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.

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:

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:

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:

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:

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:

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:

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:

Given the likely role of biomass in an energy system compatible with achieving Net Zero, Holland et al (https://doi.org/10.1016/j.rser.2015.02.003) synthesise evidence of the implications of 2G feedstock production for a range of key ecosystem services beyond climate regulation. They consider feedstocks typical of temperate systems (Miscanthus, short-rotation coppice, short rotation forestry) and transitions from areas of forest, marginal land and first generation (1G) feedstock production. For transitions from 1G feedstocks, studies suggest significant benefits may arise for a number of ecosystem services, including hazard regulation, disease and pest control, and water and soil quality. Although less evidence is available, the conversion of marginal land to 2G production will likely deliver benefits for some services while remaining broadly neutral for others. Conversion of forest to 2G production will likely reduce the provision of a range of services due to increased disturbance associated with shortening of the management cycle.

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:

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:

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:

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:

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:

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:

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:

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:

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:

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:

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

ANSWER:

Bioenergy from UK biomass feedstocks represents a sustainable renewable energy option that can help the transition away from fossil fuels. In many cases, biomass and biofuels may provide direct drop-in alternatives to fossil fuels using existing UK infrastructure [1]. There are particular opportunities from:

- High-potential availability of biomass and energy crops without impacting food systems – Our analysis shows that the potential availability of biomass and energy crops for the bioenergy sector remains high, even when land is 'ring-fenced' for the UK to maintain its food production requirements [1].
- Robust and continuous resource availability from ongoing UK activities – Biomass residue resources, including agricultural, forestry, industrial and arboriculture residues were found to represent a continuous and robust resource that maintained a high availability regardless of the scenario or time within the analysis. Agricultural residues, particularly both straw and slurry resources represent a major opportunity for the bioenergy sector due to their high abundance, availability robustness and current under-utilisation [1].
- Large potential from UK waste resources – Where adopted waste management strategies emphasise energy recovery, the potential waste resource availability for the bioenergy sector was shown to be substantial (>1,308 million tonnes equivalent per year in 2050). The abundance of both household and food/plant-based waste streams were identified as showing particular potential for the bioenergy sector [1].
- The non- and under-utilisation of indigenous biomass resources in the UK, and the major, currently missed, opportunities that are contrary to the current direction of the UK bioenergy sector [1].

[1] Welfle AJ, Gilbert P, Thornley P. Securing a Bioenergy Future without Imports. Energy Policy 2014;68:249–66. doi:10.1016/j.biombioe.2014.08.001.

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:

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:

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:

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:

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:

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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:

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:

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:

Qi et al (https://doi.org/10.1016/j.scitotenv.2018.03.395) benchmark the potential national availability of grassland biomass, identify optimal strategies for its management, and investigate the relative importance of intensification over reversion (prioritising productivity versus environmental ecosystem services). The effects of climate change, rising atmospheric [CO_2] and technological progress on baseline dry matter yields (DMYs) were used to estimate future grassland productivities (up to 2050) for low and medium CO_2 emission scenarios of UKCP09. UK benchmark productivities of 12.5, 8.7 and 2.8 t/ha on temporary, permanent and rough-grazing grassland, respectively, accounted for

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productivity gains by 2010. By 2050, productivities under medium emission scenario are predicted to increase to 15.5 and 9.8 t/ha on temporary and permanent grassland, respectively, but not on rough grassland. Based on surveyed grassland distributions for Great Britain in 2010 the annual availability of grassland biomass is likely to rise from 64 to 72 million tonnes by 2050. Assuming optimal N application could close existing productivity gaps of ca. 40% a range of management options could deliver additional $21 * 10^6$ tonnes of biomass available for bioenergy providing up to 12.5% of the total gas output or 25% of the gas imports to the UK in 2017 assuming standard conversion rates from grass biomass to biogas. Scenarios of changes in grassland use intensity demonstrated considerable scope for maintaining or further increasing grassland production and sparing some grassland for the provision of environmental ecosystem services. For example, reversion of improved grassland in upland Britain coupled with a corresponding shift to more intensively managed lowland regions could maintain total GB grassland production and enhance the provision of critical ecosystem services provided by upland (eg, water quality and carbon stocks).

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:

There are six key challenges that need to be addressed to enable the widespread deployment of BECCS technologies:

- How does BECCS fit with carbon budgets?
- Evaluating negative emissions from BECCS – how negative is BECCS?
- Can BECCS be delivered at sufficient scale?
- Can sufficient biomass be provided sustainably?
- How does BECCS fit into the policy context?
- Distributional aspects and emissions accounting: how does BECCS fit with climate agreements?

Gough C, Garcia-Freites S,Jones C, Mander S, Moore B, Pereira C, RöderM, Vaughan N, Welfle A (2018). Challenges to the use of BECCS as a keystone technology inpursuit of 1.5^0 C.Global Sustainability1, e5,1–9. https://doi.org/10.1017/sus.2018.3

Bioenergy with carbon capture and storage is technically feasible and many studies have evaluated its efficacy. However, there are many different technology options and some of the more promising ones (that would maximize carbon sequestration and minimize net energy consumption per unit output) are complex, integrated systems. There will inevitably be significant learning that will occur in the early stages of demonstration and deployment. The lead time for design, permitting, financing and engineering of such a facility is likely to be in the order of 3-5 years. Construction of a utility scale plant would then be expected to take 2-3 years and a further 2 years for commissioning and operational experience and learning to be gained. Therefore lead time for a first-of-its-kind plant is 7-10 years. While subsequent plants could be deployed more quickly (perhaps 5 years for replicas) the need to stage deployment to learn from experience and minimize future risk is key. This sets a trajectory whereby one plant could be commercially viable by 2030, with others following from 2035 onwards. The key constraint on the rate at which deployment can be executed is dictated by the capacity (skills, financial risk, power system, etc) to pursue such a programme of deployment.

It is important to understand that the more efficient pre-combustion (gasification) technologies for BECCS are not directly scalable. The technology that is deployed at small scale is fundamentally different from that at large scale with different chemical reactions and gas specifications being produced during the process. Therefore there is not necessarily anything to be gained from starting at small scale and scaling up. The most significant learning curves are associated with the technologies used for larger scale applications and it is simply not possible to adequately demonstrate these to de-risk at small scale. Rather, if large scale operation is required, there is a need to focus on a supported plant at that scale from which learning can be derived.

Valuable information on the technology options, costs and efficiencies was collated for the ETI's Biomass to Power with Carbon Capture and Storage project.

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?

For more information on performance projections and the significant barriers to implementation, see Gough et al. Biomass Energy with Carbon Capture and Storage (BECCS): Unlocking Negative Emissions, Wiley, 2019

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:

As explained in response to 35, this is not a linear, scalable, predictable entity. Up to half of the actual cost of a new facility can be focused on the design, engineering, process engineering, control and integration. These are not directly transposable from one technology, feedstock or scale to another. Therefore the integrated BECCS systems cannot really be expected to present learning curves/cost reductions in the same way as more modular or manufactured systems would. Any projected learning curves that are postulated therefore need to be viewed with extreme caution. Evidence of this is available in the underpinning data behind the ETI's Biomass to Power with Carbon Capture and Storage report.

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:

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: