production**, with grants to cover capital outlays and the CfD covering operational costs. The reference price would be the natural gas price, plus a CO_2 price for those sectors that currently pay CO_2 prices on natural gas consumption.

For transport usage, the RTFO should also be expanded to include all forms of low carbon hydrogen production, and UK hydrogen production only could be supported, to avoid the issue identified by the CCUS Advisory Group that renewable transport fuels delivered to date have been largely imported.[53]

This would mean that – together with power and industrial sector CCS schemes – there would be up to four mechanisms to fund the production of low carbon hydrogen:

- RFTO, if it was expanded to all forms of low carbon hydrogen;
- Power CCUS CfD, if hydrogen production was allowed within the CfD and hydrogen was solely used for power generation;
- Industrial CfD, if wider CO_2 abatement was included, therefore covering fuel switching;
- Hydrogen production CfD.

It would be important to avoid double-subsidies, and this could be achieved, for example, by only allowing one mechanism to be used for each unit of hydrogen produced. A recent report by the Hydrogen Council concluded that the cost of hydrogen could fall by 50% by 2030 with the right investments.[54]

For transport of hydrogen, an extension to the existing RAB-based network charging regime is most appropriate, ensuring a low cost of capital and using an existing well-understood and successful mechanism.

We envisage early applications for hydrogen to be focused on HGVs, Buses, Shipping, Rail, industrial use, and blending in gas networks.

[53] CCUS Advisory Group, Investment Frameworks for the Development of CCUS in the UK, July 2019, p.172 http://www.ccsassociation.org/files/4615/6386/6542/CCUS_Advisory_Group_Final_Report_22_July_2019.pdf
[54] Hydrogen Council, Path to hydrogen competitiveness: A cost perspective, January 2020 https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf

Question 32 (Aviation and Shipping): In September 2019 the Committee published advice to Government on international aviation and shipping and Net Zero. The Committee recognises that the primary policy approach for reducing emissions in these sectors should be set at the international level (e.g. through the International Civil Aviation Organisation and International Maritime Organisation). However, there is still a role for supplementary domestic policies to complement the international approach, provided these do not lead to concerns about competitiveness or carbon leakage. What are the domestic measures the UK could take to reduce aviation and shipping emissions over the period to 2030/35 and longer-term to 2050, which would not create significant competitiveness or carbon leakage risks? How much could these reduce emissions?

ANSWER:

The recent Hydrogen Council report on hydrogen technologies provides detail on the potential for hydrogen in shipping and aviation:[55]

Aviation: *"Most emissions in aviation, however, stem from long-haul flights. For the large aircrafts used on these routes, the most realistic decarbonisation option is to replace kerosene from fossil sources with kerosene that does not bring new carbon into the atmosphere. One option is to use biofuels (bio-kerosene); another is to produce synthetic kerosene from hydrogen. Synthetic fuel is a liquid fuel derived from a blend of hydrogen and carbon monoxide, for which hydrogen and a carbon feedstock are needed. Since bio-kerosene and synfuel are chemically similar to conventional kerosene, they can be 'dropped into the fuel pool' and stored, transported and used like conventional kerosene. That makes the transition to these fuels easier, as existing infrastructure and aircrafts can be used … For small aircrafts, hydrogen can also be used directly in fuel cells instead of converting it into synfuel. This is currently being tested in planes of up to 20 passengers and ranges up to 800 km."*

Shipping: *"For smaller ships with motor power requirements under 2 megawatts (MW), like passenger ferries or ferries with room for fewer than 100 cars, hydrogen fuel cells offer a potential alternative for the near term. In fact, hydrogen can serve as a competitive low-carbon alternative to electric ferries before 2030, as the latter requires expensive large batteries and associated charging and infrastructure … Hydrogen passenger ferries are particularly competitive in situations where there are short docking times that do not allow enough time for charging the battery … For larger ferries with motor power up to 4 MW, hydrogen can be an attractive low-carbon alternative. Batteries are unlikely to be suitable due to the high cost, weight, and volume of the battery required for ships of this size and fuel consumption … For longer-distance shipping involving, e.g. large container ships, ammonia fuel may offer the most viable low-carbon option … the conversion of hydrogen to ammonia is a well-established and low-cost process, and ammonia would be a low-cost option if used directly."*

There is also a current proposal to the EU H2020 for the decarbonisation of long distance shipping called RECAST, which may be retrofittable. A dry exhaust gas scrubber uses low emissions lime, which absorbs 85% of the CO2 and recovers the heat of absorption to help power the ship. The ambition is net zero carbon shipping at moderate cost.

[55] Hydrogen Council, Path to hydrogen competitiveness: A cost perspective, January 2020 https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf

Question 33 (Agriculture and Land use): In Chapter 7 of the Net Zero Technical Report we presented our Further Ambition scenario for agriculture and land use (see page 199). The scenario requires measures to release land currently used for food production for other uses, whilst maintaining current per-capita food production. This is achieved through:

- A 20% reduction in consumption of red meat and dairy
- A 20% reduction in food waste by 2025
- Moving 10% of horticulture indoors
- An increase in agriculture productivity:
  - Crop yields rising from the current average of 8 tonnes/hectare for wheat (and equivalent rates for other crops) to 10 tonnes/hectare
  - Livestock stocking density increasing from just over 1 livestock unit (LU)/hectare to 1.5 LU/hectare

Can this increase in productivity be delivered in a sustainable manner?

Do you agree that these are the right measures and with the broad level of ambition indicated? Are there additional measures you would suggest?

ANSWER:

Question 34 (Agriculture and Land use): Land spared through the measures set out in question 33 is used in our Further Ambition scenario for: afforestation (30,000 hectares/year), bioenergy crops (23,000 hectares/year), agro-forestry and hedgerows (~10% of agricultural land) and peatland restoration (50% of upland peat, 25% lowland peat). We also assume the take-up of low-carbon farming practices for soils and livestock. Do you agree that these are the key measures and with the broad level of ambition of each? Are there additional measures you would suggest?

ANSWER:

Question 35 (Greenhouse gas removals): What relevant evidence exists regarding constraints on the rate at which the deployment of engineered GHG removals in the UK (such as bioenergy with carbon capture and storage or direct air capture) could scale-up by 2035?

ANSWER:

We have been provided the following from Drax, which we think is relevant to this question: *"Drax as one of the few GGR developers in the UK is currently investigating the possibility of scale up of their BECCS pilot plant to operate at commercial scale. They believe that they could scale up at a rate of 4MtCO2 per year, every 2 years from 2027 to 2033 for a total of 16MtCO2 of negative emissions per year."*

This would of course be dependent on government policy to provide an investible framework for negative emissions. Policy would need to be put in place soon for the above timescales to be met. It will be important to ensure a fair fiscal regime for BECCS that doesn't put the burden on industry or energy producers.

Question 36 (Greenhouse gas removals): Is there evidence regarding near-term expected learning curves for the cost of engineered GHG removal through technologies such as bioenergy with carbon capture and storage or direct air capture of CO_2?

ANSWER:

DNV GL's 2019 Energy Transition Outlook provides estimates of learning rates for CCS technology, which could be applied to BECCS.

Estimating learning curves for CCS is not straightforward, however, as the history of capacity additions is limited. DNV GL therefore used a similar capture technology as a proxy – sulphur dioxide and nitrogen oxide control technology in coal-fired power plants. These technologies have shown cost learning rates (per doubling of cumulative installed capacity) of 13% for capital costs, and 15% for O&M, as well as for energy efficiency (Riahi, Rubin, Taylor, Schrattenholzer, & Hounshell, 2004).[56]

The biomass fuel costs would need to be estimated and projected separately.

Question 37 (Infrastructure): What will be the key factors that will determine whether decarbonisation of heat in a particular area will require investment in the electricity distribution network, the gas distribution network or a heat network?

ANSWER:

Firstly, investment in the gas distribution network is already happening through the Iron Mains Replacement Programme, which, subject to ongoing H21 and Hy4Heat testing work, will allow the network to carry 100% hydrogen. This is a key advantage, as the gas distribution network is effectively becoming "hydrogen-ready".

For particular regions, key factors determining whether heat decarbonisation will need gas or electricity distribution network investment include:

- Hydrogen supply, and for hydrogen produced from methane, CCS availability;
- Biomethane supply, for regions where biomethane could be rolled out with hybrid heating systems;
- Take up of hybrid heating systems;
- EV charging levels;
- National or regional policies to support different heat decarbonisation technologies.

Another key factor is the energy efficiency of housing, and the implications for heat demand. Between 2003 and 2017, the average SAP score for homes in England increased from 48 to 62,[57] and at the same time average domestic gas consumption (most of which is for heating) fell from 18,000 kWh to 12,500 kWh[58] – an extremely strong correlation. The future trend of average SAP scores will have a big impact on domestic heating demand – and hence on both electricity and gas network investment.

[56] DNV GL, Energy Transition Outlook 2019: Model Documentation
[57] 2017-18 English Housing Survey Headline Report
[58] BEIS, DUKES – Natural Gas

Question 38 (Infrastructure): What scale of carbon capture and storage development is needed and what does that mean for development of CO_2 transport and storage infrastructure over the period to 2030?

ANSWER:

We agree with the scale of CCS needed to meet net zero set out in the Committee's net zero report – of 75-175 million tonnes captured and stored per annum by 2050. We also agree that CCS will be needed across sectors – including for hydrogen production, power generation, BECCS, industry and biofuel production.

In order to achieve this, CCS infrastructure will be required in all major clusters by 2030 at the latest, and CO2 shipping will need to be established for those regions without offshore geological storage capacity, for example South Wales.

As set out in our answer to Question 9, a target of 10 million tonnes of CO2 captured and stored annually by 2030 implies a growth of 2 million tonnes of capacity per annum from 2025, assuming 2025 as a reasonable first date for storage. To meet the Committee's requirement of 75-175 million tonnes captured and stored per annum in 2050, CCS capacity growth would need to expand to 3.25-8.35 million tonnes per annum after 2030.

In our view, 10 million tonnes captured and stored annually by 2030 should be viewed as an absolute minimum.