

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.

Summary

The 6th Carbon Budget for 2033-37 will be an important step on the road to net zero, and the CCC's analysis will be a critical opportunity for showing UK leadership ahead of COP26. 2030 ambition discussions at COP26 itself will steer decisions on the UK's 4th and 5th Carbon Budgets, and if the UK and the EU collectively increase its ambition to a 55% reduction on 1990 levels by 2030 then this should be reflected in the UK's domestic legislation. However, what is critically important is that the policies are in place to achieve it.

To meet the 6th Carbon Budget and net zero, significant investment will be required in low carbon generation to power the economy – the technologies are ready, the frameworks just need to be in place to deploy them. With current commitments, the risk of a low carbon generation gap even with increased electrification across the economy should not materialise until at least 2040, if at all. The backbone of UK decarbonisation will be the delivering of 40GW of offshore wind by 2030, and continued progress up to at least 75GW by 2050. With the recent CfD auction in September 2019 the expected cost of deploying this volume of offshore wind have come down dramatically.

In the CCC's net zero report of May 2019, it was assumed offshore wind would cost £69/MWh to deploy in 2025, and £51/MWh in 2050 in 2018 prices. Offshore wind being deployed from 2023/24 will cost £43.90/MWh in 2018 prices (£39.65/MWh in 2012 prices). This a reduction of over £25/MWh lower than was expected for 2025, and £7/MWh lower than the 2050 expectation. Given the central role offshore wind will play in decarbonising the UK energy system, this really is a game changer and should be reflected in an updated GDP cost expectation to reach net zero from the CCC.

Even with the costs of offshore wind, the UK is overlooking the lowest cost renewables. Onshore wind should have a route to market or meeting the 6th Carbon Budget will be more expensive than would otherwise be. Merchant onshore wind will happen in limited volumes at the windiest sites, and with each turbine cannibalising the value of the next one, there's a disincentive to build at scale. There's a massive opportunity in the coming years to boost output from repowering of the existing onshore wind sites with fewer, but more powerful turbines. This will become increasingly important over time, and will require a considered view on electricity market design to ensure low carbon generation can be delivered at lowest cost.

To ensure the necessary enabling infrastructure is in place, there's a need for anticipatory investment across the board to unlock the UK's low carbon opportunities. Electricity distribution networks need to be able to accommodate heat pumps and EVs, and electricity transmission networks need to connect both onshore and offshore wind with demand centres. This extends to the new low carbon infrastructure required – public EV chargepoints at a range of speeds, CO₂ transport and storage, low carbon hydrogen production and heat networks. De-risking these investments ahead of demand will significantly reduce the financing costs of deployment, and for higher risk investments can dwarf the costs of underutilised infrastructure, leading to higher usage costs.

Much of the progress required to meet the 6th Carbon Budget will be needed on heat and transport. With the right infrastructure in place reductions in transport emissions is ready to accelerate given developments in EVs and the upcoming availability of low carbon hydrogen in industrial clusters and expected cost developments in hydrogen electrolyzers. Heat will be the biggest challenge for UK decarbonisation, and the Government's Heat Roadmap due in the summer will be a critical step.

The 2020s need to be a decade of action to get to net zero, and we have an opportunity with historic low interest rates to deploy the low carbon infrastructure required to help achieve this. In particular, the UK could show leadership by committing to the most extensive EV charging network in the world by 2025, and the deployment of CCUS/hydrogen infrastructure in 5 industrial clusters by 2030.



About SSE

SSE is a UK-listed energy company with operations and investments across the UK and Ireland. It is primarily a developer, an operator and an owner of low-carbon energy assets and businesses, with a strategic focus on regulated electricity networks and renewable energy.

A. Climate science and international circumstances

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:

Given the prospective ETS linking agreement between the UK and the EU, there's a need to ensure ambition increases are aligned with ETS linking partners.

If not, linking partners could free-ride from increased ambition in the UK, with the cost being incurred by the ambitious country through foregone revenue through unilaterally reducing the number of its own ETS allowances, but having limited impact on territorial emissions as the impact of the tightened markets is shared across all linking partners (31 others in the case of the EU ETS (EU, EEA and Switzerland)).

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:

The value of setting stricter domestic carbon budgets will be limited if not collectively done with EU. SSE supports the UK and the EU collectively increasing its 2030 ambition to at least a 55% reduction in greenhouse gas emissions on 1990 levels.

However, there is a strong opportunity for the UK to encourage greater international ambition through domestic actions, as seen with the coal phase out before the Paris Agreement, the net zero target itself and wider technology leadership such as seen with offshore wind.

SSE supports the UK making a number of commitments across the economy ahead of COP, and in particular thinks the following could have value impact internationally: Deploying CCUS/hydrogen infrastructure in at least 5 industrial clusters by 2030; and committing to the most extensive EV charging network in the world by 2025.

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:

The roles of consumers/individual/household will be important, and market signals/regulation will

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be required to steer decisions. However, if consumers are not price-sensitive, such as on heat and transport, it may have adverse impacts on public support for climate policy without driving the desired abatement.

As such, when decisions are not price sensitive regulation/tax may need to be focussed at point of change, such as a car purchase or boiler change, rather focussing entirely on operational costs. We also cover this in Q12.

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:

Where risks are not appropriately apportioned or managed, this may lead to higher financing costs to overcome the respective risk ([PWC have looked at IRRs for a range of energy infrastructure](#)). The costs of deploying underutilised infrastructure or even stranded assets at a low cost of capital, will be dwarfed by the financing costs associated with deploying infrastructure efficiently but at a higher cost of capital, or the cost/lost benefit of not deploying the infrastructure given the high hurdle rates. Ultimately, high risks may present a barrier to deployment of key enabling infrastructure such as public EV chargepoints, CO2 networks, low carbon hydrogen production and heat networks, and consumers may benefit from risks being socialised.

An area where uncertainties could be problematic, and a pre-emptive approach will be of material value is in reducing costs and experience for consumers, is electricity networks, particularly given the short outlook of the price control framework and Ofgem's remit. At the transmission level, there's a need to have the transmission infrastructure in place to connect the low carbon generation needed to get to net zero, and it is welcome that Ofgem are looking at taking a more coordinated approach on offshore grid infrastructure with greater certainty over the need for offshore volumes to meet net zero. However, this is also the case for onshore transmission infrastructure, and ensuring that the lowest cost low generation from the regions of the UK with the greatest renewable resources such as the Scottish Islands can help meet net zero cost effectively.

As the distribution level, the extensive electrification of heat and transport will require a regulatory framework that enables strategic investment, adapts to rapid change, apportion risk fairly and is outcome focused. SSEN commissioned [REGEN](#) to apply NG ESO's Future Energy Scenarios (FES) to our distribution areas to capture the scale of change we might expect from 2018-2032 – although it should that these scenarios are not net zero compliant, but the previous target 80% by 2050. NG ESO updating FES to be net zero, and will be very important to steering a number of policy, regulatory and operational decisions for the GB electricity system.

Our electricity distribution network areas have 2.7 million and 750,000 households in south central England and the north of Scotland respectively. The Regen study found that reaching 80% emission reduction will require a minimum 50% take up of EVs from a baseline of 0.7% in the south, and

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0.43% in the north. In terms of heating our south distribution area will require a minimum 14% uptake in heat pumps, from a baseline of 0.35%, and 27.3% uptake of heat pumps in the north distribution area based on a baseline of 1.05%.

Currently there is no clarity about where in the distribution network these new electric loads will come forward, and in the case of EVs that load will be mobile and difficult to predict when compared to heat which will be driven by a fixed location and weather patterns. Ensuring the regulatory framework enables pre-emptive investment in infrastructure to prepare for, or sufficient flexibility to respond to, these significant demand increases is critical to ensuring that consumers are not limited, avoid local grid stability issues or lead to increased costs through shorter-term fixes.

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:

Revisiting the 4th and 5th Carbon Budgets should be done after there is clarity over the UK and the UK's portion of the EU's Nationally Determined Contribution (NDC) under the Paris Agreement, and the prospective ETS linking agreement between the UK and the EU. In the event the UK and the EU increase their existing NDC, then reflecting these changes in UK legislation at the same time as setting the 6th Carbon Budget would be sensible. However, what is more important is the policies to meet longer term targets which will mean we overachieve on our interim targets.

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:

For the period up to 2030/35, our view is the main focus for decarbonising the economy should be deploying 40GW offshore wind by 2030 and setting out a plan to maximise the offshore wind potential of the North and Irish Sea out to 2050. In addition, a route to market for onshore wind at scale, with be important is meeting carbon targets cost effectively, particularly given the repowering opportunities as existing sites come to the end of their operation.

More generally, investment in enabling infrastructure ahead of need will be critical to unlock low carbon opportunities through incentives over the period. EV charging infrastructure, CO2 transport and storage infrastructure, low carbon hydrogen production facilities and heat networks are

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investments which fit into this category. This also extends to existing network infrastructure. At the distribution level this means ensuring our electricity distribution networks can accommodate the required electrification of heat and transport. At the transmission level this means making sure the infrastructure is in place for to connect the required renewable energy capacity, both onshore and offshore.

With this focus on maximising our offshore wind and onshore wind resource and deploying the enabling infrastructure to be put in ahead of need will be sufficient to get us to 2030, whilst we develop plans to decarbonise other areas of the areas of the economy over the 2030s and 2040s, notably heat.

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:

Important that ambition shown by local areas, cities etc is accounted for as accelerated ambition, not used to account for missed targets elsewhere.

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:

All of the listed points in the question are important consideration for policy design in meeting a carbon budget of any level.

On infrastructure investment a significant impact on the overall project cost is the cost of capital, and with interest rates at historic lows there should be a focus on de-risking mechanisms to bring private investment into enabling infrastructure reducing the burden on central funding. A better route to leverage investment is to use available funding to underwrite infrastructure investment rather than direct investment by Government itself.

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?

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ANSWER:

Costs should be appropriately apportioned, with a principle that infrastructure costs are paid by users. However, a major aspect of the costs of infrastructure is the capital costs for the investment in that infrastructure. With interest rates at historic lows, de-risking mechanisms can help dramatically reduce the costs of infrastructure and thus the costs to use. Reducing IRR from on infrastructure from 15% (public EV chargepoints IRR is 10-20% according to [PWC](#)) to 5% can reduce financing costs of a £1bn investment over 15 years by up to £1bn.

There's a need to create the right incentives to steer consumer choices, whilst protection for vulnerable consumers. In addition, consideration should be given to the public attitude for individual policies, which may damage the public support for ambitious climate action, such as with policy costs on energy bills in 2014 and international examples in Australia, France and the US.

The distribution of policy costs on gas and electricity is a difficult issue that needs to be addressed, at least incrementally with social policy not being funded through electricity bills. A hybrid approach to ensure that consumers are incentivised, but not penalised whilst raising revenue for positive initiatives is voluntary carbon offsetting on heat and transport fuel suppliers. Consumers would be engaged with the cost of their carbon emissions to inform their heating system choices whilst being steered by other incentives/regulation, with the option to opt out of carbon pricing if not able to pay. A range of offsetting options could be provided, including domestic offsets for afforestation or energy efficiency funding, or for international abatements using robust carbon credits.

D. Scotland, Wales and Northern Ireland

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

ANSWER:

For ambition in a number of areas Scotland is reliant on GB energy frameworks, which has benefits for both Scotland and the rest of GB, in a similar way that the UK is currently dependent on EU frameworks to meet its targets. Scope for additional flexibility on policy and regulatory frameworks may help Scotland reach its more ambitious targets and where they have not been adopted within GB frameworks. Some scope for divergence to allow for greater ambition could provide an opportunity for innovative approaches to be later replicated across GB. Examples could include low carbon support mechanism for onshore given the support frameworks as we move away from subsidy to underwriting price risk, and on DNOs acting as a deployer of last resort for public EV charging infrastructure.

E. Sector-specific questions

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

ANSWER:

There is an impact for electricity distribution networks around where reinforcement needed. Charging of autonomous fleets could be focused where there is spare network capacity.

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:

We support moving forward the phase out date across the UK to at least 2035, and would support it coming forward to 2030 as well as setting interim deployment targets to ensure the focus is on increasing uptake. In addition, we would suggest wider targets may be helpful for vehicles which may have higher usage rates including full decarbonisation of corporate fleets, buses and taxis by 2030 and trains by 2035.

EVs and other transport solutions are developing at pace, and are a better driving proposition, particularly for high usage vehicles given the lower running costs, however a significant barrier is EV charging infrastructure. The UK should seek to have the most extensive EV charging network in the world by 2025 at COP26, setting a target for people per public EV chargepoints, bringing it down from the 2200 people per public EV chargepoint currently.

SSE views that this commitment can be achieved by reducing the cost of capital on EV charging infrastructure by reducing demand risk. A lot of the debate on costs relates to the efficiency of the roll-out, or underutilization /stranding of assets, and whilst this is important, it is dwarfed by impact of the financing costs. [PWC](#) suggested that public EV chargepoints have an IRR of around 10-20%, compared to other energy infrastructure of 5% which have de-risking mechanisms (such as Offshore wind and CfDs, a major reason for the price reductions).

As an example of the potential impact of de-risking demand for public EV chargepoints, reducing the cost of capital of £1bn capital investment from 15% to 5% would save £1bn in financing costs over 15 years (£1.4bn→£0.4bn nominal) or put another way a £1bn investment at 15% cost of capital would cost the same over 15 years, as a £1.7bn investment at 5%. De-risking demand can deliver a lot more infrastructure for the money available. This can be achieved by:

- **Tendering for network of public EV chargepoints** - Local bodies should tender a network of public EV chargepoints which would pool demand risk, and could include wider service provisions (ie coverage). A [recent tender](#) in 3 provinces in the Netherlands will deploy 20,000 public EV chargepoints in a region of 3.2m people. This tender equates to 160 people per public chargepoint vs 2200 people per public chargepoint currently for the UK. The revenue from a successful tender would be provided to the local body.

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- **Local EV charging Infrastructure plan** - To implement a tender, the local body in collaboration with the transport authority and the electricity distribution network operator (DNO) would develop a comprehensive Local EV Charging Infrastructure plan within Local Area Energy Plans (LAEPs), which could also include heat zoning to aide heat decarbonisation choices. This also would assist anticipatory investment challenges for DNOs with Ofgem by providing a locally endorsed evidence to support local distribution system planning. There are opportunities to reduce the cost by socialising the grid connection costs, and planning could be pre-approved or streamlined. Resourcing will need further consideration as local bodies don't have the resourcing or capability to undertake this task comprehensively.
- **Deployer of last resort** - Finally, to reduce the failure risk in developing these Local EV Charging Infrastructure plans, DNOs could act as deployer of last resort, with demand risk underwritten by network consumers or devolved/central funding. The charging infrastructure would only be built by DNOs if Ofgem had high confidence that the charging infrastructure would be economic in a high EV scenario. If the economic analysis was correct, then there would be no cost to those underwriting the demand risk, and the then built charging infrastructure could be re-tendered to the market with real world data. The revenue from the tender would repay the DNO investment, with any excess provided to the local body. Ultimately, it would be hoped that the infrastructure would be deployed by the original tender.

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:

For drivers, fleet operators, taxis, HGVs etc to make the switch to low carbon vehicles, they need confidence they access to charging facilities at home, in transit and at their destination, and at appropriate speeds to have comfort that they can complete 100% of their journeys in the UK with an EV. Much of the EV charging for fleets will be done at depot, and supported by high-speed public EV chargepoints for use within and between journeys.

A strategic hydrogen refuelling network will also be required for HGVs, but can be more targeted around strategic points in the transport network and industrial clusters. Ports would be a sensible starting point, given the number of HGVs and potential use in shipping, along with the availability of low carbon hydrogen.

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:

Enabling infrastructure such as CCUS/hydrogen infrastructure will be critical in providing low carbon opportunities for manufacturing sectors for price signals to steer them towards. In the absence of low carbon options, price signals become pass-through costs or could cause manufacturing to become uncompetitive. Low carbon thermal power generation can help reduce costs for industrial decarbonisation through the use of shared CO₂ infrastructure, driving down technology deployment costs and providing a source of low carbon hydrogen.

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:

Given the international competitiveness issues for industry, a potential option for incentivising low carbon industrial products is to stimulate demand through market pulls. This could be done via public procurement, domestic regulatory requirements or through creation of a kitemark to steer consumer decisions towards products made through low carbon components (for example, a car certified as made with a certain % of low carbon components). This may be an opportunity for UK industrial leadership given the low carbon opportunities being presented through development of CCUS and hydrogen infrastructure is not currently being replicated at the same scale elsewhere in the world.

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

ANSWER:

Ensuring a just transition is critically important, and SSE seeks to ensure that the impacts of changes in its activity does not adversely affect the communities that host our sites. However, whilst much is done to ensure a range of options are available to employees for their futures, there can have a wider impact on the local community from the loss of high-value jobs.

Specifically for the fossil fuel supply sector there is a positive story on the development of offshore

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wind, and with the scaling up to 2030 and beyond there are further opportunities for the utilisation of existing skills as well as new opportunities in the same regions home to oil & gas, as well as other industries such as fishing. A more defined plan up to 2050 will encourage the development of more of the offshore wind supply chain to develop in the UK, with increasing export opportunities internationally.

Likewise the prospective development of CCUS and hydrogen provides an opportunity to develop opportunities in fossil fuel supply sectors and industrial clusters, and can help develop a world-leading clean industrial base required to address climate change.

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:

No / low regrets options such as energy efficiency and properties off the gas grid should progress at pace, while evidence is gathered on deployment of heat pumps and hydrogen through trials at scale.

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:

There is a supply chain lacking for the roll out of heat pumps at scale, and coupled with incentives /regulation this needs to be a focus of Government policy given its importance in decarbonising heat.

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?

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ANSWER:

Including heat zoning and Local EV Charging Infrastructure Plans within Local Area Energy Plans (LAEPs) as set out by the Energy Systems Catapult, is an area where local decision making can assist heat and transport decarbonisation, with additional benefits to longer term planning for the local electricity distribution networks. Covered in more detail in Q37.

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:

Despite positive moves for merchant projects and Corporate PPAs, onshore wind will be limited and will not deliver the low carbon generation at scale. As such long term contracts will need to be continued for the foreseeable future, and this should be extended to onshore wind as the lowest cost low carbon generation.

However, an electricity market based dominated by zero marginal cost could present challenges to existing market arrangements, particularly from wind price cannibalisation, and may need to evolve to ensure it continues to appropriately value energy, firm capacity and different forms of flexibility for a fully functioning electricity system at lowest cost. Repowering of wind generation will become increasingly important given the increased capacity this could provide at these sites (see Tangy example for Q30) rather than securing life extensions or running assets to the end of their operational life.

Given this, Government should undertake a review of electricity market design to ensure it is fit for purpose to bring forward new low carbon generation and repowering the significant existing low generation that will begin to come to the end of their operational life. The divide between existing generation and repowering will need to be considered to ensure there are no perverse incentives one way or the other.

Requirements for firm capacity will be a challenge in net zero particularly with significant electrification of heat. However, peak demand can be met by a combination of gas with CCS and hydrogen generation. Both the exact capacity required, and the load factors are uncertain and will be driven by other developments. Greater flexibility on the system from a range of sources will help reduce the costs to meet peak demand by reducing the need for generation capacity and increasing load factors, as well as reducing associated emissions.

However, even with lots of flexibility, low carbon thermal generation may need plant operating at very low load factors to provide comfort that seasonal peaks can be met. On the low frequency incident on 9th August, we saw that the economists value of Value of Lost Load (VOLL) is not

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necessarily aligned with society's value of modern life without a stable electricity system.

Given the respective capex and opex costs, gas CCS and hydrogen generation will perform different roles in the electricity system. Post-combustion gas looks more favourable at higher load factors given its relatively higher capex costs, and lower opex costs. Whereas hydrogen looks more favourable at lower load factors given its lower capex and higher opex (assumes SMR capex reflected in fuel cost). At current commodity prices and technology costs in the [Wood Group](#) report, we estimate the cost over is at load factors in the region of 38%, but this could change with commodity prices and technology costs, notably if green hydrogen is available at low cost. [Element Energy](#) also have good information on cost developments of hydrogen and gas CCS power generation.

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:

For individual technologies, please find the following views:

- We welcome consideration of the fixed-based offshore wind potential for UK territorial waters. An exact number for the 2050 potential will develop as greater clarity of the deployment over the 2020s develops. However aiming for at least 75GW and testing scenarios above this will be sensible for informing UK carbon budgets. [Wind Europe \(2019\) suggests](#) 80GW of offshore could be economic given existing constraints, and notes significant potential in Ireland which could be de-risked by UK or EU mechanisms and exported to GB.
 - Given the potential wind resource in Ireland, consideration should be given to import of renewables generated in Ireland with sufficient infrastructure/storage in place. As low carbon support mechanisms move away from providing subsidy to underwriting price risk, it may make sense for the UK to share this price risk given UK consumers would benefit from deployment of offshore wind in Ireland.
- Floating offshore wind could play an increasingly important role in the UK energy system if deployment costs come down, and could play a greater role than proposed in the CCC's

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net zero report.

- Onshore wind has a significant range of uncertainty over current policy limitations extending indefinitely. A range between 15 and up to 60GW could be possible. The CCC's expectation of 35 GW is sensible.
 - As an example of the potential for repowering in the UK, SSE's Tangy wind farm built in 2003 has planning permission to repower and increase its capacity by over 4 times from 18.7MW to 80MW, while reducing the number of turbines from 22 to 16 - although increasing tip heights by 20m. If these same factors were simply extended across the UK's nearly 2400 onshore wind farms, the number of turbines would decrease from 8400 to 6100, while capacity increased from 13.6GW up to 58GW. Whilst this is a simplified approach, it highlights the potential magnitude of the repowering opportunity with the right support framework in place, particularly with 5-6MW onshore wind turbines coming to market.
- Solar capacity could also increase significantly, however given load factors it is unlikely to play a central role in meeting net zero in the UK. In addition, it may have limited value at scale in the UK given it is not aligned to UK demand with winter peaks, meaning additional flexibility is required. However, it could provide a useful source of electricity during windless high-pressure weather systems during winter.
- Given the costs of new nuclear and costs of comparable low carbon technologies, as well as its record of failing to deliver on time and on budget, we do not envision that Government will be able to sign off further new nuclear projects on a price basis as they do not present value for money and are not irreplaceable in meeting net zero in the UK. For example, the [Wood Group](#) highlight that post-combustion CCS could be delivered at an LCOE of £69.9/MWh in 2025 (unabated gas at £74.2/MWh). Even if assuming low load factors increasing LCOE of gas CCS, when coupled with offshore wind at £50.60/MWh in 2025 prices (CPI at 2% from 2020, and historical CPI up to 2019), this makes Hinkley Point C at £118/MWh in 2025 prices look very expensive.
 - Relying on gas CCS (and hydrogen) in the absence of new nuclear or other low carbon as a fall-back would not present a barrier to meeting net zero, as an extra 10TWh delivered by gas CCS only emits 0.3mtCO₂. Even doubling the CCC's expectation for gas CCS in 2050 (148TWh→296TWh) which would almost meet the UK's 2018 demand, would only produce 11mtCO₂ in total. However, whilst not an insurmountable barrier to meeting net zero, it would likely imply a greater need for negative emissions or greater emissions reductions elsewhere in the economy.
 - The decision over a missing low carbon generation gap will not materialise until at least 2040. The Government should focus on delivering of existing cost-effective technologies at scale, most notably offshore wind, and review whether

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?

interventions are required in 2030. At this point the UK's offshore wind potential will be clearer after deploying 40GW and other technologies would have matured.

- Within the net zero analysis, the CCC outlined a scenario including 148TWh from gas CCS. The volume is sensible, but whatever the volume is will probably be split between post-combustion CCS and hydrogen generation.
 - As outlined by [Element Energy](#), the technologies will likely perform different roles within the electricity system (and in Q29). Given the higher capex of gas CCS associated with the capture unit, and competitive dispatch costs, it will likely operate at higher load factors than hydrogen which is lower capex (equivalent of unabated gas generation), but has higher operational costs given the fuel cost from producing hydrogen – which could come down with hydrogen produced from electrolysis. In addition, large-scale [gas generation](#) being installed will be capable for blending with up to 30% hydrogen, and manufacturers have committed to having a large-scale hydrogen turbine by 2030. The UK could encourage leadership in this space by seeking to develop the world's first large scale hydrogen generation by 2030 as part of COP26.
- There's a need for a range of storage technologies over a range of time periods, the question how to bring forward cost-effectively. A particular technology which could have significant benefits for consumers in energy and balancing markets, as well as minimise transmission constraints is hydro pumped storage. Coire Glas is 1500MW hydro pumped storage project capable of storing 30GWh of electricity – double that of the existing hydro pumped storage capacity at 26.7GWh. Consisting of 5 X 300 MW units it could supply 300MW of power for 112 hours or 1500MW for 24 hours (SSE numbers).
 - This compares against the largest lithium-ion battery in the world, in South Australia which can store 0.129GWh with a power capacity of 100MW, and a £ per GWh over times that of Coire Glas.
 - However, given the high capex, uncertain revenues across a range of markets and long time, as well as the inability to project finance means that deploying hydro pumped storage is challenging, and will likely need some form of support.
 - Further evidence on wider benefits of hydro pumped storage can be found here from [DNV GL](#) and [Strathclyde University](#)
- Over time negative emissions will grow in importance. In addition to post-combustion biomass CCS, there is an opportunity for Energy from Waste (EfW) to capture negative emission as it contains biogenic content and part of its output could be considered as BECCS.

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:

Carbon pricing in the power sector will remain important beyond the phase of coal, as it will encourage the market dispatch of post-combustion gas CCS and the incremental blending of low carbon hydrogen with gas generation, through to 100% combustion of hydrogen. Reports from the [Wood Group](#) and [Element Energy](#) highlight the Short Run Marginal Costs (SRMC) of post combustion gas CCS, and thus the dispatch costs are in a similar range to unabated gas. The report suggests that £55/MWh of the LCOE of post-combustion gas relates to SRMC, compared to £66.2/MWh for the LCOE of unabated gas.

Developing a business model for hydrogen power generation, could assist providing a source of low carbon hydrogen in industrial clusters.

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:

Need for development of low carbon options, such as electric aviation and ammonia for shipping. Removing free allocation from intra-EEA aviation under the EU ETS and including intra-EEA aviation in the EU ETS, as proposed by the European Commission would be beneficial.

Ports in industrial clusters could act as low carbon transport hubs providing EV charging infrastructure and low carbon hydrogen for HGVs and trains.

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:

For negative emissions from the power sector, from dedicated biomass and Energy from Waste (EfW) generation, access to CO₂ transport and storage infrastructure will be critical and generation

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?

sites should all be included within CCUS network plans.

Question 36 (Greenhouse gas removals): Is there evidence regarding near-term expected learning curves for the cost of engineered GHG removal through technologies such as bioenergy with carbon capture and storage or direct air capture of CO₂?

ANSWER:

It is important that negative emissions have a market pull for the technologies to be delivered without additional subsidy. The UK should commit to a carbon pricing trajectory that will incentivise negative emissions by at least 2040. The precise level should be informed by the CCC, but a trajectory aiming for £80-100 in 2020 prices (as outlined by [Vivid Economics](#)) would be a sensible minimum to initially aim for, with scope to more upwards with further ambition increases.

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 heat choices for individual properties will be based on a number of factors including access to the gas grid, the energy efficiency of the property, the density of heat loads in the surrounding area and the access to low carbon hydrogen. The heat hierarchy proposed by the CCC is sensible, with an immediate focus on improving energy efficiency and off-gas grid properties as no/low regrets options being important.

Local decisions will be important on heat decarbonisation pathways. As outlined by the [Energy Systems Catapult](#) local bodies should develop Local Area Energy Plans (LAEPs), including heat zoning down to individual properties (as well as including Local EV Charging Infrastructure plans). This will provide information to consumers over their low carbon heating choices and signal to deployers of low carbon heating solutions where there may be a prospective market for them to have the confidence to develop a localised supply chain to bring deployment costs down.

Heat zoning will also be important to inform medium-long term electricity distribution network development. It will help to reduce medium-to-long term electricity distribution networks costs and mitigate the risk to local grid stability from new electricity loads connecting within a short period, by providing an evidence base for distribution network planning for anticipatory investments ahead of heat pumps, and/or EV charging infrastructure being deployed.

As developers of new infrastructure, heat network developers may face challenges in having sufficient confidence over demand to make a sizeable capital investments. In addition, moreover higher demand risk, leads to higher hurdle rates which feeds directly into higher usage costs for consumers. De-risking demand for heat network can bring financing costs down to those seen in

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?

other energy infrastructure.

Resourcing of LAEPs will need further consideration as local bodies don't have the resourcing or capability to undertake this task comprehensively.

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

ANSWER:

The focus should not be on a CO₂ volume target, but on ensuring the appropriate CCUS/hydrogen infrastructure is in place to provide low carbon opportunities in at least 5 industrial clusters by 2030.

The current competitive approach to CCUS funding is important for ensuring price discovery and driving down costs, but there is also a risk of failure which is holding back development plans. To meet net zero CCUS infrastructure and low carbon hydrogen will need to be available in all industrial clusters for industry to decarbonise, as well as providing hydrogen for use transport (HGVs and shipping) and for heat in nearby urban areas.