Committee on Climate Change

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

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

Background to the UK's sixth carbon budget

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

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

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

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

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

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

Background to the Welsh third carbon budget and interim targets

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

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

Question and answer form

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

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

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 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: 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: n/a

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: n/a

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 joint DNO/GDN project, Green City Vision (2019) explored the role and extent that different players could make in reducing emissions. Based on Swindon, this ranged from what the consumers could achieve in energy reduction terms in the extreme, but concluded what contribution consumers had to make in a balanced scenario between

industry, domestic consumers and supply of green energy (both gas and electricity). This followed the WWU project to understand consumer willingness and ability to pay to decarbonise heat in their homes in Bridgend. It concluded that 80% were either unwilling or unable to pay. Combined, these two pieces of research indicate that reliance on consumer actions has a high risk of failure. WWU Pathfinder+ simulator was used in Green City Vision to assess the impact of consumer actions and the Bridgend research calculated the incentives needed for typical UK cohorts to change and act.

See:

https://www.wwutilities.co.uk/media/2718/integrated-gas-and-electricity-networks-support-the-journey.pdf

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: A key uncertainty is the discrepancy between the population's concern for the environment and their willingness to act. A simple example is poor recycling rates for household waste. Despite overwhelming concern for the environment in opinion polls, many do not follow simple recycling guidance at no cost to them. It is evidence that options and approaches that minimise disruption, cost and inconvenience should be favoured when they are 'no regrets'. Examples are greening the electricity and gas supply, which consumers don't notice. Similarly, when it comes to changing home heating systems, those with the lowest impact and disruption should be favoured by government incentives and policy. The following 'order' has been described via the WWU disruption index, starting with the least disruptive:

1. Do nothing – leave the boiler and feed with biomethane

2. Fit hydrogen ready boiler in advance of a switch to hydrogen as part of routine boiler exchange

3. Retrofit air source heat pump to the existing central heating system to create a hybrid heating system

4. Fit a hydrogen boiler at the point of hydrogen change over

5. Fit full heat pump system in place of existing central heating system

6. Install heat network and fit heat exchanger in place of boiler

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, the CCC must revisit these budgets in light of net zero target.

Smart grid-aware hybrid heating systems analysed in a whole energy system context, using our Pathfinder energy balancing tool with hour by hour profiles of demand and supply, offer a low-regret, quick way to make rapid progress in decarbonisation of domestic and commercial buildings. This is also evidenced by the Freedom Project. We agree with the CCC's 'Hybrid First' principle.

Consideration should be given to the transfer, or upstreaming, of emissions from one sector to another during a rapid transition to a low carbon whole energy system, such as perversely burdening power generation with more emissions than have been saved in buildings, An example would be the increased electricity demand from heat pumps being met by dispatchable power generation with emissions that can't be overcome by the live efficiency of the heat pump, resulting in higher emissions than a gas boiler using fossil gas. A smart hybrid heating system can manage a minimum heat pump efficiency to avoid such an imbalance of transferred emissions whilst allowing heat pumps to be deployed urgently at scale. We estimate that minimum COP for heat pumps should be 3.5 to manage this issue.

The 'Pathways to Net Zero: Decarbonising the Gas Networks in Great Britain' report by Navigant studied the role that low carbon and renewable gases could play in a transition to a 2050 net zero energy system. Using a Balanced Scenario, they used the carbon budgets as currently defined for the previous 80% target to estimate the carbon budgets required to reach net zero in 2050. These budgets focused on four of the largest emitting sectors in GB: buildings, power, industry and transport.

Gas-related emissions from the four sectors were modelled in the analysis. Almost all gas-related emissions along the Pathway arise from consumption of natural gas, which reduce over time with increasing supplies of biomethane, BioSNG and hydrogen (green and blue). Some limited emissions from blue hydrogen remain in 2050, but are balanced by negative emissions from biomethane and BioSNG production coupled with CCUS.

See:

http://www.energynetworks.org/assets/files/gas/Navigant%20Pathways%20to%20Net-Zero.pdf

https://www.wwutilities.co.uk/media/2829/freedom-project-final-report-october-2018.pdf

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: One example of co-benefits is through the decarbonisation of agriculture with AD, which supports the decarbonisation of energy - providing molecules that can be injected into the gas grid and flexibly stored and released for of heat and/or power and/or transport. This is already happening and needs to accelerate. Inefficient, inflexible biogas CHP needs to transition to gas grid entry since co-generated heat (5.2 TWh out of 8.5 TWh) is mainly vented to atmosphere (ADBA, 2018 data).

AD of waste water could offer a significant net energy benefit and is being trialled at the moment by Welsh Water and Severn Trent. A lot of energy is currently used to aerobically treat waste water, which wastes a great deal of energy potential. GB net benefit from moving to AD of waste water could be in the order of 25TWh/year (~10TWh saving and ~15TWh supply) - further investigation is needed, including funding the cost of waste water

treatment technology transition.

Developing new industries for hydrogen and CCUS to help decarbonise industry, heat, power and transport presents wide-ranging co-benefits of local jobs, supply chain opportunities and the reinvigoration of industrial regions, such as one of the most heavily industrialised areas across south Wales.

Committing to, for example, support to develop low carbon steel where hydrogen replaces fossil fuels currently used in the coking and blast furnace processes retains direct and indirect jobs in the UK, secures a UK steel supply and avoids offshoring of emissions to be someone else's problem and provides a globally exportable model.

Clearly, one of the most obvious co-benefits to decarbonisation of transport is the improved air quality in built-up areas, through the ramp-up of EV uptake and the transition of buses and heavy goods vehicles to biomethane and hydrogen. Although the transfer of demand from hydrocarbons filling up ICE vehicles to electricity to charging EVs results in upstreamed emissions from power generation, these emissions are lower than those released from ICE vehicles and air quality is much improved around where the vehicle is used.

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: The following would be important:

• EV Charging – By 2030, over 10 million EVs could be on the road and the estimates of charging infrastructure in the 30,000 mark will be a factor of 100 too low, especially if smart charge/discharge is needed for flexibility. V2G can't happen if the vehicles are not consistently connected to the network.

• Compressed gas (methane or hydrogen) filling stations in all cities and large towns.

• Enabling biomethane entry onto the existing gas grid – providing capacity via smart control of networks and compression to higher pressure storage systems

• Flexible power generation – as coal and nuclear decline rapidly by 2030, balancing a big increase in renewable generation will require multi hour/day flexibility. Short term storage and demand flexibility will not be sufficient to keep the power grid balanced, and hence low capital cost generation such as gas engines are likely to be the most feasible solution. Investment to enable this will be essential.

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: Advice regarding targets/ambitions for UK local areas, cities, city regions, growth areas, powerhouses, combined authorities etc needs to be clear on policy that achieves net zero and not carbon neutrality. Carbon neutrality is easier to achieve but at a much higher cost. Investing in best value generation assets outside of local areas should be encouraged; for instance a share of offshore wind with a very high capacity factor rather

than onshore wind with a much lower capacity factor, or even worse, solar with an even lower capacity factor and a seasonal performance that is diametrically opposed to heat demand.

Investing in the easy, local carbon neutral options like solar and heat pumps requires back-up generation assets to be invested in for the winter, since the peaks of heat demand and solar generation occur at different times of year. Wind is the best cross-season match for electricity demand, and critically works in winter, albeit with windless periods that need an economic low load factor dispatchable back-up for power demand, such as gas peaking plants, and stored decarbonised gas for heating, such as boilers in smart hybrid heating systems.

The work we did to support the Cornwall Energy Island project, which used the first iteration of our Pathfinder model, shows the need to consider hourly supply and demand profiles - highlighting the risk of annualised planning with regards to forecast blackout hours/storage deficit/supply capacity shortfall etc, which highlights the additional costs to balance an imbalanced energy system.

We have shared the Pathfinder whole energy system model with local energy groups to run scenarios and identify the actions they can take to reach net zero affordably.

See:

https://www.wwutilities.co.uk/media/2610/cornwall-hlp-project-summary.pdf

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

ANSWER: Hybrid heating systems can optimise based upon cost, switching between renewable electricity with the heat pump and decarbonised gas with the boiler, to always guarantee lowest cost heat - a benefit to fuel poor households and all other consumers cohorts.

Heat services with hybrids also open the opportunity to aggregate demand and use domestic properties in fast frequency response services, particularly with high value indefinite turn-off within seconds across the portfolio. Pre-heating services can also add value to households to efficiently use surplus wind rather than generation being curtailed.

Hybrids also limit the costs of installing significant measures of building fabric efficiency, which is needed for stand-alone low temperature heat pump systems, and can be installed with natural gas, LPG or oil boilers today to have an immediate benefit without the prerequisite of any fabric improvements.

Hybrids reduce the degree of electricity network reinforcement that would otherwise be needed to fully electrify heat, and allow their capacities to be better utilised - with capacity signals to switch over to the boiler in high demand periods, or during increasing extreme weather events from climate change that may impact upon local electricity distribution. Hybridisation can be considered an adaptation to climate change, as well as a mitigation action.

Smart, grid-aware hybrids also reduce the required ceiling capacity of low carbon

generation and back-up generation assets. This saves the need to have more wind generation capacity than necessary to support the peak demand periods, which would come at a high levelised cost from a low load factor. Electrical batteries cannot cope with the demand ramp-up and length of peaks that would need to be covered, and even the most optimistic cost reductions for battery storage of electrons are exorbitantly more expensive than storing decarbonised gas molecules in the UK gas system. The gas system can be used as the flexibility and storage asset as the back-up for hybrids in periods of low wind, peak heat demand and to manage any electricity distribution network constraints.

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: As a start, the just transition needs to begin with the lowest cost pathway to net zero. Options for how this is financed in the fairest way will take careful planning, however we provided options to Ofgem in our recent Business Plan submission.

We consider the pros, cons and who pays with energy supplier obligations, delivery provider auctions, gas and electricity network obligations, ECO bank funding and a network-led roll-out. Network led roll-out.

A network-led roll-out is a new approach where networks lead the installation of innovative measures to eligible households, would be funding through RAV and paid back over a lifetime of, for example, 45 years (included in the capex element of network charges). Networks are experienced in delivering major projects and are delivering exceptional standards of customer service.

See our Business Plan here, especially the net zero chapter and page 125 specifically for the financing options table:

https://www.wwutilities.co.uk/media/3567/3-wwu-business-plan-december-2019.pdf

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: With respect to the emissions pathway for Wales, renewables within Wales are not cost competitive compared to offshore, high capacity factor wind in the North Sea. Scotland and England have the benefit of better performing renewable generation, whereas Wales counts the emissions for, and is therefore penalised by, being the location that balances the intermittency of renewable supply with flexible generation for Scotland and England. Wales targets should reflect interconnection with England. Scotland relies on gas generation in Wales as much as Wales relies on wind generation in Scotland across the GB grid – regionalising carbon emissions is not appropriate and drives expensive local policy and decisions.

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: The Welsh Government set up a Decarbonisation of Existing Homes Advisory Group to report to them on the ways in which Wales can take urgent action over a 30 year programme to decarbonise the existing housing stock. This looked across the different tenures, fuel poverty, the able-to-pay cohort and dwelling types and ages, as well as quality assurance, home log books, the role of communities, behaviour change and pushing ambition. One of the emerging themes to follow on from this work is the emerging policy development for Optimised Retrofit, which is seeking to navigate a way to deliver lowest cost net zero-ready homes. This net zero-readiness being achievable through the optimisation across three key low-regrets areas:

- economic fabric retrofit – installing 'tier one' measures in a whole-house approach which does not lock-out further tiers of fabric retrofit in the future, if required or desired.

- installation of smart, efficient heating systems, which for existing homes is expected to be dominated by hybrid heating systems.

- supporting the decarbonisation of gas and electricity grids.

Welsh Government ambition is to test Optimise Retrofit at the building level in a few thousand homes with fabric and technology improvements which are within their devolved powers, whilst continuing to lobby for decarbonised grids.

See

https://gov.wales/sites/default/files/publications/2019-07/independent-review-on-decarbonising-welsh-homes-report.pdf

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: Adopting the 'hybrids first' principal will set Wales on a pathway to net zero (their ambition beyond the 95% which was recommended) and tackle heat with urgency.

The HyHy Project is a feasibility study for Cardiff that is currently in progress. It is using Pathfinder for whole energy systems modelling and is delivering household energy bills for heat, power and transport, which for heating combines hybrid systems with the supply of hydrogen. The project is developing a series of outputs to complete net zero for Cardiff by 2050, including the capacities and economic balancing between hydrogen production and storage and the profile of carbon to be captured and shipped for storage.

Beyond the scope of the HyHy Project, we are going to take some next steps to carry the learning into a whole-Wales model and backtrack from 2050 to the different carbon budgets. The net zero baseline modelling scenario will be further adjusted to be more Wales-specific (with/without nuclear and/or marine energy). Hybrid penetration and growth in wind power can then be used to help inform actions to meet interim targets.

Also note the live project 'Zero 2050' led by National Grid ESO, which involves a wide range of stakeholders. This project is using the Pathfinder model to integrate heat, power and transport to inform action needed for south Wales to achieve net zero.

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: Coordination needs to be effective across UK and devolved decisions to achieve the best outcomes. UK decision making needs to deliver policy to decarbonise gas and electricity grids to complete the three-pronged approach of Optimise Retrofit (see response to Q12).

As also outlined in the response to Q13, emissions accounting for power generation needs to be reviewed for fairness across GB, since Wales hosts flexible generation to balance supply in England and Scotland, yet suffers from lower capacity factor wind opportunities than those presented in the North Sea. Scotland relies on gas generation in Wales as much as Wales relies on wind generation in Scotland across the GB grid – regionalising carbon emissions is not appropriate and drives expensive local policy and decisions.

Referring again to the issue of net zero vs carbon neutral, which was outlined in our response to Q10, carbon neutral is easier to achieve but at a much higher cost. As an example, investing in the easy, local carbon neutral options at a local level with solar generation and heat pumps will work for carbon neutral, but in reality requires back-up generation assets to be invested in for the winter, since the peaks of heat demand and

solar generation occur at different times of year – hence the higher cost to then net zero these carbon neutral decisions.

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: n/a

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: With regards to adverse consequences specific to EVs, our whole energy system modelling has shown that there's not enough renewable generation being deployed quickly enough - and so EV charging will come from fossil generation much of the time during this transitionary period. The Green City Vision project, undertaken collaboratively between Wales & West Utilities, SSEN and UKPN, demonstrated that EVs were a bigger impact than had been expected, however this impact was eased by offloading demand from HGVs and buses to decarbonised gas.

Our response to Q8 explained that although the transfer of demand from hydrocarbons filling up ICE vehicles to electricity for charging EVs results in upstreamed emissions from power generation, these emissions are lower than those released from ICE vehicles and air quality is much improved around where the vehicle is used.

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: Wales & West Utilities are a fleet operator – and while we are encouraging the uptake of EVs and providing charging infrastructure, electrification of our heavy vehicles is out of the question. Hydrogen offers the easiest transition for a wide range of our heavy vehicle fleet. From observing the challenge of installing overhead lines for the electrification of some of the railway lines, the infrastructure challenge to do the same on roads would seem to be a challenge too far, even when only considering the number of bridges that would need to be raised, as well as the batteries needed to deal with payloads off the main trunk roads.

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: n/a

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: n/a

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: 2050 remains an incredibly ambitious but realistic date to achieve net zero for heat in buildings with energy efficiency and low carbon technology. As energy networks, we can be ready much sooner than that - with our Business Plan targeting net zero-readiness by 2035. The challenge of delivering on supplies of renewable electricity and decarbonised gas, as well as having made improvements to the energy efficiency across all of the housing stock will likely need every day available. Hybrid heating is a way of ensuring greatest flexibility to deliver net zero for heat in buildings as quickly as possible and at lowest cost, least disruption and with limited behaviour change - with progress simultaneously pushed with heat pump and hydrogen-ready boiler deployment, biomethane and hydrogen production, CCUS development and growth and offshore wind growth.

As outlined in the response to Q7, consideration should be given to the transfer, or upstreaming, of emissions from one sector to another during a rapid transition to a low carbon whole energy system, such as perversely burdening power generation with more emissions than have been saved in buildings. An example would be the increased electricity demand from heat pumps being met by dispatchable power generation with emissions that can't be overcome by the live efficiency of the heat pump, resulting in higher emissions than a gas boiler using fossil gas. A smart hybrid heating system can manage a minimum heat pump efficiency to avoid such an imbalance of transferred emissions whilst allowing heat pumps to be deployed urgently at scale. We estimate that minimum COP for heat pumps should be 3.5 to manage this issue.

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: It would be a very simple to update training and qualifications for the existing fleet of Gas Safe Registered (GSR) engineers to fit hydrogen-ready and hydrogen boilers. It is also relatively simple to upskill this workforce to be able to install heat pumps in hybrids. Subject to the deployment and smart control testing of single unit hybrid heating systems with only a gas connection to make, there would be no skills gap for the existing GSR engineers in delivering this solution.

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

ANSWER: The governance model needs to always hold together the whole energy system and not attempt to manage each aspect in isolation. The net zero vs carbon neutral issues, typically at local/regional levels, need to be overcome (see responses to Q10 and Q17).

Welsh Government are taking strides in understanding and exploring decarbonisation through an integrated, multi-vector, whole energy system across heat, power, transport and industry. As discussed in our responses to Q14, Q15 and Q17 – the emerging approach to decarbonising existing homes through Optimise Retrofit and their leadership in the Zero 2050 project are examples of Wales pushing ahead as exemplar on whole systems.

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 renewable penetration increases, traditional markets will tend to fail as utilisation decreases and constraints radically increase. The whole energy system needs to become a national asset operated on a model that rewards the provision of the asset and its capacity, rather than its production. In such a scenario, RAB based models used by the distribution and transmission networks may be more appropriate.

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:

a)

The no regrets generation mix for 2030 should be dominated by wind. It is required in all scenarios and most importantly, delivers energy in the winter when energy demand is highest. Solar soon reaches a point where additional generation will be constrained, made worse by increasing wind which still generates in the summer. Wind generation also complements a hybrid solution for heating, absorbing as much wind energy as the generation mix can deliver. This produces early heat and power emission reductions.

Moving into the 2040s and 2050s, the reducing cost of hydrogen through electrolysis provides an alternative to Gas CCS using hydrogen for generation. WWU Pathfinder+ simulations indicate very intermittent gas back up generation, with load factors dropping beneath 10%. (Hydrogen via electrolysis heading to £70-90/MWh due to falling electricity prices and electrolyser cost reductions – with wind dropping towards £20-30/MWh, hydrogen could drop to £40-60/MWh).

b)

i. Hydrogen powered generation is an emerging possibility as flexible demand and battery storage are soon exhausted in winter during low generation periods. Increased flexibility can be provided by hybrid heating systems, both absorbing excess renewable generation, but switching to gas (biomethane or hydrogen) for extended periods of renewable generation deficiency.

ii. WWU has completed multiple simulations using Pathfinder and Pathfinder+ whole energy system models. As a whole system simulation, it includes the ability to utilise V2G, demand reduction, storage etc, revealing the increasing sensitivity to weather conditions. The SSEN/WWU/UKPN Green City Vision also examined some of the practical elements of scenarios, such as increased local peak demand and loss of inertia on the system.

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: The demand for solutions around industry will be a key driver for further hydrogen use and production. Industry will need to be protected from simply 'off-shoring' industrial emissions and a good case study is steel production in South Wales. It can be decarbonised using CCS, with reformation of the blast furnace gas to capture the carbon and produce a 400MW stream of blue hydrogen. An ideal opportunity for a major industrial cluster linking to other hydrogen facilities along the M4 corridor and then spreading to decarbonise the, by then, hybridised cities of Swansea, Cardiff and Newport. A similar scenario exists in North Wales extending from then proposed NW England hydrogen cluster. The ENA Pathways report, produced by Navigant (2019) provides detail of the vision and plan for the whole of the UK.

See:

http://www.energynetworks.org/assets/files/gas/Navigant%20Pathways%20to%20Net-Zero.pdf

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

longer-term to 2050, which would not create significant competitiveness or carbon leakage risks? How much could these reduce emissions?

ANSWER: The Pathways to Net Zero: Decarbonising the Gas Networks in Great Britain report covers a UK pathway to decarbonise international shipping and aviation. In the work undertaken by Navigant for the Balanced Scenario, by 2050 international shipping relies predominantly on Bio-LNG, while domestic and short-distance shipping becomes electrified. Aviation relies heavily on bio and synthetic fuels.

See:

http://www.energynetworks.org/assets/files/gas/Navigant%20Pathways%20to%20Net-Zero.pdf

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

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

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

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

ANSWER: 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: BioSNG production from the gasification of household waste incorporates CCU within the process – see the Swindon production plant for details, which is due to come online in 2020 and connect into the Wales & West Utilities gas network.

See:

https://absl.tech/download/2308/ and https://absl.tech/download/2305/

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: See our response to Q35 for an early commercial bioenergy (BioSNG) plant with carbon capture to provide evidence and learning to apply more widely with BECCS.

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: The key consideration should be solutions that suit local factors and hence provide the least cost and least disruptive pathway. However, heat cannot be siloed from the decarbonisation of power and transport – a whole systems approach is essential to identify the best local solution.

Three key projects cast light on this issue:

1. WWU/SSEN/UKPN Green City Vision (2019) – identified the optimal approach for Swindon. This project identified that a combination of consumer action, renewable gas and renewable electricity utilising hybrid heating systems minimised investment in all networks.

2. ENA/Navigant Pathways Project (2019) – identified pathways to decarbonise heat, power, transport and industry across the UK and hence identified areas favoured for hydrogen and hence investment in production, storage and CCS. Elsewhere a mixed approach was more suitable – not unlike the findings in Green City Vision.

3. WWU/Regen Regional FES (2019) – identified at very local level across SW England and Wales options based on local supply/demand characteristics to meet heat, power and transport demand. The gas network requirements to meet net zero were included in the WWU submitted business plan to Ofgem (December 2019). The work also identified the broad factors affecting electricity networks in SW England and Wales as well as enabling requirements such as generation needs, energy efficiency needs and appliance changes.

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: The ENA/Navigant Pathways Project report includes detailed calculations of hydrogen requirements and hence CO2 requirements. A more detailed study is close to completion – Wales & West Utilities' HyHy Project (2020) – hydrogen hybrid analysis of Cardiff in a net zero scenario. This has identified hydrogen production and storage

requirements and CO2 capture, shipping and storage requirements. This has included, for example, the feasibility of carbon dioxide tanker berthing facilities, tankers per month and the cost of hydrogen production, CO2 shipping and storage gate fees. Its conclusion is that local ‘city gate’ hydrogen production using ATR/CC technology with marine shipping of CO2 and storage in offshore depleted gas fields is feasible and cost effective compared to alternative pathways.