A Day in the Life 2035

How a fully decarbonised electricity system might operate

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Executive summary

The Day in the Life 2035 presents an illustration of what a net zero power system could look like on winter's day with low winds and very little sunshine.

The analysis suggests that, even on such a winter day, the delivery and operation of a net zero power system is achievable, albeit with some legacy fossil fuel generation as a reserve. The technology needed is available today or will be attainable with continued innovation.

But it is a massive endeavour and success is uncertain. The critical requirement is a comprehensive net zero strategic delivery plan to accelerate the investment in low carbon generation, sources of flexibility, network infrastructure and digitalisation, as well as new system and market capabilities.

Achieving net zero will require the mobilisation of all parts of the energy industry and a myriad of market actors and stakeholders. It will also require the consent and active participation of businesses, energy consumers and communities in the wider society.

The prize is a decarbonised electricity system that remains both secure and reliable, and a major milestone towards net zero economy. It is also the opportunity to create a far more resilient and secure energy system, new consumer-based energy services and a range of enabling technologies and business solutions that will establish the UK as a world leader in the delivery of low carbon energy.

A net zero power system for a calm, cloudy winter day…

Despite good progress over the last decade, the race to build the necessary renewable generation to power a net zero electricity system is far from over. There is a huge challenge ahead to commission new wind, solar and other renewable energy projects, and to ensure that the infrastructure, systems and markets are in place to bring abundant low carbon energy to consumers in a cost-optimal way.

Energy storage is key, alongside development of low carbon dispatchable generation

The Day in the Life demonstrates that energy storage, especially long-duration storage, will be critical to make best use of low-cost energy, balance demand and supply, and to operate the system. The system will also need a significant capacity of low carbon dispatchable generation, potentially using fossil gas or bioenergy generation with carbon capture and storage or fuelled by low carbon hydrogen. New modular nuclear reactors could also play a role. However, the deployment pathway for these technologies is unclear

All types of demand-side flexibility will be needed

Energy consumers can play a critical role to deliver net zero in a way that is equitable and cost effective; they must be enabled to become active system participants. Domestic consumers play an important role, as do industrial clusters where concentrations of high energy demand, low carbon electricity generation, energy storage, heat recovery and hydrogen production could provide opportunities for multi-vector energy optimisation.

Smart technologies and agile markets unlock flexibility from across the energy system

There is an opportunity for new sources of energy demand to become active system participants, helping to balance the system and reduce energy costs. Smart electric car chargers, smart heat pumps with thermal storage, data centres and other energy users all play a major role throughout the Day in the Life, flexing their demand in response to price and/or system signals.

Integration, interconnection and diversity of supply will be critical.

During the Day in the Life, the net zero energy system is resilient because it is able to draw on energy from different technologies from different regions across GB, and from neighbouring energy markets. Diversity and market integration will help to reduce generation and price volatility caused by the weather. Interconnectors allow electricity to be imported during days like the Day in the Life, while allowing GB to become a net exporter of low carbon energy to neighbouring markets throughout the rest of the year.

Executive summary

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System operability is critical

Managing the quality and continuity of power supply will become more challenging, but good progress is being made in this area with exciting new technical and market solutions coming forward. The Day in the Life points to a wide range of industry initiatives and innovation projects that are addressing this issue. However, it is important that the operability challenge remains at the centre of the sector's thinking to ensure that the GB electricity system remains reliable.

Markets must also be efficient

Markets must demonstrate high levels of information transparency, good forecasting, competition, price discovery and transactional/market efficiency to enable a net zero system.

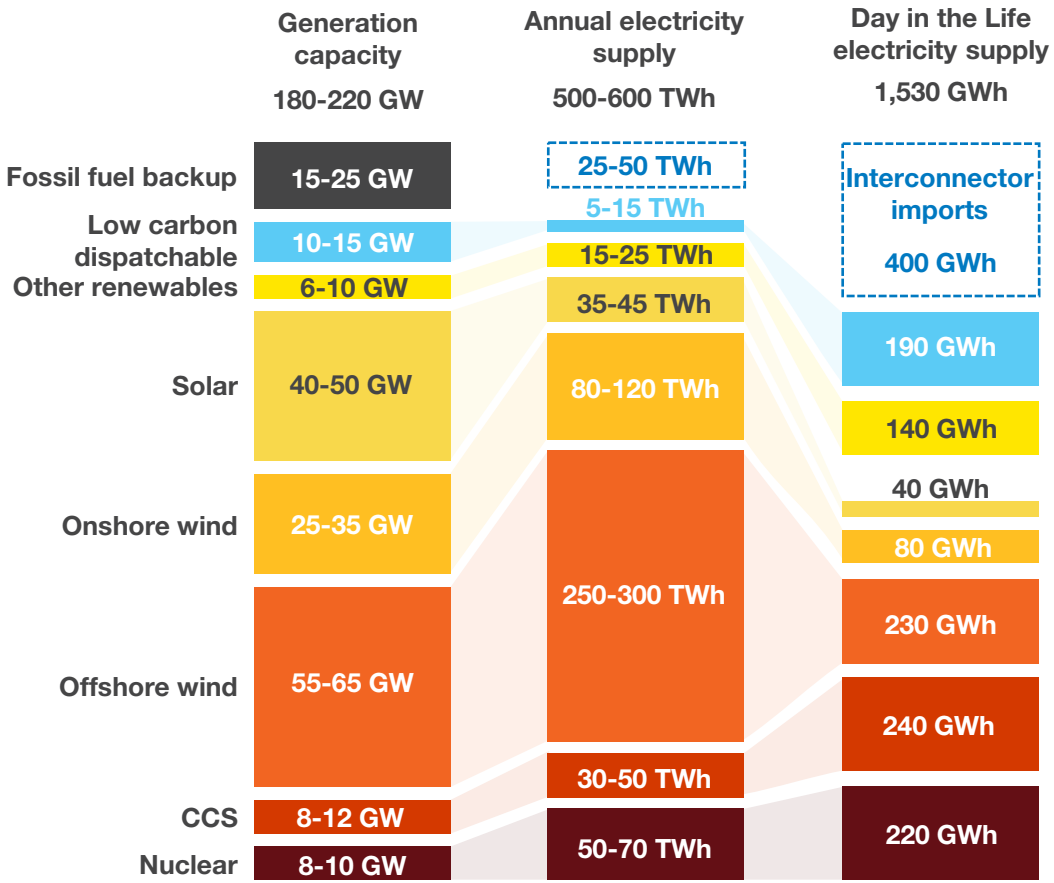
Collaboration and coordination between system operators, markets and actors is needed to ensure that the energy system works effectively and fairly

The technical and market solutions to operate a resilient net zero electricity system can only work if there is close collaboration between the ESO, network operators and the wider industry. Digitalisation and shared data will enable collaboration between these energy system actors, but there is still an organisational, regulatory and business process challenge to ensure that different system functions work effectively together.

Throughout the transition to net zero, there is an imperative to address wider socio-economic and equality issues. This includes, for example, tackling fuel poverty through energy efficiency, creating new green jobs while helping carbon-intensive industries to transition, ensuring costs are distributed fairly, and that access to new energy products and market services is open to everyone. In a more decentralised energy system, local and regional stakeholders have a greater governance and delivery role.

The Day in the Life 2035 reflects an energy system that will have undergone an unprecedented level of change in a little over a decade. Although there is a broad agreement on what is needed to make this happen, the nature of the transition will inevitably change and evolve as new solutions and opportunities present themselves.

The Day in the Life 2035 power system



Annual electricity supply in 2035 is dominated by renewables. However, on the winter Day in the Life, with low renewable output and high demand, supply draws heavily on carbon capture and imports, alongside energy storage and demand-side flexibility.

The net zero system

Click to explore eight key aspects of the 2035 net

Sources of energy flexibility

All forms of energy flexibility will be critical in the net zero energy

- **Vector shift**, such as using electrolysis to convert low cost or

Electricity storage

Electricity storage plays a critical role in the net zero power system. In addition to providing system services at both transmission and distribution level, energy storage will be critical to maximise the value of renewable electricity through 'price arbitrage': when electricity is cheaper, typically during periods of low demand and/or high renewable output, energy is stored. Electricity is then supplied when prices are highest, either when demand is high, available generation is low, or there is a requirement for system services.

In this way, energy storage, especially longer-term storage, helps to balance the system. Storage also helps to capture the value of what might have been 'wasted' excess renewable energy.

As technology costs reduce, and the business model for storage operators shifts from the provision of highly responsive network services to arbitrage, reserve and system balancing, it is expected that the duration of energy storage plants will increase. There is already a noticeable shift towards multi-hour batteries underway.

For the Day in the Life over 20 GW of battery storage is available, with an average storage duration of at least three hours, which is charged overnight and discharged at peak times during the winter day. This includes new liquid air and gravity-based storage, alongside new pumped hydro. Storage assets will often be co-located alongside sources of generation, and potentially near new forms of energy demand such as data centres and hydrogen electrolysis plants.

- **Location shift**, such as using interconnectors, Offshore Transmission Networks and greater grid integration within GB will allow electricity to be shifted to where it has most value.

Low carbon dispatchable 10-15 GW

CCS 8-12 GW

Flexible generation is covered in the 'Electricity generation' drilldown