Briefing

The building blocks of a secure 2035 zero carbon power system

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green alliance...

The government has committed to a decarbonised power system by 2035, subject to security of supply. What will that system look like and how will it provide secure electricity supply?

Zero carbon power by 2035 is achievable and cost effective

Analysis of electricity system models from six organisations, including the Climate Change Committee and National Grid, covering 30 scenarios, shows that a zero carbon power system by 2035 is achievable.[1] All but one model balances predicted supply and demand on an hourly basis throughout the year to demonstrate secure electricity supply.

In all scenarios renewables will provide most of the electricity. Renewables, predominantly wind and solar, are coupled with clean dispatchable (on demand) power and energy storage, to keep the lights on when the wind is not blowing and the sun is not shining. The scenarios also show that a zero carbon electricity system is likely to be cheaper than running a system that continues to rely on fossil fuels. The 2035 target is therefore significant in the context of the cost of living crisis.

National Grid expects periods of 100 per cent zero carbon electricity to begin occurring in 2025, demonstrating that a zero carbon system is within reach.

While this briefing focuses on electricity supply, the studies emphasise the critical need for energy efficiency measures, both to reduce overall electricity demand and to shift demand away from peak times.

What does a zero carbon power system look like?

Assessment of the 30 scenarios suggests that a zero carbon power sector will comprise three blocks:

Block 1: renewables

In 2035 the largest block is renewables, which will generate between 70 and 90 per cent of all electricity from a capacity of between 80GW and 280GW. Most models predict around 80 per cent of supply and 150GW of capacity. Offshore wind, onshore wind and solar will provide the vast bulk of renewable power.

Renewables capacity currently stands at 40GW, and it contributed about 40 per cent of the UK's electricity supply in 2020.

To develop the 2035 system, continued rapid build out of renewables, including onshore wind, and an end to grid connection delays, is required.

Block 2: clean dispatchable (on demand) generation

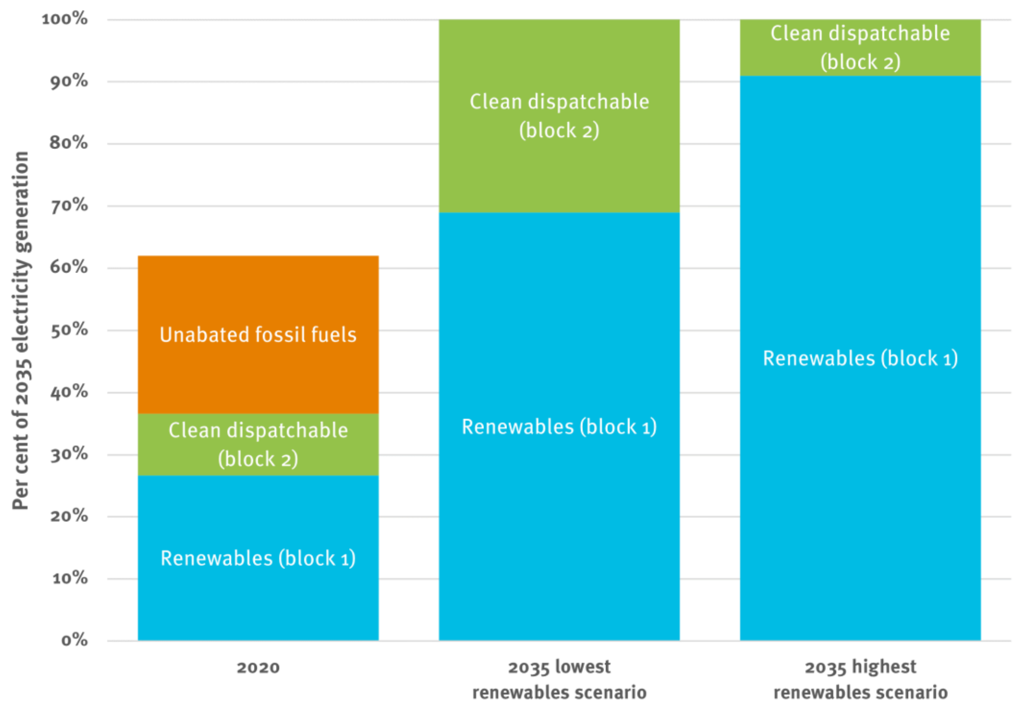
In 2035, the second block will comprise clean dispatchable generation using steam powered turbines, generating the remaining ten to 30 per cent of electricity from a capacity ranging from 10GW to 60GW.

The technologies may include green (from renewables) hydrogen powered turbines, nuclear, gas power stations with carbon capture and storage (CCS), or bioenergy with carbon capture and storage (BECCS). New technologies like enhanced geothermal, wave and tidal power may also play a role.

The grid has historically relied on unabated fossil fuels, bioenergy and nuclear generation for both constant and dispatchable power. Nuclear could be used more flexibly in future to provide dispatchable power, though this may make it more expensive.

Renewables will be the major source of electricity in 2035

Electricity generation by block in 2020 and 2035. Generation in 2035 will be about 50 per cent higher than in 2020. Block 3 is not shown here because storage and interconnectors do not generate new electricity.



There are pros and cons to each technology and there are climate risks associated with BECCS, gas with CCS and hydrogen that must be addressed for them to be truly considered 'clean'. None of these are deployed at the necessary scale yet, but all are in development.

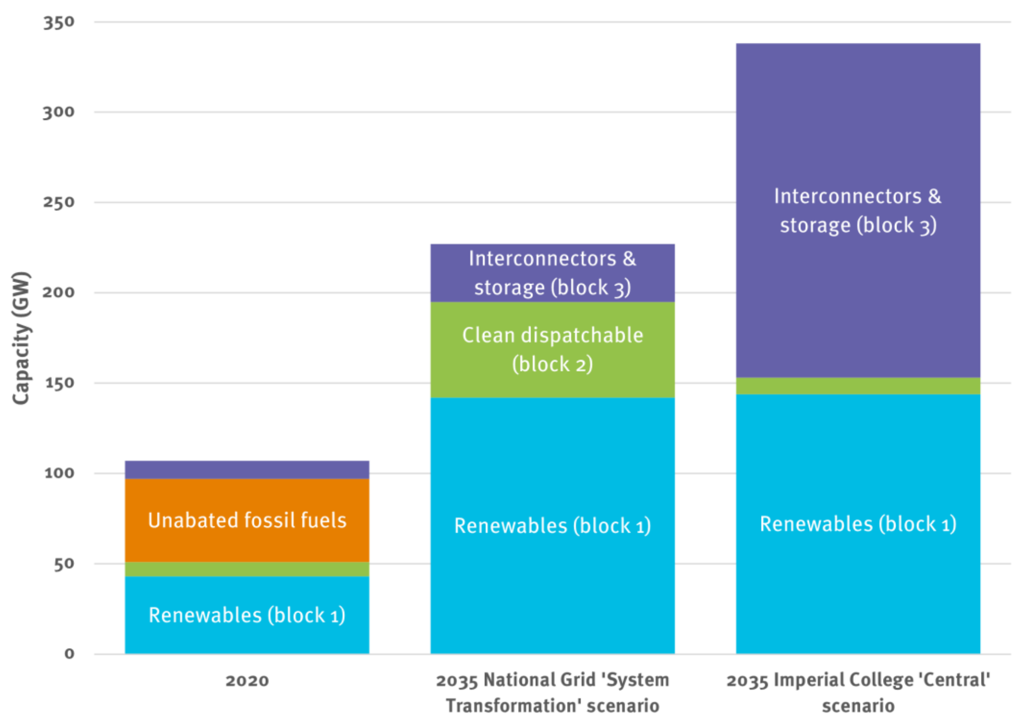
The government uses the capacity market to ensure security of electricity supply by providing a payment for reliable future sources of power generation. Reforming the capacity market so it increases the incentive to purchase clean dispatchable technologies, rather than funnelling money to fossil fuels, is important for this block to reach zero carbon.

Block 3: storage and interconnectors

The third block of a zero carbon power system comprises energy storage and interconnectors, which are crucial for matching supply and demand. Most studies expect 20GW to 30GW of energy storage and 20GW to 40GW of interconnectors, although Imperial College's models have 80GW to 190GW of storage.

Both clean dispatchable power and storage and interconnection will be needed, but there is uncertainty about how much of each

Power capacity by block in 2020 and in two example scenarios for 2035. Capacity reflects the maximum power that different technologies can supply. In general, scenarios with more storage and interconnection require less dispatchable power, and vice versa.



Battery storage, which can typically store energy for a few hours, will play a large role in 2035, and electric vehicle batteries could contribute to this. There is also a need for long duration energy storage, which can supply energy at times of extended low wind and solar production. Several long duration storage technologies exist. Some are well established, such as pumped hydropower, while others are less well developed but show promise, such as green hydrogen produced from excess renewable energy, flow batteries or compressed air storage.

Currently, energy storage consists of 2.8GW of pumped hydropower and 1.7GW of battery storage. Existing interconnector capacity is 7GW and is expected to grow to at least 10GW in the next few years.

Storing excess renewable energy at times of overproduction for use later is more cost effective than over building renewables (block 1) or using larger amounts of dispatchable power (block 2). Using interconnectors to export surplus energy and provide an additional source of flexible power at times of peak demand can also increase system efficiency.

As with clean dispatchable power (block 2), reforming the capacity market so that it increases the incentives to purchase these technologies can help the development of energy storage and interconnectors.

How the government can build a secure power system by 2035

The government has committed to a decarbonised power system by 2035, while Labour proposes to achieve it by 2030, which Ember's analysis demonstrates is possible. Support for a major expansion of renewables and faster grid connections is essential. The policies to achieve these are largely in place, though they need to be simplified and sped up.

However, there is not an adequate policy framework to provide dispatchable power and energy storage. There are opportunities to fix this via amendments to the Energy Security Bill, and through oral questions to the Department for Business, Energy and Industrial Strategy.

In the Energy Security Bill the government should:

- Commit to a 95 per cent zero carbon power sector by 2030 and 100 per cent by 2035.
- Commit to reform the capacity market to ensure capacity procured to balance the electricity system has a rising share of zero carbon power, consistent with achieving a zero carbon power system by 2035.
- Give Ofgem a net zero duty, to ensure the networks and infrastructure required for a decarbonised electricity system are built at sufficient speed and scale.

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Endnote

[1] We analysed 30 scenarios from studies by the Climate Change Committee, National Grid ESO, Imperial College London Energy Futures Lab, Regen, CREDS and Ember. Four scenarios had emissions intensities of 20 to 50gCO_2/kWh so were excluded; all other scenarios had intensities of 12gCO_2/kWh or less, including Ember's 'UK Gas Phaseout' 2030 scenario, and are included in the results.