Committee on Climate Change

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

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?

Others will be better placed to comment on this question.

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?

Others will be better placed to comment on this question.

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?

Others will be better placed to comment on this question.

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?

A revised and strengthened decarbonisation objective for the period around 2030 will send a clear and important signal of the UK Government's commitment to being on a credible trajectory to meet Net Zero by 2050. This international signalling should, in turn, help to

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promote higher ambition globally in the lead up to the UK hosting COP 26 in Glasgow.

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?

As the CCC highlighted in their advice to the Government on Net Zero, consumer behaviour will play a vital role in delivering emissions reductions. There are, however, some areas of the economy where limited consumer engagement is required, such as the further decarbonisation of the power sector. There are also some areas where there may be limited consumer engagement required beyond switching to low carbon technologies (such as the take-up of electric vehicles or electric heat pumps in new houses). The challenges around decarbonising heat in the existing housing stock are significant, however, and consumer behaviour will be important. The Government will need to develop a better policy framework that encourages households to take energy efficiency measures and install low carbon heating solutions; this framework will need to be a combination of regulation, fiscal incentives and the provision of information. For example, there is a well-understood issue around new heating systems being distressed purchases (eg when boilers break down) rather than planned ahead of time. It will, therefore, be important to focus any awareness-raising campaigns on issues such as this.

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?

Whilst there are some technologies that have the potential to become cost-effective, viable solutions in the future (and it makes sense to keep options open around their potential deployment), we consider that the Government needs to prioritise continuing with 'no regrets' steps in the 2020s based on the deployment of low carbon technologies that are already offering cost-effective practical solutions now and can be delivered through proven delivery mechanisms, such as onshore and offshore wind through competitive CfD auctioning on a regular basis. Likewise, there is a clear forward pathway for transport decarbonisation in a cost-effective way based on promoting the uptake of electric vehicles (EVs) at scale. However, in this context there needs to be further thought about the overall delivery framework in terms of deploying the necessary grid and EV charging infrastructure across the country in a timely way. For example, we agree with the recommendation in the CCC's Net Zero report around Ofgem giving greater focus to incentivising anticipatory investment in the network infrastructure which is needed to support a timely roll-out of EVs. Similarly, we agree that bringing forward the date for ending the sale of new petrol and diesel vehicles closer to 2030 would be a helpful step in terms of driving low regrets progress in this area. Further, in terms of energy efficiency schemes that run into the early 2020s, we consider that there is merit in considering how these might promote the uptake of heat pumps in off-gas grid properties as another low-regrets option.

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?

Moving to the net-zero target emphasises the importance of earlier action and it would seem to make sense to revisit the recommended levels of the fourth and fifth carbon budgets to establish whether there are any further abatement actions that can sensibly be taken in the next 12 years. In particular, we consider that there should be further consideration around the setting of the fifth carbon budget given the lead in time to the 2028-32 period. Moreover, we would expect the CCC to be considering these matters further in light of the UK's expected departure from the EU ETS at the end of 2020 as a result of exiting the EU (given the current approach to the traded sector in calculating the budget levels for the fourth and fifth budgets). As a minimum, we consider there needs to be a focus on the Government looking to over-achieve in respect of the existing fourth and fifth budgets through domestic action so as to get on track with a credible trajectory for progressing towards the Net Zero target in a timely way.

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?

Others will be better placed to comment on assessing and potentially quantifying the co-benefits associated with acting on climate change. However, we very much recognise the importance of taking into account these kind of co-benefits in considering the optimal decarbonisation pathway in progressing towards Net Zero by 2050. For example, there are clearly important air quality benefits associated with the roll-out of EVs (and the associated replacement of existing diesel and petrol vehicles), as well as potential economic benefits for the users of EVs. Likewise, in terms of improving the energy efficiency of the existing housing stock for those in or at risk of fuel poverty there are potential health benefits from such steps as well as economic benefits resulting from energy bill savings.

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?

We support the delivery priorities for the 2050 net-zero target that were outlined in the CCC's Net Zero advice. In particular, the need for Ofgem to incentivise anticipatory investment in network upgrades to facilitate the uptake of electric vehicles in the 2020s, and the continued need for auctioning of long-term CfD contracts in the future to support the continuing deployment at scale of offshore and onshore wind through the 2020s. More generally, we consider that there needs to be a focus on accelerating delivery through the 2020s, with appropriate policy action led by the Government and Ofgem, since we agree that there needs to be a ramp up in progress in the immediate years ahead so as to get on track with a credible pathway towards the Net Zero target.

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?

As we highlight in our recent Zero Carbon Communities report[1], we consider that local areas and cities etc have an important role to play in addressing climate change given that those local communities are very well placed to help identify the most cost-effective and practical low carbon transport and heating solutions in their area, as well as to promote and mobilise local action.

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?

In making progress with decarbonisation, one important way in which impacts on competitiveness and fuel poverty can be managed, in the first instance, is by focussing on the most cost-effective technologies and promoting those technologies through delivery mechanisms that are designed to minimise costs and indeed drive down costs over time. One striking example in this respect relates to the deployment of both onshore and offshore wind generation through competitive CfD auctioning.

Onshore wind is now the lowest cost technology for new electricity generation in the UK and we see substantial opportunities for the continued development of onshore wind projects in suitable locations in Scotland in a way that finds public support from local communities. Additional suitably located onshore wind projects in Scotland could deliver new capacity at very low cost using the CfD mechanism, ensuring that any impacts on electricity bills are minimised. Indeed, BVG Associates estimate that the net payback to consumers from five such CfD auctions (at a capacity each of 1 GW) could be around £1.6 billion over the 15-year CfD contract period[2].

Analysis for ScottishPower conducted by Arup in 2017, explored the value of a revenue stabilisation CfD in supporting low cost deployment of onshore wind in suitable locations.[3] Moreover, more recent analysis by Arup in 2018 highlights the value of revenue stabilisation via a CfD in increasing the appetite of investors and the availability of finance by limiting wholesale price risk[4]. The CfD mechanism improves project viability, enabling investment to come forward at a lower cost of capital, and thereby lowering the levelised cost of energy for an onshore wind project. (Arup estimates the scale of this benefit at £6/MWh- £12/MWh relative to the position where no revenue stabilisation is provided.) In short, we strongly agree with the CCC's assessment that competitively-awarded CfDs are an essential tool for securing finance in new renewable energy generation through the 2020s and delivering decarbonisation at lowest cost.

Recent cost reductions in offshore wind delivered through highly competitive CfD auctions, combined with the potential for new projects around the coast of the UK, demonstrate the highly significant role that offshore wind can play in meeting carbon budgets cost-effectively. In this context, we welcome the new Government's commitment to increase their ambition from 30 GW to 40GW of offshore wind by 2030 (as set out in the Conservative Party Manifesto and reiterated as part of the Queen's Speech legislative programme). To make progress towards meeting this higher ambition, it is important that the Government sets out the future programme for CfD auctioning on a regular basis, as

[1] ScottishPower, *Zero Carbon Communities*, October 2019
[2] BVG Associates, *The Power of Onshore Wind,* June 2018
[3] Arup, *Enabling Investment in Established Low Carbon Electricity Generation,* July 2017
[4] Arup, *Cost of Capital Benefits of Revenue Stabilisation via a Contract for Difference*, November 2018

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long-term industry planning is key to both growing the UK supply chain and continuing to drive down the costs of delivery through innovation and learning. Greater regularity of auctioning than we have seen in the past would be helpful and auctions should certainly be run at least every two years. Moreover, it will be important to move away from the capacity capping approach that was used in the last Pot 2 CfD auction (i.e. Allocation Round 3) so as to deploy at scale in a timely way and thereby grow the supply chain. This can be done whilst still managing costs through the use of Administrative Strike Price capping which takes into account the impressive clearing prices seen in the auction results last year.

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?

Developing the policy framework so that it delivers an equitable approach towards the transition to Net Zero is absolutely critical and so we welcomed the Government's decision to take forward a review of the distributional impacts arising from the costs of reaching Net Zero as recommended by the CCC in its Net Zero advice. We have identified a number of high level principles that the Government could consider as part of this important workstream:

- Funding social and energy efficiency policy costs (which are unrelated to electricity generation) through government spending rather than consumers' energy bills, given that recovering policy costs from energy consumer bills is regressive when compared to funding them from general taxation (as UKERC demonstrated in their 2018 report[5]).
- Ensuring that low carbon generation support mechanisms are, wherever possible, based on competitive auctioning and open to the range of technologies, to promote least cost decarbonisation (as outlined in our response to Question 11 above).
- Promoting a cost-effective and fair approach in encouraging consumer uptake of low carbon technologies, such as electric vehicles (EVs) and heat pumps. For example, it will be important to ensure that EV users are able to charge their vehicles at a similar cost, irrespective of their income or the characteristics of their home (such as whether or not they have off-street parking).
- Considering some re-balancing of policy costs and tax measures from electricity to gas bills to better reflect the "polluter pays principle". Electricity consumers currently bear a disproportionate burden of energy and climate change policy costs compared to gas consumers. This is likely to have some negative distributional impacts, as well as inhibiting the switch from gas heating to electric heat pumps.
- Facilitate engagement with local communities to identify and promote effective local solutions to low carbon challenges around transport and heat. This kind of engagement could also help to identify those local communities that are at risk of paying a disproportionately high price for low carbon transport and heating solutions from which they might not be benefiting in a fair way. Given that the optimal solution for transport (and heat) decarbonisation may vary widely from region to region, there may also be a

[5] UKERC, *Funding a Low Carbon Energy System: a fairer approach?*, 2 March 2018

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case for devolving certain functions and activities of the national economic regulator to a more local level. For example, a recent report by the think tank Localis[6], supported by SP Energy Networks, suggested that certain regulatory powers of Ofgem could be regionally devolved so that cities can better develop and promote smart infrastructure that supports the roll out of electric transport in their areas. A similar theme was highlighted in our more recent Zero Carbon Communities report.[7]

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?

As is recognised in the CCC's advice on setting the Net Zero target, the geographical nature of the dispersion of renewable energy resources is such that it makes sense for Scotland to have a more ambitious decarbonisation goal (in terms of timing) than the rest of the UK. Of course, in delivering upon any such differentiation on decarbonisation ambitions across the UK, the UK Government will need to put in place the right policy mechanisms to facilitate timely progress with meeting this, such as allowing established renewable technologies, including onshore wind, to participate again in CfD auctioning.

[6] Localis, *Smart Cities: Fair investment for sustainable growth*, January 2019
[7] ScottishPower, *Zero Carbon Communities*, October 2019

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?

Others will be better placed to respond to this question.

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?

Others will be better placed to respond to this question.

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

Others will be better placed to respond to this question. We would, however, highlight the potential for the further deployment of onshore wind and offshore wind at scale through CfD auctioning to support progress with decarbonisation in Scotland but also more widely across GB.

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?

Others will be better placed to respond to this question. In terms of the decarbonisation challenge across the UK, it is clearly important that the UK Government and the Devolved Administrations work closely together and, indeed, with other levels of government, as well

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as other institutions such as Ofgem. A co-ordinated approach reflecting high ambition on decarbonisation at all levels of government will be key in making timely and effective progress with the low carbon transition, as well as effective engagement with local communities. Whilst institutional fora might facilitate this (e.g. the existing Joint Ministerial Committee), there is also a need for ongoing day-to-day contact between those working in the various institutions of government.

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?

Others will be better placed to comment on this question.

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

Others will be better placed to comment on this question.

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?

The provision of a comprehensive electric vehicle (EV) charging infrastructure across the country will be key to the objective of phasing out conventional car sales by 2030. To facilitate an effective and timely EV charging point roll-out, it will be important to promote the potential role for anticipatory investment in electricity networks, as recognised by the CCC in the advice to Government on a 'Net Zero' target (and, as is recognised in the National Infrastructure Commission's National Infrastructure Assessment). We agree that it is important that grid capacity constraints do not impede the growth of EVs in the 2020s and, accordingly, that it will be important to facilitate anticipatory investments to upgrade electricity networks (including by the option of re-opening the allowed investment pathway through the 2023-2028 regulation period (i.e. RIIO ED2)) so as to ensure timely upgrades. We are strongly supportive of this kind of approach. More generally, we consider that further thought needs to be given to how best to ensure that appropriate charging

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?

infrastructure reaches into all parts of the country in a timely way, with a particular need to consider 'hard-to-reach' areas. In this context, it will be important to optimise the role of DNOs building on their knowledge and expertise.

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?

Whilst others will be better placed to comment on the different technological solutions for decarbonising HGVs, if electrification emerges as the most attractive and cost effective solution, as it has for lighter vehicles, it will be important to consider the potential role for anticipatory investment in electricity networks (as we outline in our response to Question 20 above), to facilitate the timely provision of a comprehensive electric vehicle (EV) charging infrastructure for these types of vehicles.

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

We are strong supporters of robust carbon pricing as a key tool in promoting a cost-effective transition to a low carbon economy. In particular, we have strongly supported the UK Government's approach to carbon pricing to date, based on participation in the EU Emissions Trading Scheme (EU ETS) complemented by the Carbon Price Support (CPS) tax in Great Britain. It is important to recognise that the CPS tax (currently set at the rate of £18/tCO2) has been a key driver of the coal-to-gas switch needed for the low carbon transition (consistent with the Government's commitment to removing unabated coal from the system by 2025). Accordingly, we welcomed the announcement at the Autumn Budget 2018 that the Government will maintain the existing CPS rate of £18/tCO2 for 2019/20 into 2020/21 and we would like to see this rolled forward into 21/22 at the next Budget on 11 March 2020. We consider that continuing to use the CPS tool to maintain a strong and effective carbon price into the early 2020s will remain crucial in terms of sending the right signals in both the power sector and in the manufacturing sector.

Looking to the future, we support the work underway across Government to develop the option of a UK ETS scheme linked to the EU ETS upon the end of the UK's current Brexit transition period ending on 31 December 2020. In this context, we have also welcomed the near term contingency planning by the Treasury for an alternative Brexit scenario based on

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the commitment (as set out in the 2018 Autumn Budget) to introducing an additional Carbon Emissions Tax (CET) at £16/tCO2 from the point of exiting the EU ETS alongside the current CPS tax. These long-term plans should enable the UK Government to deliver upon its commitment (as set out in the Clean Growth Strategy) to maintaining a total carbon pricing position that is at least as ambitious as current plans.

Lastly, we note the importance of the Government continuing to monitor and assess the possible implications of exploratory work at the EU level around carbon border adjustment taxation.

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?

Others will be better placed to respond to this question.

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

As the first major integrated company in the UK to be generating 100% green electricity, based on our position as a leading developer of offshore and onshore wind, we successfully exited some years ago from coal generation and, more recently, we transferred our gas generation assets in a sale transaction to a third party. At all stages of this process, we have engaged closely with our workforce both individually and through the trade unions with a view to managing change in a way that promotes future employment opportunities and facilitates a just transition. Looking forward, we are committed to playing a leading role in progressing towards meeting the 'Net Zero' challenge with a focus on renewable energy, smart grids and helping to drive the transformation to a cleaner, electric future. We are investing over £7 million every working day in the UK to make this happen – investing a record £2 billion last year in renewables generation and electricity network infrastructure that will help the UK meet its decarbonisation goals whilst delivering jobs and economic benefits. To sustain progress in this way with clean growth, it will be vital for the UK Government to ensure that it plays its part in maintaining a stable and effective regulatory and investment framework. For example, maintaining momentum with a forward CfD auctioning programme into the 2020s (for offshore and onshore wind) will be key. Likewise, it will be important that Ofgem, as economic regulator, plays a positive role in setting out an effective investment framework through the networks prices control mechanisms that it is responsible for.

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)?

Others will be better placed to respond to this question.

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?

a) Delivering the energy efficiency measures and the low-carbon heating required to meet the Net Zero target will certainly be challenging, however, it is vital that the UK Government acts now to accelerate progress with this. In terms of making progress with delivering energy efficiency measures in the 2020s, we consider that there needs to be a focus in the near term on three fronts:

(i) Making a shift towards funding support for domestic energy efficiency measures for those in or at risk of fuel poverty through government funding (rather than consumer bills) so as to minimise negative regressive impacts;
(ii) Considering the scope for further smart regulation such as by strengthening the existing regulatory regime in the Private Rented Sector;
(iii) Considering ways of growing an energy efficiency market in the able-to-pay sector through a mix of incentives, better information, and smart behavioural 'nudges'.

As regards making progress with heat decarbonisation, we welcome the Government's commitment to publishing a long-term 'roadmap' later this year. However, we agree with the CCC that there also needs to be a near term focus on taking the kind of 'low regrets' steps which can help with progress now.

For example, we think that there is scope to consider ways of better taking advantage of existing technologies (such as ground source and air source heat pumps). Promoting the deployment of these technologies in off-gas grid properties (where they are most economic) could help to drive technology and installation cost reductions (as we have seen through the deployment of offshore wind).

In promoting these technologies in this way, there will also be an opportunity to consider and explore how to realise overall system benefits in a holistic way in any given local area. For instance, a more efficient and flexible solution that provides thermal storage and facilitates cyclical loading could help in diversifying the overall demand and limit the upstream reinforcement and wider system costs. Furthermore, thermal storage becomes a much more attractive proposition where the fabric of a building is highly thermally efficient. In these cases, it is likely that the hot water demand will create the system peaks rather than space heating load and an efficient storage solution can help in shifting demand to a

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different time of day. These storage technologies could also support the future integration of EVs as they can better work together to limit the peak demand through local control systems that regulate the net demand.

b) As pointed out in the CCC's advice on a Net Zero target, behaviour change will play a key role in the transition to Net Zero. As such, government at all levels might work together in considering the role for smart public awareness campaigning to promote steps that both individuals and organisation can take. Of course, there are many practical challenges in this area as is recognised by the CCC. For instance, there is a well-recognised issue around new heating systems being distressed purchases (eg when boilers break down) rather than being something that households plan ahead for. Addressing such issues through appropriate communications strategies will need to go hand-in-hand with policy development.

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?

We are confident that the right skills to enable widespread retrofit and construction of low-carbon buildings could be developed if the supply chain has sufficient confidence that the market is going to expand, though we recognise that a significant amount of re-skilling will need to be done. More specifically, we would highlight the following challenges, particularly with respect to the heat pump supply chain:

- Installers often perceive accreditation to registered bodies to be expensive and this can put many off either gaining or renewing licences while installation volumes are low.
- Those working with split heat pump systems require additional refrigerant qualifications, adding further cost and installation complexity.
- College training often does not cover in enough detail the more particular elements of heat pump design – for example, accurate sizing and heat loss calculations. This is not an issue with boilers, but detailed heat loss calculations are needed for adequate heat pump system design.
- A strong 'back office' design service is one area where there could be an opportunity for more companies to participate in the supply chain and offer value to the sector as a whole.
- Commissioning is another issue – manufacturers still often send a representative to ensure the job is properly commissioned, possibly reflecting a lack of confidence in the skills of installers.

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?

We consider that a national heat policy framework is needed to coordinate and inform actions at a local level and we therefore look forward to the UK Government publishing its long-term Heat Decarbonisation Roadmap later this year. However, we also recognise that appropriate heat decarbonisation solutions may vary across different localities. Indeed, as is highlighted in our recent Zero Carbon Communities report[8], we consider that it will be important to work closely with local communities in developing the most effective strategies for heat decarbonisation in any particular locality.

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?

As mentioned in our response to Question 11 above, competitive auctioning of the CfD instrument has been very successful at bringing on low carbon generation at the lowest cost to the consumer, as well as driving down costs over time. Moreover, inspite of the significant cost reductions seen in renewable electricity generation technologies, we strongly consider that CfDs still have an important role to play in providing a revenue stabilisation mechanism that is needed to promote further deployment of renewable generation (such as offshore and onshore wind) at scale through the 2020s. The need for a revenue stabilisation mechanism is amplified by uncertainty around the future power price resulting from increasing volumes of zero marginal cost intermittent renewable generation coming on to the system.

Analysis for ScottishPower conducted by Arup in 2017, explored the value of a revenue stabilisation CfD in supporting low cost deployment of onshore wind in suitable locations.[9] Moreover, more recent analysis by Arup in 2018 highlights the value of revenue stabilisation via a CfD in increasing the appetite of investors and the availability of finance by limiting wholesale price risk[10]. The CfD mechanism improves project viability, enabling investment to come forward at a lower cost of capital, and thereby lowering the levelised cost of energy for an onshore wind project. (Arup estimates the scale of this benefit at £6/MWh- £12/MWh relative to the position where no revenue stabilisation is provided.) In short, we strongly agree with the CCC's assessment in its Net Zero report that competitively-awarded CfDs are an essential tool for securing finance in new renewable energy generation through the 2020s and delivering decarbonisation at lowest cost.

[8] ScottishPower, *Zero Carbon Communities*, October 2019
[9] Arup, *Enabling Investment in Established Low Carbon Electricity Generation*, July 2017
[10] Arup, *Cost of Capital Benefits of Revenue Stabilisation via a Contract for Difference*, November 2018

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?

a) As mentioned in our response to Question 11, we consider that well-proven and cost-effective renewable electricity generation technologies (including offshore wind, onshore wind and solar) have the potential to play a highly significant role in both the 2030/35 generation mix and the 2050 generation mix. This was rightly recognised by the CCC in its advice to Government on Net Zero. It was also recognised by the National Infrastructure Commission in its National Infrastructure Assessment in 2018, where their modelling showed that 'delivering a low carbon electricity system for 2050 powered mainly by renewables is a low-cost option'.

b) In terms of the potential role of flexibility options, interconnection, battery storage and flexible demand in a future low carbon energy system, we consider that these will all have a role to play. In this context, however, it will be important to ensure that there is an appropriate level playing field across the range of technologies so that market forces can be harnessed to promote the least cost mix. From our perspective, we are looking to invest in on-site battery options to complement our existing onshore windfarm capacity with plans for a 50 MW battery installation at our large-scale onshore windfarm at Whitelee outside Glasgow; we believe that these kinds of developments could significantly help in optimising system management in a high renewables energy mix.

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?

Electrolysis, which has the potential to be a cost-effective source of 'green' hydrogen in the future, has two key benefits: (i) it does not have any of the production-related residual carbon emissions associated with blue hydrogen (hydrogen produced using steam methane reformation, SMR, combined with carbon capture and storage); and, (ii) it can use excess renewable electricity at times of high renewable output, thereby helping to integrate intermittent renewables onto the system. We would therefore be supportive of further consideration of the potential ways in which this might be explored further in terms of its potential benefits for facilitating a low carbon transition. That said, we think that the CCC and the Government has rightly recognised the need for much more detailed analysis and careful consideration around the potential role for hydrogen in a future low carbon economy.

For instance, we consider that the decarbonisation of transport and heat can be tackled in the near term by making use of more mature technologies, such as electric vehicles (EVs)

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and heat pumps (combined with a decarbonised power system with a high proportion of renewable generation). There are, however, some niche areas, such as heavy industries and heavy road transport, which are difficult to electrify with current technology. Hydrogen-based technologies, as well as other low carbon gases (such as ammonia for shipping), could play an important role in these niche areas.

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?

Others will be better placed to comment on this question.

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?

Others will be better placed to comment on this question.

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?

Others will be better placed to comment on this question.

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?

Others will be better placed to comment on this question.

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?

Others will be better placed to comment on this question.

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?

Where a typical domestic property moves from gas to electric heating, then the electricity demand could double or even triple from its current levels (excluding any impact from decarbonisation of transport). The key factors that will determine whether electricity network investment is required include:

- Service position: It has historically been common for a service cable feeding one property to be looped into another property; this is termed a looped service. Introducing electric heating to a property with a looped service is very likely to exceed the capacity of the looped service cable.
- Clustering: If several properties in a non-rural area move to electric heating, then the cables and/or substation serving those properties may need to be upgraded.
- Rural properties: In rural areas, even 1 or 2 properties moving to electric heating could require network investment as they may be connected to small substations/transformers that are only rated for 1 or 2 properties at current load.

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?
Others will be better placed to comment on this question.

ScottishPower
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