

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.

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: n/a

Question 2: How relevant are estimates of the remaining global cumulative CO₂ 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: n/a

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: The UK must continue to take a leadership approach, which in the first instance should include working towards the existing legislative target for net zero by 2050. Should global political and scientific consensus indicate that a swifter decarbonisation is required the CCC should recommend an earlier target to date to Government and revise the carbon budgets accordingly.

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: A revised and strengthened UK NDC will provide strong international signalling value, but this would be further fortified by an indication that without comparable efforts by all major economies there is merit in the UK pursuing policies which take account of GHG emissions associated with consumption.

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: A strong policy framework is essential to securing 'buy in' and positive action from consumers across the UK. The journey in emissions reductions should not be seen in isolation from the wider positive societal impacts. For example, there are currently 27 million homes in the UK, accounting for 14% of total UK emissions. The majority of UK housing has a D rating for energy efficiency (13 million homes), which can make bills £500 a year more expensive than those who live in an EPC A/B rated property. Poorly insulated homes are also contributing to extra winter demand pressures in the health service, which is estimated to cost the NHS £1.4 billion a year. Many businesses continue to operate in buildings where the amount of money they spend on energy could be reduced significantly by proactively investing in energy efficiency. The government should make energy efficiency a key infrastructure priority. By boosting the current ECO budget from £640 million to £2 billion, strengthening the regulatory framework, and incentivising energy efficiency through tax reliefs and preferable mortgage rates, the government would be signalling how every household can play a role in the 2050 target. We regard energy efficiency as an essential element of a just transition.

We believe that the emissions reductions targets will not be possible without a smart meter in every building in Britain as they will play an immediately crucial role in improving the energy efficiency of the UK's housing stock. The influence of smart meters and other flexibility technologies should encourage a power system that creates a flexible environment providing access to homes and businesses to input into that system, which Imperial College London estimates could save between £17-40 billion between now and 2050. The Government must help suppliers by announcing that from 2021, smart meter installations will move from an opt-in to opt-out regime. To further normalise smart meters and transition in an orderly way to a mandatory system, the following should occur from 2021:

- i) installation of a smart meter should become part of the eligibility criteria for any form of Government funding or subsidy.
- ii) installation of smart meters must be recognised as an integral tool in improving energy efficiency in buildings, therefore the installation of smart meters should be included in the energy efficiency criteria that all landlords and home-owners are required to meet.

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: One key uncertainty is the assumed cost reduction in low carbon technologies as they mature and become mass market. Tracking international cost curves for differing technologies as they mature would help HMG to manage this uncertainty (examples could include large scale energy storage, heat pumps, hydrogen and CCS).

With regard to low regret options we strongly urge HMG to prioritise investigation of opportunities to support domestic manufacture of low carbon solutions and the wider extent to which these can positively impact the UK economy through jobs, growth, export opportunities and the reduction of fossil intensive imports such as gas. The Government's strategy should therefore include strong and coherent support for low carbon innovation and R&D along with financial support and a beneficial taxation regime for those companies manufacturing low carbon solutions, such as heat pumps.

Another key uncertainty is public reaction to policies that deliver required changes. HMG's focus on a Just Transition (supported by the ongoing Treasury Review in this regard) is an essential strategy to ensure that citizens remain supportive of an ambitious climate agenda. Resultant policies must ensure that all sections of society face a fair share of transitional costs and are able to benefit from the opportunities of the transition.

The rate of transition to low carbon heat solutions creates significant uncertainty. HMG can help to alleviate this by removing an existing market distortion which serves to disincentivise low carbon heat investments. Currently, electricity pays its fair share of a carbon price, however other fuels such as gas and oil are currently able to avoid these costs for heating. A more balanced approach is required which means introducing a carbon price signal for oil and gas heating that rises over time. We would support the money raised being given back to customers via a rebate on their electricity bill. This is consistent with delivering a fair transition by protecting vulnerable customers, whilst creating greater certainty that the deployment of alternative low carbon heating systems can occur over a timeframe commensurate with net zero.

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: Yes. To the extent that the fourth and fifth budgets could be revised to facilitate a more cost effective transition to net zero they should be revisited.

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: Creating a flourishing energy efficiency market in the UK will have huge benefits. UKERC research shows that for every £1 invested by the Government in domestic energy efficiency, GDP can be increased by £3.20 and tax income is increased by £1.27; investing in energy efficiency could deliver a net benefit to the UK economy of £7.5 billion, with the full economic benefits of reducing energy demand by a quarter up to £47 billion.

In a briefing note to the NHS, 'The cost of poor housing to the NHS', the BRE estimate that poor housing costs the NHS £1.4 billion every year. Two hazards are responsible for 85% of the costs, excess cold (£848m p.a.) and frailty (£435m p.a.). The BRE estimate that "if we could find £10 billion now to improve all of the 3.5 million 'poor' homes in England, this would save the NHS £1.4 billion in first year treatment costs alone. It is estimated that such an investment would pay for itself in just over seven years and then continue to accrue benefits into the future."

It is not just energy efficiency that would have positive impacts on health. If action on climate change could contribute to a 1µg/m³ reduction in fine particulate air pollution in England over an 18 year period it could prevent around 50,900 cases of coronary heart disease, 16,500 strokes, 9300 cases of asthma and 4200 cases of lung cancer (Public Health England - Estimation of costs to the NHS and social care due to the health impacts

of air pollution). A significant improvement in air quality would also have benefits in promoting healthier lifestyles with more cycling and walking and as a direct consequence lower levels of obesity and other health consequences of an inactive lifestyle. HMG must bring forward the proposed ban on fossil fuelled vehicles from 2040 to 2030.

The opportunities from achieving net zero for employment are significant. In their recent report 'Building the Net Zero Energy Workforce' National Grid estimate that the UK's energy sector needs hundreds of thousands of people to fill 400,000 roles in the Net Zero workforce. Of these, 260,000 will be in new roles, while 140,000 will be replacing those who have left the energy workforce. It is estimated that c117,000 will be needed between 2020–2030. To facilitate this immense opportunity HMG must do all it can to encourage STEM skill development throughout schools, apprenticeships and universities.

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: HMG should look to substantially improve levels of energy efficiency by;

- Making energy efficiency a national infrastructure priority with weekly installation rates raised from c9k/week to 21k/week (driven through regulation)
- The current Energy Company Obligation should be trebled in size (to £2bn from £640m), reducing energy consumption and providing warm and healthy homes.
- Private rented sector regulations should be strengthened so that only buildings achieving at least EPC C by 2030 can be let to residential and business tenants.
- A supportive tax regime (including stamp duty and business rates relief) will encourage homes and businesses to invest in energy efficiency measures.
- Green Mortgages and other low cost finance should be made available for energy efficiency investments (backed by HMG guarantees to reduce risk for lenders)

On heat decarbonisation HMG should;

- Develop a successor scheme to the RHI with a new capital grant available to customers to replace gas boilers with low carbon alternatives.
- Government should set a phase out date of 2035 for the installation of new fossil fuel boilers progressively tightening efficiency regulations up to this date.
- A carbon price signal should be introduced for oil and gas heating (addressing a current market distortion. Revenue should be returned to consumers as a rebate on electricity bills.
- A new heat network regulatory framework complemented by a supportive planning system is required to drive up standards and create an investable framework.
- The Business Rates regime should also be fully aligned with the Government's Net Zero ambitions.

On the decarbonisation of electricity HMG should;

- Low carbon technologies including solar PV and battery solutions should be subject to a zero rate of VAT.
- New build housing standards should be tightened to unlock opportunities for onsite generation and storage.

- Imperial college have stated that the UK could save £17-40bn across the electricity system between now and 2050 by deploying flexibility technologies. The creation of a single system operator across transmission and distribution would represent the most efficient structure to realise these benefits.
- Future network charging reforms must better incentivise small scale energy solutions to enable consumers to participate in balancing, flexibility and ancillary service markets.

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: The CCC should seek to aggregate local area/city level climate targets and ensure that these are commensurate with UK's net zero target. These urban and city level targets also provide a useful guide as to the art of the possible. Government should look to benchmark national climate aspirations against the most ambitious local level targets where the anticipated decarbonisation activities are considered to be both credible and replicable.

We expect decentralised generation and storage to play a major role in decarbonising local areas and cities. Significant advantages include but are not restricted to the fact that decentralised generation is less capex intensive, quicker to build compared to large transmission connected power assets and shares growth opportunities around the UK (and is therefore aligned with a just energy transition).

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: Electrification of heat could reduce the UK's dependency on imported gas, this could be worth around £97.1bn to 2050. Annual saving from the reduction of gas demand for heat in 2050 is £6.4bn using 2018 as the baseline (this excludes gas demand for power generation). This has been estimated using the Community Renewables scenario from the National Grid future energy scenarios, DUKES and BIES published energy prices 2018.

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: In the Net Zero report (May 2019) the CCC recognised that policies must be designed to ensure that the distribution of decarbonisation costs do not disproportionately affect some groups. The costs of decarbonising heat in particular are inescapable, and so great care is needed when distributing how and where these costs fall.

At present, whilst the electricity used by heat pumps and resistive heating internalises a cost of carbon via the EU ETS and Carbon Price Support (CPS) rate, the gas used to fuel a traditional boiler (whilst covered by the effort sharing mechanism) does not internalise carbon. Nor does gas incorporate the same level of other environmental and social obligation costs as electricity. Failure to provide a level playing field between such technologies is ultimately working against our ability to deploy electrical low carbon heating

solutions. This market distortion must be addressed.

Introducing a carbon price for gas heating will be politically challenging, however it is possible to design a scheme which can address this. By way of example, as the income and heat consumption are strongly correlated, applying a modest hypothecated carbon tax on gas and returning a dividend back to customers at a flat rate is one potential progressive policy solution. A carbon price applied to domestic gas consumption and returned via a fully hypothecated carbon dividend (at a flat rate to all consumers) could reduce energy bills for those with lower disposable incomes. This would facilitate a just transition and improve the comparative economics of low carbon heating installations such as ASHPs.

Whilst it is possible to introduce reforms to internalise a cost of carbon and compensate a significant number of low-income energy consumers, even progressive taxation cannot ensure that every low-income household is compensated (financially vulnerable consumers are spread across all consumption quintiles). Other policy levers, including a significantly increased ECO4 must be used to target and support outliers to mitigate any financial impact from introducing a carbon price for gas.

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: n/a

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: n/a

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: n/a

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

ANSWER: n/a

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: It is essential that the Committee on Climate Change, Devolved Administrations and UK Government continue to work together closely to ensure that cumulative Greenhouse Gas Reductions remain commensurate with a cost effective UK trajectory to achieve net zero by 2050.

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: n/a

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

ANSWER: If we witness an inefficient adoption of autonomous vehicles this may result in an increase of road traffic. Fully Autonomous vehicles have the potential to broaden access to private vehicles allowing segments previously unable to drive (e.g. elderly and children) access to vehicles and thereby increasing traffic volume. In addition, autonomous

vehicle fleet operators' primary objective will be to optimise car journeys rather than ensuring that their fleets are charging at locations and times which are beneficial for the grid. To reduce the risks of an increase in vehicles on UK roads policy makers may wish to encourage the use of Autonomous Vehicles as an essential component of a ride sharing economy, rather than a private transport solution. If we do see a sectoral shift in transport towards to an Autonomous Vehicle Fleet approach, charging hubs that utilise decentralised energy and smart solutions to reduce energy costs (reduce grid upgrades and provide load management capabilities) are essential.

It is also important that public transport competes effectively with the Autonomous Vehicle Fleet Operators of the future. We have already seen trends in the UK for usage of public transport to be replaced by services such as Uber which increases road traffic. HMT's just transition review and a renewed focus on the need for greater infrastructure spending (particularly in the North) provides an opportunity to encourage commuters to utilise low carbon public transport. To make such behavioural change sustainable, HMG must also seek to ensure that all new public transport is affordable, clean, safe and that alternative forms of fossil transport appropriately internalise environmental and health damage costs.

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 public perception of charging infrastructure remains an issue. Whilst we believe the majority of charging will be done at home or the workplace, many drivers are delaying their purchase of an EV because of their beliefs on their requirement of public charging infrastructure. As such, regardless of the dominant charging location of the future, public charging infrastructure is vital to support adoption of EVs. However, the business case for EV Charging Operators remains uncertain. The UK must support the increase in further charging installations and just as importantly the maintenance and operation of these chargers must be maintained as a favourable public perception on chargers is essential. Similar challenges have been witnessed with respect to the Smart Meter roll out where public perception has acted as a barrier.

The impact of a trend towards 500-600 mile and beyond-ranged batteries must also be considered. The majority of public journeys in the UK will mean that a significant proportion of battery capacity will be redundant and unused. Policy makers may wish to consider what can be done to encourage manufacturers to utilise this spare battery capacity in smaller ranged cars, that are more affordable, thereby increasing the availability of EVs to the market and better facilitating a just transition.

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: n/a

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: It is essential that all sectors of the economy are protected from carbon leakage, but this does not mean that these sectors do not need to decarbonise. Exemptions from carbon costs (especially where policy costs are funded through domestic consumers) are unsustainable and not aligned with the concept of a just transition. Instead, we would urge government to continue to lead international efforts to ensure that all countries are internalising a similar cost of carbon (through whatever means). Where this is not occurring and UK sectors are exposed to competitors whom are not internalising an adequate cost of carbon, then Government may need to explore options for policies which protect the economy of the UK and address the GHG emissions associated with consumption (this could include a potential role for Border Tax Adjustments).

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: n/a

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

ANSWER: HMG can best facilitate a just transition for such sectors by providing certainty of when existing fossil fuel activities must become zero carbon (either through fuel substitution or carbon capture and storage). A cost-effective decarbonisation trajectory towards this deadline must then be supported by incentives/subsidies for hard to tackle emissions (recognising that low carbon solutions generally require a higher level of capex) and a regulatory regime which tightens through time in line with the fossil phase out target. Finally, strong carbon pricing signals for industry and expansion to other sectors like transport and buildings are necessary to ensure a fair burden-sharing of the costs and steer consumption patterns towards sustainable choices.

In transitioning the fossil economy there will inevitably be an impact on existing employment, however HMG has the opportunity to deliver a green industrial revolution by supporting investment in domestic low carbon supply chains. In addition, infrastructure investments can employ large numbers of blue-collar workers and develop people with STEM skills, providing employment across the UK. The IPPR estimates development of heat networks could create up to 81,000 jobs and generate up to £22bn in private investment into the economy.

This approach has clearly been successful in the power sector with a clear coal phase out date (2025) supported by increasing regulatory requirements for purchasing renewable energy and the application of a meaningful carbon price (in the form of the EU ETS and the Carbon Price Support Rate). A similar approach can be seen with respect to transport with an Internal Combustion Engine phase out date (2040, although we believe that this should be 2030) and increasing regulatory requirements on vehicle manufacturers and a pseudo carbon price (via Fuel Duty and VED regime).

At some point during the early 2020's the Government will also have to determine the future of the gas grid. However, a clear deadline such as that requiring all retrofit heating systems to be low carbon from 2035 supported by progressively tightened regulation of energy efficiency standards should sit alongside capital support for industry decarbonisation projects. HMG must also give greater thought as to how fossil fuels used for the purposes of heat (outside of the traded sector) can start to internalise the full cost of carbon.

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: n/a

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: Energy efficiency is a no regrets measure and supports far more than just emissions reductions targets: improving wellbeing, health, and boosting the local economy. Enabling home and business-owners to invest in their buildings and make those investment low carbon as soon as possible should be a priority for HMG.

In the domestic sector, it is clear that in the short term, there will be a continued requirement for financial incentives to persuade more customers to adopt lower carbon heating solutions such as heat pumps. We encourage HMG to move away from the current approach of providing payments over a long period of time to a new regime which is targeted at reducing the upfront capital cost. We recommend consideration of a fossil fuel heating scrappage scheme to deliver this outcome.

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: n/a

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: E.ON is building the world's first ectogrid at Medicin Village in Sweden. Ectogrid effectively takes the characteristics of heat pumps and cooling machines and combines them with energy distribution grids to provide all of the cooling and heating needs a city may have. The ectogrid at Medicin Village will connect 15 commercial and residential buildings with different heating and cooling needs. The current energy consumption is around 10GW of heating and 4GW cooling. When completed the system will use as little as 3GW of supplied energy. We would be delighted to meet with you to discuss our perspective on how schemes of this nature can be coordinated across local/regional governance structures.

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: As the most recent Contract for Difference (CfD) auction cleared at prices lower than current wholesale, it is unclear why a future power system should look to move away from this support mechanism. However, should Government decide that support via CfDs should be removed then an alternative could be to offer a mechanism similar to network capital recovery via a regulated asset base (RAB) payment.

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: Aurora Energy Research have previously suggested (June 2019) a 2050 generation mix that is far more weighted towards intermittent renewables than the CCC illustrative scenario with an annual capital investment in renewables of £4-9b pa for the

next 30 years, delivering a total of 259GW of wind and solar by 2050. Following this scenario would suggest an additional 37GW of wind and solar capacity being added to the generation mix by 2030.

Battery storage needs to include EV via V2G. It is also possible that hybrid heat pumps could be used as a fuel switching option under power system stress events. There have been multiple reviews of the potential for DSR across the years by Ofgem, BEIS and others. The most regularly updated analysis comes from NG ESO's Future Energy Scenarios. They offer a range of I&C DSR participation of 2-7GW by 2050.

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: n/a

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: n/a

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: n/a

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: n/a

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: n/a

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 CO₂?

ANSWER: n/a

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: One of the key factors will be the change in customer diversity factors on Low Voltage (LV) electricity networks. Currently, LV networks rely on customers not all using their full capacity at the same time to build smaller networks i.e. 10 customers with 16kW capacity are serviced by an LV network line rated at 50kW which is a 30% diversity factor. With the electrification of heat, customers are more likely to all turn on their heat pumps at the same time i.e. first thing in the morning thereby stressing the LV network far more than current diversity factors allow for.

High levels of pure hydrogen heating may require significant investment in old gas distribution networks that were not designed to transport hydrogen (hydrogen makes metal brittle). Whilst hydrogen can be blended with natural gas and transported with little impact on the current system, the need to deliver net zero means that blending cannot be the ultimate answer and that pure hydrogen would have to be used. At this point, a major upgrade of our entire gas system would be needed. As the level of existing heat networks is low, then national or local policy that makes heat networks preferable is required.

E.ON is also concerned that the development of distributed renewable generation is

outpacing the investment in distribution networks. We have seen many examples of projects being made unviable due to the significant network reinforcement costs that DNOs apply to applications for firm access. We recognise that the Access and Forward Looking Charges SCR is looking at this issue currently with the connection boundary being a particular focus. E.ON would support new mechanisms that will make access for renewable distributed generation easier, cheaper and quicker and that socialise the non-project specific costs of reinforcement across all benefitting consumers better. However, any new mechanism also needs to allow generators to be fairly paid for flexibility that they can bring to the network through fair and transparent markets e.g. flexibility markets.

Question 38 (Infrastructure): What scale of carbon capture and storage development is needed and what does that mean for development of CO₂ transport and storage infrastructure over the period to 2030?

ANSWER: n/a