

Written evidence submitted by the Electricity System Operator for Great Britain (POW0090)

Introduction

As the Electricity System Operator (ESO) for Great Britain, we welcome the opportunity to submit a response to your inquiry. Our role is to operate the national electricity transmission system, whilst building a secure, clean, and fair system for tomorrow. We move electricity around the system, procuring services to balance demand and supply second by second, 24/7. We do not generate or sell electricity, or own and maintain any infrastructure, as the system operator we ensure fairness is at the heart of how we manage the system by remaining impartial and basing our decisions on consumer outcomes.

We work in partnership with Government, Ofgem, industry and consumers to guide Great Britain (GB) on the energy resources, markets and networks required to securely accelerate the transition away from fossil fuels. The ESO will make net zero carbon operation of the electricity system technically possible for short periods by 2025. By 2035, providing the market supplies a 100% renewable generation mix, we will operate a net zero carbon electricity system all the time.

We are currently transitioning into an independent public body, with responsibility for advising government across the whole energy system as it transitions to net zero, from strategic network planning across electricity and gas to new vectors such as hydrogen. The intent is for the Electricity System Operator to be at the heart of the FSO, which will build on the ESO's track record and world-leading expertise.

Why are we submitting evidence

In the last decade, working with Government, industry and Ofgem, we have helped Great Britain decarbonise its electricity system, with the pace and scale of decarbonisation amongst the fastest in the world. The scale of change needed to deliver a decarbonised energy system, demands urgent and collaborative action. We have provided a summary of our views below.

Executive Summary

- As the UK moves towards its 2050 net zero target, the Electricity System Operator (ESO) has an ambition to operate a net zero electricity system for short periods of time by 2025, doing this all the time by 2035 in line with government targets.
- Analysis commissioned by the ESO¹ indicates that even at times of low renewable output, it will be possible to operate a net zero electricity system in the 2030s. However, investment in clean, reliable technologies that are not weather dependent are required to reach this goal.
- Achieving a 2035 net zero electricity system requires a carefully controlled reduction in unabated natural gas use. This means that GB will need to find alternative sources of flexibility to fill the gaps when the sun doesn't shine and the wind doesn't blow, across durations of days to weeks.
- Extended periods of low renewable generation could be covered by a mixture of natural gas with carbon capture and storage, power plants that use hydrogen, new nuclear power stations, energy storage that can discharge for tens of hours or days, and interconnectors that import to or export from other countries.
- Extended periods of excess low carbon electricity supply could be addressed by flexible technologies such as electrolyzers, which use spare electricity to split water and create green hydrogen.
- Decision making in these areas should consider impacts across the whole energy system. For example, building a lot of inflexible, non-weather dependent generation could cause more periods of excess electricity supply. This is an example of a potential trade-off that should be considered in the context of keeping costs as low as possible, maintaining energy security and delivering net zero.

¹ [Electricity System Operator, Resource Adequacy In the 2030s, December 2022.](#)

GB's current electricity system and progress made so far

1. The British electricity system is one of the oldest and most complex in the world. It is evolving daily, as more renewable generation is connected into the grid from different locations. This evolution comes with new challenges that the ESO and industry partners need to collectively solve.
2. Today's electricity mix is made up primarily of renewables, gas and nuclear, supplemented by a few other sources. As of February 2023, GB had approximately 83 GW of generation from these sources connected to the transmission system. In 2022 our data² showed that zero carbon sources continued to outperform traditional fossil fuel generation by providing 48.5% of the electricity used this year, compared to 40% from gas and coal power stations. On 7th January 2023, GB was able to achieve 90.2% generation from zero carbon sources for a short period of time.
3. However, even with increased renewable generation, we are still dependent on fossil fuels, primarily unabated gas, to meet peak demand and to operate a reliable electricity system. This is because renewables are generally intermittent sources of generation, and therefore other dispatchable generation and technologies that provide flexibility are required to supply electricity and balance demand when it isn't windy or sunny.
4. The next few years will be critical to ensure there is a holistic whole-system energy plan, accounting for supply, demand and required transmission build. This plan must ensure strategic accountability is assigned to key bodies and decisions are made at pace.

Building a reliable net zero electricity system

5. As the UK moves towards its 2050 net zero target, the Electricity System Operator (ESO) has an ambition to operate a net zero electricity system for short periods of time by 2025, doing this all the time by 2035 in line with government targets.
6. Analysis commissioned by the ESO³ indicates that even at times of low renewable output, it will be possible to operate a net zero electricity system in the 2030s, however investment in clean, reliable technologies that are not weather dependent are required to reach this goal.
7. Today, the majority of GB electricity system flexibility comes from unabated natural gas. When electricity demand is high and there is low output from wind and solar, gas can be used flexibly to create electricity. Achieving a 2035 net zero electricity system requires a controlled reduction in unabated natural gas use. This means that GB will need to find alternative sources of flexibility to fill the gaps when the sun doesn't shine and the wind doesn't blow, across durations of days to weeks.
8. Extended periods of low renewable generation could be covered by a mixture of natural gas with carbon capture and storage, power plants that use hydrogen, new nuclear power stations, energy storage that can discharge for tens of hours or days, and interconnectors that import to or export from other countries. Extended periods of excess low carbon electricity supply could be addressed by flexible technologies such as electrolyzers, which use spare electricity to split water and create green hydrogen.
9. Decision making in these areas should consider impacts across the whole energy system. For example, building a lot of inflexible, non-weather dependent generation could cause more periods of excess electricity supply. This is an example of a potential trade-off that should be considered in the context of keeping costs as low as possible, maintaining energy security and delivering net zero.
10. The scale of the required build-out of new electricity generation and flexibility is immense. Some of the technologies required for a net zero electricity system still need proving at commercial scale and many have long lead times for delivery. The current barriers to delivering this capacity at scale by 2035 should be identified and addressed as soon as possible to reduce dependence on unabated gas.
11. Additionally, more transmission network infrastructure is needed to move energy from supply to demand. Our analysis⁴ shows that GB Electricity Transmission System is facing significantly growing

² [Electricity System Operator, Britain's Electricity Explained, January 2023.](#)

³ [Electricity System Operator, Resource Adequacy In the 2030s, December 2022.](#)

reinforcement needs in several regions. Across GB an investment of at least £50 billion in our electricity transmission network alone by 2030, this compares to around £100 billion invested in all energy networks since 1990.

12. There needs to be confidence to build the network in the timescales needed to connect new generation and demand if it is to be an enabler to net zero. A Strategic Spatial Energy Plan (SSEP), as recommended by the Electricity Network Commissioner, could play a key role in this if taken forward. The SSEP would aim to bridge the gap between Government policy and network development plans, with Government targets across the whole energy system to be spatially mapped across GB⁵. An SSEP would have oversight of many energy network plans, such as the centralised strategic network plan (CSNP), hydrogen network plans, carbon capture and storage (CCUS) plans and regional energy plans (REP).
13. This scale of investment within GB's transmission system could boost economic growth across the country over the next decade but developing this requires urgent anticipatory investment across the supply chain.

What will encourage a reliable net zero electricity system to develop at pace?

14. Wholesale market reform, network build and speeding up connections to the transmission system is required. Accelerated electricity transmission network build is needed to ensure the low carbon generation GB needs can connect into the transmission grid. However, electricity markets and subsidy support mechanisms must also be reformed to ensure investment in the right technologies occurs at pace and in the right location, and so that those assets generate and consume power in the most efficient way.
15. GB's electricity market was designed when our generation mix was fossil fuel dominated, easily switched on and off, and where a generator's location was agnostic to weather patterns. With rising weather-driven generation, the current wholesale market now can't effectively communicate which units of electricity are more or less valuable. These inaccurate price signals are resulting in wasted renewable generation. This is seen most starkly in the annual cost of paying generators to stop generating electricity causing constraint costs on the system.¹⁰ The cost turning off generators has increased eight-fold from £170m in 2010 to £1.36bn in 2022, with expectations this will rise further this decade.
16. Locational wholesale energy pricing reveals the true value of electricity at different times and locations - this market design is used successfully in other countries. International experience and recent research have suggested that locational energy pricing could reduce overall costs on the consumer by c.£30bn by 2030¹¹, with Ofgem shortly due to be publishing research on this. This design would also reduce network congestion costs by incentivising energy generators and storage behind constraints not to dispatch if the network is at capacity. We believe locational energy pricing would be a key enabler for GB's energy transition: coordinating high levels of weather driven renewables and new sources of flexible demand, such as electric heating, requires highly accurate communication between generators, consumers, networks, and system operators.
17. Innovation and smart digital solutions are required to enable consumers to further benefit from energy savings at times when they are not able to manually adjust their demand. Key to this will be developing consumer trust in data privacy. Smart digital solutions will enable effortless consumer participation in the delivery of a net zero whole energy system. Successful delivery of Market-wide Half Hourly Settlement will enable consumers to participate more readily in demand flexibility.
18. The potential of efficiency improvements in reducing energy demand should be harnessed, including improvements to the construction and technology within existing and new build homes.
19. The growth of distributed flexibility (flexible energy demand resources, such as storage, EVs, heat pumps and thermal storage, connected at distribution level) is a key enabler of net zero. A market-wide strategy, including government targets, policy support and market reform is required to facilitate the

⁴ [Electricity System Operator, Electricity Ten Year Statement, January 2022.](#)

⁵ [Electricity Networks Commissioner, Report Findings and Recommendations, June 2023.](#)

significant growth in distributed flexibility. This can also provide incentives for consumers to provide Demand Side Response, such as smart charging of EVs.

20. The electrification of cars will increase electricity demand and requires strategies to manage how they are charged and how system costs are recovered. Increasing implementation of smart EV charging is a low-regret action to help reduce the impact on peak demand and reduce curtailment of renewables. Commercial trials of Vehicle-to-Grid (V2G) business models are required to explore their viability and contribution to system services. It also requires current challenges to be addressed, such as the slow rollout of charging infrastructure.
21. Connections reform is required to facilitate quicker, more coordinated and efficient connection to the GB electricity system to deliver net zero. Continued collaboration between Government, Ofgem and industry is critical. We recognise that receiving a timely grid connection is a key challenge facing the GB electricity system. GB is not alone in facing this challenge - other countries with similarly rapidly decarbonising electricity systems are also seeing an exponential rise in applications to connect into their transmission systems.
22. As we transition to net zero, we've seen the electricity system transform from a relatively small number of large fossil fuel generators to a bigger number of diverse technologies. This has led to an unprecedented growth in applications, while the approach to connecting to the system has remained largely unchanged.
23. That is why, working alongside GB's Transmission Owners, Ofgem and industry partners we initiated a five-point plan to speed up the connections process:
 1. Allowing customers to leave our queue without incurring penalties for doing so. This amnesty closed in April 2023 and received over 8GW of interest – alleviating pressures within the pipeline of projects. This action has now been completed allowing developers of 52 projects to be offered the chance to give up their place in the grid connections queue without incurring hefty cancellation charges.
 2. We are working with GB's Transmission Owners to review and update existing contracts (that expressed an interest) with new Construction Planning Assumptions (CPAs).
 3. Batteries and other energy storage technologies soak up energy generation when connected to the grid as well as releasing it back onto the grid. As this technology has a dual purpose, we have changed how we calculate their impact on the system.
 4. We are also working with Transmission Owners to allow Energy Storage projects to connect quicker on a non-firm basis. This will speed up connections for up to 95GW of Energy Storage projects.
 5. We are developing new contractual terms for connection contracts to manage the queue more efficiently, so that those projects that are progressing can connect and those that are not can leave the queue. The proposals have now been consulted on and are with Ofgem for approval.
24. Alongside these measures, our GB connections reform project is considering enduring, long-term reforms to the process for connecting to and making use of GB's electricity transmission network. Our recent connections reform consultation, setting out our initial recommendations for enduring long-term reform, has now closed, and we are analysing the results of these. As part of these reforms, we are working closely with Ofgem and Government as they develop their Connections Action Plan, due out this Autumn.

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