THE CARBON TRUST'S NET ZERO INTELLIGENCE UNIT

Response to EAC call for evidence on sustainable electrification of the UK economy

8 June 2023

Overview of this written evidence

The Carbon Trust was originally established by the UK government in 2001 and is driven by the mission to accelerate the move to a decarbonised future. The Carbon Trust's work as a global climate consultancy involves supporting governments, business and financial institutions on their journey to Net Zero. The Carbon Trust has significant experience in supporting the UK's energy transition, both in policy design and implementation. This includes major industry initiatives such as the Offshore Wind Accelerator, which has delivered a £34bn reduction in costs in the offshore wind industry. The Carbon Trust also supports UK Government clean energy projects such as the Heat Pump Ready Programme, as well as UK Government backed technology accelerators such as the Clean Hydrogen Innovation Programme. The Carbon Trust's policy work has covered a wide range of topics but notably includes extensive work on energy market reforms, including the development of REMA.

This response was prepared by the Carbon Trust's Net Zero Intelligence Unit. The Net Zero Intelligence Unit was founded to ensure the Carbon Trust's experience-led insights on how governments, companies and financial institutions can accelerate towards Net Zero and deliver broader benefits along the way are available to key decision makers.

This written evidence submission focusses on areas where the Carbon Trust has significant experience and expertise and can therefore offer relevant insights to the inquiry. In particular, it draws on the Carbon Trust's flagship analysis of flexible energy systems in the UK[1]. Throughout the submission, the following key points are stressed:

1. The ability of the UK to deliver on its target of decarbonising the power system by 2035 rests on the swift roll out of flexibility technologies and systems, in the form of energy generation, storage and demand management.
2. A combination of improved regulatory frameworks, industry incentives and innovation programmes could help to ensure flexibility is built into the transition of the UK's power system, enabling it to be more resilient to the pressures of a significant increase in electricity demand as the whole economy transitions to Net Zero.
3. This approach would also deliver material net savings of up to £16.7bn a year across all Net Zero by 2050 scenarios analysed by the Carbon Trust.

[1] The Carbon Trust, Flexibility in Great Britain, 2021: Read the report - Flexibility in Great Britain - The Carbon Trust

The Carbon Trust would welcome the opportunity to discuss this written evidence in more detail with the Committee.

The National Grid and the Government's Energy Targets

What challenges does connecting more renewable electricity to the grid pose, both for those businesses and households who wish to connect to it, and for grid operators?

1.1 The UK's energy transition creates opportunities and challenges across infrastructure, technology, policy and markets. According to the Government's own strategy, by 2037, demand for fossil fuels (natural gas and oil) is assumed to decrease by >63%, whereas electricity demand increases by 70%. Heat pumps and electric vehicles, for example, add significant additional demand to the energy system. This increases electrical loads on distribution networks, leading to periods of constraints as the existing network was not built to meet this new demand.

1.2 Significant renewable energy supplies will need to be connected to the grid to support the UK's target of achieving a decarbonised power system by 2035 – the Government has set targets to deliver up to 50GW of offshore wind by 2030 and 70GW of solar by 2035. Solar and wind are the cheapest forms of new electricity generation, however, **businesses and households** currently face significant barriers in establishing grid connections for new renewable energy.

1.3 There is currently a significant wait time (up to 15 years) to establish a grid connection. A backlog of significant renewables infrastructure projects (wind and solar farms, as well as battery/storage projects) and an out-dated first come, first serve queuing system has led to a long grid connection wait time that does not reflect the urgency with which the UK needs to bring new renewables online. The backlog reflects the challenge of transitioning the grid from being connected to fewer, larger power plants to a more complex system connected to many more, smaller energy sources. This is a critical hurdle for delivering a Net Zero energy system – both in terms of deploying new renewable energy and bringing energy storage solutions online.

1.4 Connecting more renewable energy to the grid also poses challenges for **grid operators.** For example, the capacity that is likely to go ahead may well be geographically concentrated. For instance, the 2022 ScotWind tender[2] may deliver up to 25GW of wind in Scotland which will exacerbate current transmission constraints between Scotland and England. The three planned offshore transmission links between the two countries – the so-called "boot-straps" – will partially alleviate the constraints, but will "only" provide around 6GW of capacity by 2030.

1.5 Additionally, asynchronous variable renewables such as wind and solar incrementally are displacing high carbon, synchronous generators. This reduces grid stability both at a national level through lower inertia and at a local level through lower short circuit level capability and reduced reactive power provision. System restoration, traditionally provided

[2] Scotland awards seabed rights for massive amounts of offshore wind, most of it floating | WindEurope

(at least partly) by fossil fuelled generators, is becoming more challenging for the National Grid Energy Systems Operator (NGESO) to secure. A substantial amount of work to address this is being carried out by all network operators and governments. The Carbon Trust reiterates that system reliability and network innovation remain core priorities for the National Grid and the Government to ensure security and sustainability of supply.

1.6 While the recently published Powering Up Britain plan sets out a commitment to publishing an action plan on reducing the wait time for grid connections, it lacks sufficient detail on how the Government and Ofgem will work with the National Grid and network companies to facilitate anticipatory investments in grid infrastructure. Both measures are needed to facilitate a coordinated, whole systems approach to decarbonising the grid at pace. Ofgem should work to reduce the risk threshold for anticipatory investments.

To what extent do the following act as barriers to the UK's targets to decarbonise the power supply? How well is the Government addressing these barriers, and what else can be done to address them? What, if any, targets should be set in these areas?

1.7 **Grid connection delays and bottlenecks, both onshore and offshore**, are significant barriers to the UK's targets to decarbonise national power supply. Taking offshore wind as an example, the vast majority of wind farms are connected individually via a transmission cable to the nearest point on the onshore grid (a 'point-to-point' connection). However, this connection point may not be located close to where the electricity is needed. Transmitting this electricity from the onshore connection point to consumers has caused bottlenecks on the onshore electricity grid, which means not all electricity that could be generated by offshore wind is actually used. Without investment in transmission networks, this problem will only increase as more offshore wind is built, see point 1.2.

1.8 One proposed solution is to replace new point-to-point links with a coordinated, meshed offshore network which would allow electricity from several wind farms to be transmitted via offshore cables to several different onshore connection points. This coordinated network could reduce the cost of offshore wind by reducing the total length of offshore transmission cable required to connect new wind farms. It could also reduce onshore transmission congestion by transmitting power from a wind farm to an onshore connection point closer to where it is needed, effectively bypassing constraints on the onshore network. The Carbon Trust is leading a joint industry programme led by offshore wind developers – the Integrator[3] – to understand and overcome the challenges of integrating offshore wind into energy systems.

1.9 Carbon Trust welcomes the Electricity Commissioner commitment to assessing how to reduce development time for transmission network projects, and that the Government will respond to this through the publication of an action plan to accelerate connections in summer 2023. This action plan should consider rebalancing the cost benefit analyses / risk assessments for anticipatory investment in favour of building more network to avoid Ofgem's authorisation process being an obstacle to achieving Net Zero cost effectively.

[3] The Carbon Trust, About the Integrator programme: The Integrator | The Carbon Trust

1.10 **Lack of, or delays to developing, necessary infrastructure;** Reaching Net Zero by 2050 whilst meeting security of supply requires unprecedented build-out across the energy system. In particular, Carbon Trust analysis of the delivery of a flexible, Net Zero energy system found that clean hydrogen can play a critical role in providing cost efficiencies and reliability within the overall energy system. The deployment of clean hydrogen across the energy system could deliver the largest impact across all the scenarios modelled in terms of reducing the total electricity generation capacity requirement.[4] However for this potential to be realised, a portfolio of production and storage methods will be required along with significant Carbon Capture, Use and Storage (CCUS) infrastructure. It is welcome that the Government is committed to publishing a hydrogen roadmap.[5] The sooner industry is given a clear signal on the future of hydrogen in the UK, the sooner the necessary investments in production and CCS infrastructure can be made. The Carbon Trust is leading the UK Government-supported Clean Hydrogen Innovation Programme[6] to help reduce end-to-end costs of clean hydrogen production and support scale up across the UK.

1.11 **Skills constraints** are a major barrier to the UK's target for achieving a Net Zero economy by 2050. To ensure the delivery of critical technologies, such as heat pumps, significant skills gaps need to be addressed. As noted by the Climate Change Committee, the installation of low-carbon heating systems will likely require around 30,000 new heat pump engineers by 2030.[7] To stay on track for Net Zero, the UK aims to install around 600,000 heat pumps each year by the late 2020s. This is a huge step up from the 54,000 installed in 2021. Progress towards such levels of heat pump roll out could be hampered by the Government's decision to retain the 2035 ban on gas boilers, instead of bringing it forward to 2033, and the continued suggestion in the Powering Up Britain Plan that hydrogen could play a 'major' role in home heating.

How resilient is the National Grid? How does it need to adapt to achieve the Government's targets of (a) decarbonising the UK power system by 2035 and (b) becoming a net zero economy by 2050? What changes are needed to promote resilience through diversity of supply?

1.12 Resilience is essential to the reliable functioning of a future Net Zero energy system. To enable this, it is important to consider the impact of very cold temperatures and very low wind speeds in an electricity system that has a high penetration of renewables. At present, the UK grid requires the use of fossil fuel plants to meet demand during these high stress periods. The current resilience of the UK grid is therefore dependent on unabated fossil fuels, whereas in the future, this resilience will need to be enabled by the integration of flexibility mechanisms such automated energy demand, and energy storage mechanisms

[4] The Carbon Trust, Flexibility in Great Britain, 2021: Read the report - Flexibility in Great Britain - The Carbon Trust

[5] HM Government, Powering Up Britain: Net Zero Growth Plan, March 2023: Powering Up Britain - The Net Zero Growth Plan (publishing.service.gov.uk)

[6] The Carbon Trust, Clean Hydrogen Accelerator receives UK Government backing, October 2022: Clean hydrogen accelerator receives UK government backing | The Carbon Trust

[7] Climate Change Committee, A Net Zero Workforce, May 2023: A Net Zero workforce - Climate Change Committee (theccc.org.uk)

to reduce peak demand for electricity, therefore significantly reducing fossil fuel capacity required and associated costs. For example, the deployment of additional flexibility in a fully electric scenario displaces over 90GW of unabated gas generation which predominantly supports the system during peak stress times.

1.13 The Carbon Trust's flagship research on energy flexibility in the UK found that **investing in flexibility is a no-regrets decision as it delivers material net savings of up to £16.7bn a year across all Net Zero by 2050 scenarios analysed**[8]. However, the current market landscape is inadequate to deliver flexibility at the pace and scale required. A portfolio approach, such as using firm capacity in addition to variable renewables, is required. These would include interconnectors (to some extent), nuclear and CCUS. Further to these technologies, the Government should consider investing in long duration energy storage (including hydrogen) as this could absorb electricity generation when intermittent generation is high and help with capacity adequacy by generating when intermittent generation is low. Together with significant electrification of demand and supported by demand side response (DSR), this would help create a more resilient future energy system.

To what extent will the measures in the British Energy Security Strategy and the Powering Up Britain plan deliver the Government's high-level targets of (i) decarbonising the UK power system by 2035 and (ii) becoming a net zero economy by 2050?

1.14 The Government's Powering Up Britain Plan included some signals of intent to deliver the flexible, integrated grid infrastructure required for a Net Zero energy system. For instance, the commitment to publication of a Centralised Strategic Network Plan by the Future Systems Operator in 2025, which will set out a blueprint for the whole electricity network, is a welcome move that will help to deliver system-wide reform.

1.15 The Government's commitment to publishing roadmaps for key technologies such as solar, hydrogen, heat pumps and CCS (in addition to the existing offshore wind roadmap) is also welcome. However, a gap remains for onshore wind – a critical source of low-cost, renewable energy. The Carbon Trust's instrumental experience of scaling up the offshore wind markets in the UK[9] and elsewhere over the past two decades, and our ongoing work on onshore wind for the devolved government in Wales, shows that clear commitments from governments can drive innovation and expansion of low carbon technologies.

Storage and Flexibility

What developments, including technological developments, and incentives are required?

1.16 The integration of flexibility mechanisms such as automated energy demand and energy storage helps to reduce peak demand for electricity, therefore significantly reducing fossil fuel capacity required and associated costs. The Carbon Trust's flagship research on energy flexibility in the UK found that investing in flexibility is a no-regrets decision as it delivers material net savings of up to £16.7bn a year across all Net Zero by 2050 scenarios

[8] The Carbon Trust, Flexibility in Great Britain, 2021: Read the report - Flexibility in Great Britain - The Carbon Trust

[9] The Carbon Trust, Offshore Wind Accelerator: Offshore Wind Accelerator (OWA) | The Carbon Trust

analysed. However, the current market landscape is inadequate to deliver flexibility at the pace and scale required.

1.17 Carbon Trust analysis found significant flexibility deployment needs in the UK by 2030 – for example the system could require 1GW of domestic demand side response, 1GW of hydrogen electrolysers, up to 3GW of electric vehicle flexibility and significant roll out of thermal energy storage (TES). Innovation is important to bring technologies such as TES and electrolysers to the market at the appropriate cost point and technical capability ahead of 2030. Given the linkages between these technologies and the wider system, especially electrolysers, it is important to design and integrate them from a whole-system perspective rather than in isolation.

1.18 The backbone of any demand-side responsive energy system is smart meters. It is crucial that the UK's smart meter roll out does not face additional delays and has a clear route to secure cost-effective data access across millions of potential sites/devices.

1.19 For technologies tied to broader energy system decarbonisation strategies (for instance the use of thermal storage capacity to decouple the demand of industrial heat pump-powered district heating networks from the supply of energy), it is important to set effective market signals to incentivise consideration of flexibility into long life time infrastructure, as the system value in the short-term might not be present or material.

1.20 In terms of energy storage (the charge, storage and discharge of energy in a controlled manner based on external signals) further innovation is needed to unlock long duration energy storage (LDES) capabilities, for instance hydrogen in salt caverns, as well as thermal storage capacity (which enables the demand from the industrial heat pumps that supply the district heating networks to be decoupled from the supply of energy). The location of the LDES should ideally be within transmission constraint boundaries so as to enable both absorption of excess variable generation and contribution to capacity adequacy.

Planning, local government and communities

What barriers are there in the planning process? Do the proposed changes to the National Policy Statements on energy infrastructure address these adequately? Can the grid development required be undertaken wholly under the nationally significant infrastructure project planning arrangements in the Planning Act 2008?

1.21 The consultation on the National Policy Statements for Energy Infrastructure limits the ability of renewable energy developers to drive progress towards a decarbonised grid because they only cover Nationally Significant Infrastructure Projects (NSIPs). To achieve Net Zero a mixture of renewable energy generation projects are required, supported by electricity network infrastructure at all voltage levels (beyond those considered to be NSIP). It is welcome that offshore wind developments and their associated grid infrastructure is recommended to have Critical National Priority (CNP) status[10], however

[10] UK Department for Energy Security and Net Zero, 2023: Planning for new energy infrastructure: revisions to National Policy Statements - GOV.UK (www.gov.uk)

the Carbon Trust believes this status should not just be limited to offshore wind. While offshore wind has a significant role to play, the quickest, cheapest forms of renewable energy are onshore wind and solar. Onshore wind is excluded from the National Policy Statements as these developments are not designated as Nationally Significant Infrastructure Projects. Additional planning support, including in relation to grid infrastructure is required to support onshore wind projects and should be provided to accelerate deployment of this technology. For solar, restrictions remain on the construction of solar farms in multifunctional sites, such as on farms with high agricultural land quality. Also, whilst the importance of grid connection with respect to site selection is highlighted there do not appear to be any measures to help support the planning consent for grid infrastructure associated with solar farm developments.

1.22 From a local government perspective, building planning regulations also lack the urgency needed to decarbonise UK housing stock – a critical aspect of achieving Net Zero by 2050. Within current planning regulations, it remains possible to build a home that will later require retrofitting to meet the low-carbon standards needed for Net Zero. The Future Homes Standard, which will require new buildings to be constructed with low carbon heating and to high standards of energy efficiency from 2025, should have more robust interim targets to support earlier adoption of these modern methods of construction, and to unlock early investment in skills and supply chains that will lay the foundations for scaled up deployment from the mid-2020s. Stronger interim targets would help to develop the evidence-base needed to identify which areas are suited for certain types of technologies, ensuring that progress towards Net Zero is catalysed and investment in technologies is concentrated in areas where they can really deliver low cost and low carbon benefits.

Is land availability a constraint? If so, how can the constraint best be addressed?

1.23 While land availability for the construction of onshore wind and solar farms is a constraint due to availability of suitable land (from both a technical and planning perspective) and land owner consent, it is also a constraint for onshore grid transmission infrastructure. In the Carbon Trust's experience of supporting the renewable energy industry, the securing of land and consent for grid infrastructure that can be as difficult (or more difficult) as securing land and consent for the renewable energy generation infrastructure itself.

1.24 Addressing the issue of landowner consent is crucial to accelerating the construction of transmission infrastructure. It is welcome that the Government has recognised the criticality of network infrastructure in its National Policy Statement (NPS) consultation. It is hoped this will speed up consenting processes, as decisions on network infrastructure covered by the NPS will be assessed by the Secretary of State.

1.25 Another approach to addressing constraints on landowner consenting/land availability is to encourage community ownership of renewable energy projects. In Wales, the government introduced a target in 2020 for every new energy project to include at least an element of local ownership. This approach can help to ensure benefits for the local community, potentially speeding up consenting processes. To gain local support for the deployment of additional electricity network infrastructure, community benefit packages similar to those commonly resulting from wind farm projects could be considered. An element of these community benefit packages, could look at reducing the network usage

charges applied to electricity bills for consumers within a certain distance of overhead infrastructure.

What potential is there for community energy schemes to contribute to sustainable electrification? How can they be encouraged to develop?

1.26 Community energy schemes are being operated nationwide and are driven by individuals and communities that are passionate about transforming the energy system. The Welsh Government's Call for Evidence on Locally Owned Renewable Energy in 2018[11], includes details of some of the benefits arising from locally and community owned energy projects in Section 3. These benefits include both financial benefits and non-financial benefits, including, improved community buy-in and increased awareness of clean energy and climate change within local communities.

1.27 Developing energy projects is a complex process requiring funding, technical expertise and capacity and resource to drive the projects through to installation. Government funded support services, such as the Welsh Government Energy Service [12] can help to provide local communities with the support needed to deliver on local energy ambitions. The Welsh Government Energy Service offers technical, commercial and procurement advice and support to help turn energy projects into reality for organisations such as local authorities, health boards, local community organisations and charities, community councils and universities. From July 2018 to March 2022, the Welsh Government Energy Service has saved 716,000 tonnes of CO_2 emissions and has committed to 45MW of new renewable energy capacity in Wales. A similar service exists in Scotland – the Community and Renewable Energy Scheme. In addition to government funded support services, community energy projects can be supported by nationwide representative organisations (such as Community Energy England and Community Energy Wales), and through the additional targeted support, which is provided by Distribution Network Operators to help community energy developers to navigate the grid connection process for projects.[13]

What role are local authorities playing in delivering the Government's targets to decarbonise the grid by 2035? Should net zero energy plans be mandated at a local level?

1.28 There is a wealth of evidence on the important role that cities and regions can play in delivering Net Zero[14]. Delivering a decarbonised grid will require national, devolved, regional and local administrations to play different roles, but currently there is a lack of clarity on where responsibilities lie, and a lack of coordination between different levels of government. A significant amount of stakeholder engagement is required to develop a shared understanding of what a local area needs and, as highlighted in the Skidmore Review, local authorities (LAs) are best placed to carry out these engagement exercises.

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[11] Welsh Government, Locally Owned Renewable Energy, 2018: https://www.gov.wales/sites/default/files/publications/2019-06/181213-summary-of-responses-locally-owned-renewable-energy.pdf

[12] The Carbon Trust, Welsh Government Energy Service: Welsh Government Energy Service | The Carbon Trust

[13] National Grid, Community Energy: National Grid - Community Energy

[14] For example, UKRI, Accelerating Net Zero Delivery, 2022: Accelerating net zero delivery – UKRI

However, at present LAs in the UK consistently lack the resources and capacity needed to deliver on Net Zero. Often, LAs have just one official responsible for delivering Net Zero, and that official may also hold a number of other responsibilities that compete for their resource. This makes it challenging for LAs to integrate Net Zero policies into wider policymaking processes. Further support from DESNZ, including improved funding and technical assistance could help LAs to make greater progress and unlock their vital role in delivering the UK's Net Zero target.

1.29 Furthermore, LAs are not mandated to take account of the UK's national Net Zero target, although most local authorities have publicly committed to achieving net zero for their own operations, and in many cases also their jurisdictions, well ahead of 2050. However, it is difficult to compare these locally-led Net Zero targets due to the lack of a consistent framework. The introduction of a framework for LAs at a national level could help to provide better read-across on LA's targets and plans, for instance on what is in scope for a credible LA Net Zero target and how best to measure progress. In Wales, the Welsh Government has set a national target for a net zero public sector (as a whole) by 2030, and are monitoring progress to achieving this by requiring public sector organisations to provide an annual report on their carbon emissions.[15]

1.30 Some local authorities are now delivering Local Area Energy Plans. Local Area Energy Plans deliver a data-driven, spatialised, integrated plan for a local area's energy system transition. Such plans can help to identify 'zones' suitable for heat networks, onshore renewables, EV charging hubs and other low carbon infrastructure. Taking a whole system view and engaging widely with local stakeholders, the optimum mix of cost effective net zero solutions for a particular area can be identified, prioritised and sequenced, helping toto de-risk investment and reduce the risk of stranded assets. Despite the importance of Local Area Energy Planning for delivering on Net Zero, the Department for Energy Security and Net Zero does not at present have a central oversight or steering function. Establishing this could help to drive progress towards Net Zero across the UK by providing frameworks and templates to support LAs.

[15] Welsh Government, Public sector net zero reporting guide, 2021: https://www.gov.wales/public-sector-net-zero-reporting-guide