Initial analysis and thoughts on the power outages on 9th August

AURORA ENERGY RESEARCH

Summary

- **Widespread disruption was caused by power outages on Friday 9th August after two large generators tripped and back-up capacity was not sufficient to stabilise the grid frequency**
- **Potential contributing factors include low inertia due to high wind and low thermal generation (though wind variability in itself does not initially appear to be a cause), insufficient flexible capacity, and oversensitive plant protection mechanisms**
- **Key questions for National Grid surround likelihood of repeat occurrences, level of procurement of services such as frequency response and reasons for disconnecting critical infrastructure**
- **If National Grid is to meet its stated intention of being able to operate a zero-carbon system by 2025, it will likely need to significantly increase its procurement of flexible capacity**

Background

- On 9th August, the system frequency dipped below 49 Hz just before 5pm when a total of 1.4 GW of generation across Little Barford CCGT and Hornsea offshore wind farm disconnected almost simultaneously – a loss of almost 5% of demand. Flexible generators contracted through ancillary services increased their output as expected, but this was not sufficient to bring the frequency back to normal levels quickly enough. As a result, National Grid's automatic backup protection system was triggered, causing selected demand across GB to be disconnected
- National Grid gave the all clear to the DNOs[1] within 15 minutes of the event and most affected areas saw power restored within an hour
- National Grid has claimed that this is a "rare and unusual" incident – the last occurred in May 2008, when Sizewell B nuclear plant and Longannet coal plant went off-line within minutes of each other - and is currently undertaking an investigation into the event
- Ofgem has called for an urgent interim report from National Grid by Friday 16th August and a final technical report by Friday 6th September; BEIS have also launched a formal investigation

Potential causes and contributing factors

Reasons for the initial plant trips are unknown (though RWE have said Little Barford shut down in line with normal practice). However, contributing factors to the resulting outage may include:

- **Low system inertia:** as non-synchronous generation (primarily wind, solar and interconnector imports) increases, the inertia of the system (its resistance to a change in frequency, arising from the kinetic energy in heavy rotating turbines) decreases and frequency becomes more volatile. When the outage occurred, wind output was high and therefore the level of inertia on the system was low (see chart overleaf), amplifying the effects of any plant trips. **Wind variability in itself, though, does not initially appear to be a contributing factor in this case.**
- **Insufficient flexible capacity:** low system inertia can be managed if there is enough flexible capacity (e.g. batteries, reciprocating engines, demand side response) able to provide 'synthetic inertia' and fast response in the case of an outage. Questions will arise over whether National Grid procures enough of this capacity through markets such as Firm Frequency Response and Fast Reserve.
- **Oversensitive protection mechanisms:** generating plants have protection systems where certain frequency events trigger a disconnection. It is possible that Hornsea dropped off the system due to activation of such a mechanism after Little Barford went offline (a similar effect was seen in grid outages in South Australia in September 2016). There may also have been contributions from smaller generators with similar protection systems.

1. Distribution Network Operators

Sources: Aurora Energy Research, Elexon, National Grid

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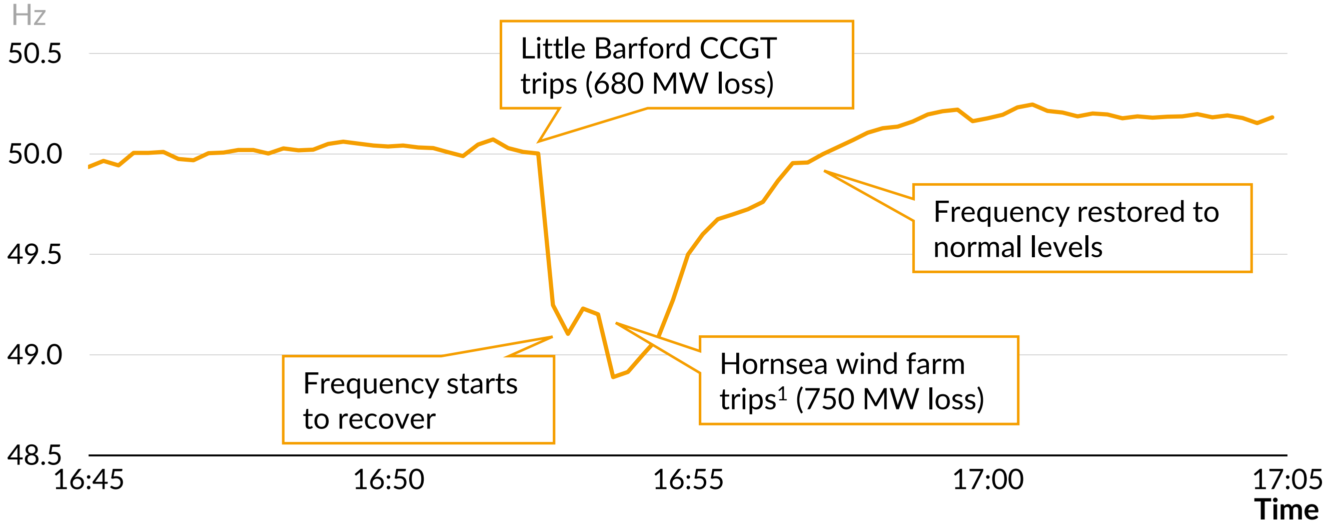
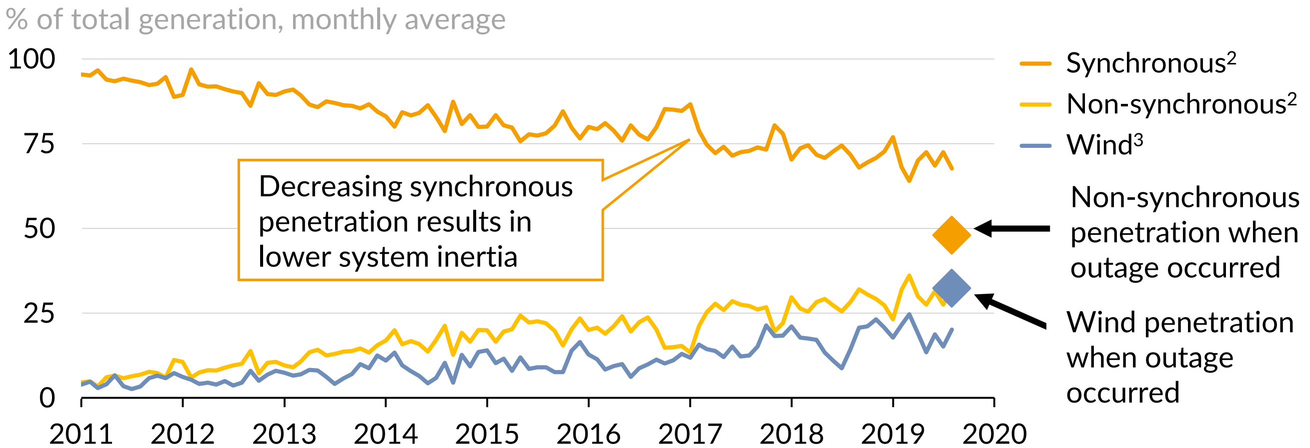
Key questions to answer

- **How unlikely was the event?** If the two plant trips were unconnected, it seems safe to assume the event was highly improbable – for example, if plant trips happen at an average rate of once per day over the entire system, the event of two independent trips within a 2-minute window would happen roughly once every 4 years. If, however, one trip caused another, then these types of events are more likely than National Grid may have intimated.
- **Is National Grid correctly valuing loss of load due to frequency variability?** Costs of procuring enough capacity through the Capacity Market have been much discussed in recent years. This event, however, highlights the need to place sufficient value on being able to manage frequency through ancillary services such as frequency response. Being prepared for every possible eventuality may be expensive, but we have seen that even short outages cause high levels of disruption and associated cost if key infrastructure such as airports, hospitals and railways are taken out. Currently around £170m per year is spent on frequency response - doubling this would add £2 to an average annual household bill. As renewable penetration increases and the expected opening of Hinkley Point C later in the 2020s adds to the largest infeed loss, requirements are set to grow significantly. National Grid must address this if it is to meet its stated aim of operating a zero-carbon grid by 2025.

Transmission network frequency during outage event



Historic generation in GB[1]



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1. Time for Hornsea trip assumed based on frequency data. 2. Synchronous generation primarily includes coal, CCGT, biomass, nuclear and pumped hydro. Non-synchronous generation primarily includes wind, solar and interconnector imports. 3. Wind is included in non synchronous.

Sources: Aurora Energy Research, Elexon, National Grid