# Net zero will only be possible if we realise the full potential of flexibility

**RenewableUK Policy Paper**
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## Context

Energy policy is now being shaped by the new realities of large-scale, low-cost clean power. We already have the technologies we need to deliver a zero-emissions power sector at the least cost to consumers; the discussion is now about how we can harness innovation to decarbonise further and faster; and how can deliver an efficient energy system, optimising and integrating high levels of renewable technologies. In 2020 we published our Energy Vision[1] on the value of innovation and flexibility in a system dominated by renewable and low carbon energy.

In order to harness the benefits of flexible technologies, we need policy regulation and markets to provide a stable and transparent platform for assets to be used in the most efficient way possible.

Flexible technologies are vital to meeting Governments targets, including integrating 40GW of offshore wind by 2030, helping to deliver on the 5GW hydrogen and 18GW of interconnector capacity white paper commitments by 2030. Greater levels of flexibility in the system such as energy storage will allow the UK to integrate renewables with significant savings by up to £16.7bn a year in 2050[2]. Flexibility is more than simply making the transition faster – it also makes it cheaper and more reliable.

System services such as frequency response and inertia will actively support the growth of non-synchronous generation such as wind and solar as they develop. The industry is already working closely with National Grid ESO to ensure renewables can enter these markets as part of the work carried out on Power Available signal through the Wind Advisory Group.

## What is system flexibility?

> Flexibility refers to *the ability to modify generation and/or consumption patterns in reaction to an external signal (such as a change in price, or a message)*[3]. Increasingly, variations in supply and demand will need to take into account the carbon intensity of the grid across all timescales. Having greater levels of renewables on the system would not be enough, we need improved system coordination to ensure best use is made of renewables output.

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[1] http://vision.renewableuk.com/
[2] Carbon Trust, 2021, *Flexibility in Great Britain*
[3] BEIS, 2016, *A Smart, Flexible Energy System*

As the deployment of renewable generation increases, storing cheap renewable power when there is an excess and discharging it when demand is higher or in low renewable periods, will become vital to the future functioning of the grid. In this regard flexible technologies and markets will be an enabler of net zero. Much of the system flexibility in the past has been provided by fossil fuels. This cannot continue if we are to operate a zero-carbon system by 2035 and meet UK's target of net zero emissions by 2050. Flexibility will need to be provided by cheap renewable and low carbon sources of energy. The Government, the Regulator and the network companies all agree on the need to invest in a smarter, more flexible system to ensure that the low carbon transition to net zero is efficient and benefits consumers and industry.

Short-duration and long-duration energy storage – from batteries, electric vehicles, pumped hydro and hydrogen – will be essential to achieve a net zero outcome at least cost to consumers while operating a safe and reliable energy grid. These smart low carbon sources will harness large amounts of data which will enable them to respond to price signals quickly and optimise performance, alongside other smaller system assets such as electric appliances.

Increased renewable generation coupled with storage, interconnection, and flexible demand (in the form of demand side response from consumers and industry such as heat and transport) would have to work hand in hand to enable all grid-connected assets to provide system flexibility when needed. Careful policy design is required to leverage the benefits of decarbonisation of heat (particularly in areas of high renewables as this could act as a useful source of system flexibility). A diverse renewable energy mix feeding into the grid will be critical to enhancing system flexibility. Regulation has the responsibility to set up new rules adapted to the new decentralised environment. Microgrids will allow better management of local production and consumption and alleviate constraints of the main grid, as well as facilitate the implementation of demand response.

By 2030 and beyond, multi-purpose interconnectors (MPIs) in particular will have a large role to play in integrating more renewables across GB and Europe and will be important source of balancing and seasonal flexibility. Despite progress made, currently there are still gaps in zero carbon operation – a factor partly addressed through the ambition to develop long term strategic storage solutions such as green hydrogen. New technologies and a growing ambition to deliver economically viable green hydrogen will ensure there is enough flexible demand to decarbonise the essential parts of the economy that electricity cannot reach.

Government has a unique opportunity to learn by doing, and we welcome early-stage innovation funding for hydrogen and long duration storage. We also believe that there are early opportunities to deliver MPIs pre-2030 and welcome the opportunity to work with Government to break down the regulatory and commercial barriers to deployment.

**Case Study: Pivot Power Cowley battery**

- Location: Cowley, Oxford
- Capacity: 50MW/50MWh
- Technology: Lithium-ion
- Commissioning date: 25th June 2021

In June 2021 Pivot Power, part of EDF Renewables, activated the UK's first grid-scale battery storage system directly connected to the transmission network, as part of the £41 million Energy Superhub Oxford project.

The government-backed project, led by Pivot Power, integrates energy storage, electric vehicle (EV) charging, low carbon heating and smart energy technologies to decarbonise Oxford by 2040 and create a blueprint for other towns and cities to accelerate net zero.

The 50MW/50MWh battery is the first to go live as part of Pivot Power's plans to deploy up to 40 similar sites throughout the UK, delivering up to 2GW of flexible capacity to support more renewables and increase the resilience of the UK's electricity network. Supplied by Wärtsilä, it is the first part of what will be the world's largest hybrid battery, combining lithium-ion and vanadium redox flow systems, which is due to be fully operational later this year.

Pivot Power is developing the battery in conjunction with a 5-mile private wire network, which will deliver large volumes of power to EV charging locations across Oxford, including the UK's largest public charging hub at Redbridge Park & Ride.

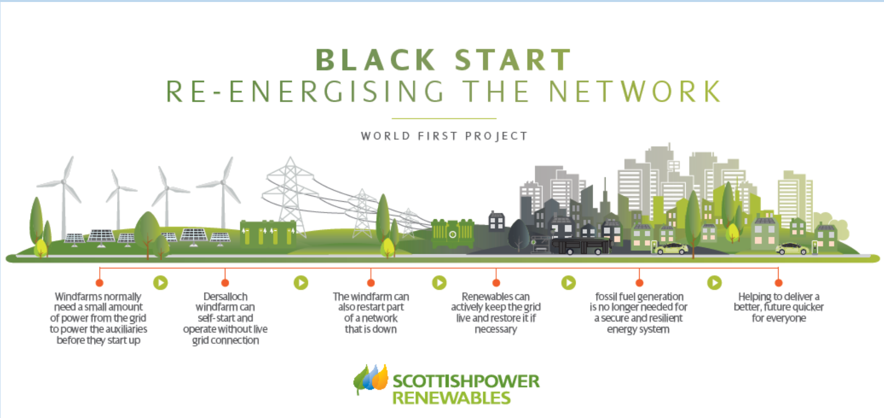
pivot power
EDF renewables

**Case study: Dersalloch Wind Farm Trailing Grid Forming capabilities (ScottishPower Renewables)[4]**

Onshore wind has the potential to be at the core of system services and restoration strategy. In November 2020 ScottishPower Renewables (SPR) and Siemens Gamesa Renewable Energy (SGRE) undertook a number of on-site trials to demonstrate converter capabilities for providing critical services to tackle identified system scarcities. Dersalloch Wind Farm project showed that a wind farm can perform the so-called black start service -- a procedure to restore power in the event of a major disruption of the transmission system. Black start restoration is typically done by conventional power plants. Using Dersalloch 69MW operational windfarm located in Ayrshire, Scotland, both inertia (fast injection of active power) and restoration capabilities were successfully proven in real life scenarios through the utilisation of the grid forming algorithm. The project is believed to be a world-first utility of scale trial that aims to work as a steppingstone for unlocking zero-carbon service capabilities for systems with high penetration of renewable energy.

**Through this project trial ScottishPower Renewables aims to demonstrate that renewables could play a bigger role in managing the electricity network, improving system resilience and security.**

While a significant amount of incremental improvement (software, hardware and energy storage) is still required to deal with the most extreme events which could occur, the wind turbines are able to provide stable and appropriate response and performance to the frequency events and fully de-energised networks.




[4] SPR, Practical Experience of Operating a Grid Forming Wind Park and its Response to System Events

**Case Study: Ventonteague Wind Farm in the Cornwall Local Energy Market (Centrica)**[5][6]

In 2020, Centrica completed construction of Cornwall's first, smart grid-connected wind turbine at Ventonteague. The 2.3MW turbine supplies energy to the equivalent of more than 1,400 Cornish homes and forms part of the innovative Cornwall Local Energy Market (LEM).

Launched in December 2016, the LEM project is a collaboration between Centrica, Western Power Distribution, N-SIDE, Imperial College, the University of Exeter and National Grid. The project brings Cornish homes and businesses together via a fully automated online flexible market platform. Through the LEM project **Centrica aims to increase the amount of renewable energy that can be deployed by managing the electricity network more efficiently**.

The smart grid-connected turbine demonstrates the concept of making small adjustments to the output in order to help smooth peaks and troughs in electricity supply and demand on the grid. It will help Cornwall better manage its energy supply and reduce Cornwall's greenhouse gas emissions by more than 3,300 tonnes a year over the next two decades.

## Why is system flexibility important?

The way electricity is dispatched and utilised through the system will need to change and that will require new dynamics in terms of network management. Greater levels of flexibility will allow the grid to cope with greater renewable generation on the system, reducing or perhaps avoiding curtailment of non-synchronous generation. We need to significantly increase the amount of flexibility on the system today in order to address the current levels of renewables curtailment on the system and rising constraint costs. As we move closer to delivering the increased commitments of the 6th Carbon Budget, curtailment of renewable energy generation should be considered a last resort.

Rules and regulations designed for centralised control of large-scale and predominately fossil fuel-based marginal cost generation will have to evolve in order to improve overall system resilience. The new dynamics in managing network flows across electricity, heat, gas and transport are a key enabler for mass adoption of low carbon solutions. These policy changes must also ensure that economically efficient security of supply standards are met so that policies and regulations are able to evolve and support the coupling of traditionally different parts of the sector. There should be an increasing focus on system needs and services out to 2050, while the use of Future Energy Scenarios and extended NOA could help identify the depth of each service requirement and location, considering additional heat and transport load for net zero.

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[5] Centrica, Cornwall's first smart-grid wind turbine to generate renewable energy from September, Ventonteague, 2020 https://www.centrica.com/media-centre/news/2020/cornwall-s-first-smart-grid-wind-turbine-to-generate-renewable-energy-from-september/

[6] Centrica, New wind turbine to supply green energy to 1,100 Cornish homes, 2020 https://www.centrica.com/media-centre/news/2019/new-wind-turbine-to-supply-green-energy-to-1-100-cornish-homes/

In the transition from DNOs to DSOs, activities such as investing in more network reinforcement are increasingly being opened up to non-traditional methods such as flexible technologies and demand-side response to provide services which can reduce the requirement for costly grid updates. Proposed policy positions driving the need for an independent Future Electricity System Operator (FSO) must consider the right outcome for the transition from DNO to DSO, while at the same time avoid any delays towards the evolution of ancillary service markets fit for net zero system operation.

Transition towards local energy markets is happening slowly across GB, but increasingly those markets will provide system solutions to decarbonising, balancing, and coordinating across supply, storage, and demand resources. Careful policy design is required to leverage the benefits of local markets whilst maintaining social equity and consumer confidence.

## Flexibility – a global opportunity

UK is the home of innovative companies in system flexibility, demand side response and energy storage. The UK could be at the forefront of developing flexibility, while greater coordination and innovation funding will create UK expertise to export across the world. There are tremendous export opportunities for some energy storage technologies and components such as flow batteries and liquid air storage.

The Government should take actions to unlock the 16GW pipeline of energy storage in the UK to provide greater flexibility and to minimise costs to the consumer to decarbonise the electricity system. An industry-led approach should be part of TSO/DSO whole energy system coordination so that novel technologies are able to compete in the market.

The development of local markets and deployment of distributed zero carbon assets brings many opportunities for community engagement and the development of skilled jobs. The Ten Point Plan for a Green Industrial Revolution and levelling-up agendas are well aligned with the devolution of energy system expertise and local development of innovative new solutions. Forward thinking policy support can help position the GB energy system as one of the most advanced and innovative on a global scale.

## Markets and system services – a key enabler

The inevitable trajectory of changing technologies, markets and behaviours is toward a smarter, more flexible system.

We are now moving into the next phase of decarbonising the electricity system - the national and local level markets that ensure security of supply and operability. To date, data has been poor on the true carbon intensity of these markets, while evidence suggest that these markets remain dominated by high carbon fossil fuel-based generators. In this regard, Government needs to ensure that markets and systems are underpinned by a clear decarbonisation remit, so that the carbon intensity of system services is valued and measured transparently.

We welcome the steps taken by BEIS, Ofgem and the ESO to enable new entrants (many of whom are renewable) to access and participate in flexibility markets. The design and implementation of all flexibility markets and services should have a benchmark of making a material contribution to achieving the net zero target. This should be at the forefront of the next electricity distribution price control (RIIO-ED2) and underpinned by greater co-ordination between DNOs and NGESO for provision of low carbon flexibility services across the whole energy system. Carbon signals have a key role to play to incentivise investment in low-carbon flexibility. A universal approach to carbon pricing would drive the transition from fossil-fuel dominated balancing markets to much more coordinated low carbon flexibility services.

The industry strongly supports the Electricity System Operator's commitment to being able to operate the national electricity system at net zero by 2035. Markets must evolve in order to facilitate that objective rather than sustain existing fossil-fuel providers. These services should provide the long-term investment signals in advance which are necessary to fund non-fossil fuel new build flexibility solutions. A good step forward would be if convertor grid forming capabilities are incentivised by NGESO through market signals to tackle stability and restoration service provision. The new System Restoration standard, which is being developed by BEIS and Ofgem, will need to ensure it does not implicitly prolong fossil fuel plant lifespans and can be delivered by a net zero energy system.

## Network charging signals – incentive for flexibility scale up

Current arrangements for network access and charging were designed in a world dominated by fossil fuel generators with centralised (and controllable) generation, with predictable uni-directional network flows.

Demands on the electricity networks have increased and significant investment is needed in new capacity, flexibility, systems, data and processes. Network operation and business models will need to evolve to ensure we decarbonise at the lowest cost and, ultimately, provide best value for the consumer.

Decentralisation is key: Transmission charges penalise generators for being connected in remote locations. This is based on the fact that those further out utilise more of the transmission network, which is built from one centralised location. These locational charges for transmission access block the commercial viability of renewable energy projects, creating uncertainty for efficient system network planning.

The ability to harness GB's renewable energy potential is reaching a limit due to the grid transmission network design, which requires upgrading. There is a clear understanding that projects in the north of Great Britain face greater barriers to compete, and greater uncertainty, than those in the south[7]. This is clearly exemplified by TNUoS transmission charges[8]. TNUoS reform is required to ensure a resilient electricity system that includes capacity and resources for flexible grid management.

Ofgem is undertaking two series of reforms to electricity transmission and distribution network charging and access to ensure the arrangements reflect the more dynamic nature of the electricity grid – the Targeted Charging Review (proposals under the TCR have been finalised) and the Access and Forward-Looking Charges Significant Code Review (where consultation is still ongoing).

These reforms have the potential to support the transition to a smarter, low carbon energy system. The industry would welcome greater assurance from Ofgem that the new charging

[7] https://vimeo.com/527746868/282e58fd46
[8] https://www.ssen-transmission.co.uk/media/5261/ssen-transmission-tnuos-paper-february-2021.pdf

arrangements will not negatively impact provision of zero/low carbon flexibility or discourage flexibility deployment in certain parts of UK. Locational charging signals have to provide a more stable long-term environment which supports growth in the provision of flexibility in areas of network congestion as well in areas of high demand.

De-risking investment into flexibility is a major driver for the energy transition. This includes greater visibility on the business case and predictable assessment of fluctuating grid charges.

## Recommendations

- Ensure that energy market regulation accelerates the transition to a smart, flexible, low carbon energy system. The design and implementation of all flexibility markets and services should have a benchmark of making a material contribution to achieving the net zero target.
- Create a fair approach to network charging which is fit for net zero. TNUoS reform is required to ensure a resilient electricity system that includes capacity and resources for flexible grid management.
- Encourage greater flexibility through increasing interconnection, grid-scale storage, vehicle-to grid (V2G) technologies and industrial demand response to maximise variable renewable generation. Provide catapult funding for long duration storage technologies – particularly those that can be deployed quickly in high constraint areas in UK.
- Put in place the right framework to enable to adapt consumption and receive pass through benefits of abundant cheap power. Increasing carbon signals in flexibility markets will also incentivise investment in the provision of low-carbon flexibility.

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