Inertia and Grid Stability

The UK Black-outs on 9th August 2019

As is well known, on Friday 9th August the electricity supplies from one wind farm (Hornsea One, 750MW) and one generator set of one gas-fired power station (Little Barford, Cambridgeshire) failed almost simultaneously at 16:54. There was then a cascade of further trips within Little Barford, taking out the entire power station (680MW). The total capacity loss was ~1,430MW at the beginning of the evening peak. While National Grid's power was restored by 18:00, disruption continued throughout the evening on the transport networks. 16:54 is in Settlement Period 33; 18:00 is the end of Settlement Period 36.

Batteries and DSR on 9th August

Battery and Demand Side Response (DSR) advocates have claimed that they provided 560MW power within 5ms to 2 seconds, and had stabilised the grid if only further generation trips hadn't happened – if only there had been more batteries, the country would have been OK. But these trips occurred because of that 5ms to 2 second delay, so batteries were not part of the solution.

While batteries and DSR offer many useful grid services, shortfalls in their ability to provide sufficient grid resilience include:

1. Inadequate scale: typical battery and DSR installations are (even when aggregated) of the order of 1-20MW while the system need was 1.43GW;
2. Inadequate duration: the outage was longer than the duration of most battery and DSR services;
3. Battery state of charge: National Grid's plans appear to assume that batteries are always kept fully charged, whereas in reality they are all cycling in charge-state according to their contracts and commercial optimisation;
4. Battery and DSR activation times: even if perfectly available, the fact that batteries and DSR (and gas reciprocating engine plants) need to be activated actively imposes delays in response of a few seconds, during which delays the system fails, whereas inertial systems are an always-on response;
5. DSR response times: DSR resources need to be polled, signal availability, and then receive and respond to an activation signal, which increases their response times still further.

Inertia

What is really needed is real inertia. The true story of August 9th is that there is generally less inertia on the system (proportional to total generation) than there has been since the construction of the grid due to the retirement of fossil fuelled power stations. That day, inertia was low because wind generation was high. Had there been sufficient inertia, only one or two trips would have occurred, not a cascade of many. Storelectric's CAES solutions provide twice the natural inertia of an equivalent-sized power station, and provide it 24/7.

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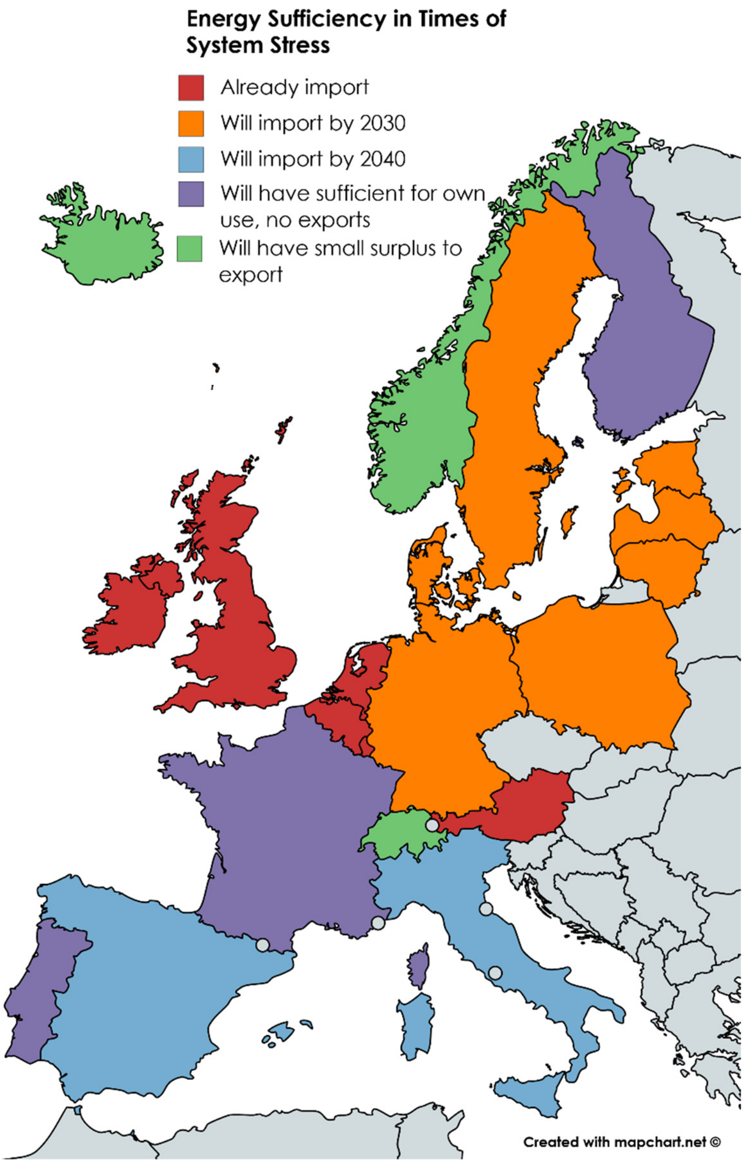
Grid-scale electricity storage
using an innovative form of
Compressed Air Energy Storage

Interconnectors in Europe

We have studied the energy transition plans of 6 countries in detail (UK, DE, FR, IT, ES, NL - who account for 75% of pre-Brexit EU GDP - please forgive the number of abbreviations!) and are aware in general terms of the plans of most of our other neighbouring countries. As can be seen from the map, during "times of system stress" (i.e. high demand and/or low renewable generation) the UK, NL, BE, EI and AT already rely on electricity imports through interconnectors. By 2030 these will be joined by DE, PL, SE and the Baltic states. By 2040 Spain and Italy will join them. France and Finland will have enough for their own needs due to nuclear, and Portugal due to hydro - but no surplus to export. Only Norway, Switzerland and Iceland will have electricity to export - and a 1GW interconnector to Iceland is expected to cost £5-10bn, 7-14 times the cost of Storelectric's CAES.



Given that these "times of system stress" are largely concurrent (e.g. after sunset on a windless winter evening), this means that there will not be enough spare electricity for all the countries that rely on the imports, yielding rolling black-outs and brown-outs (euphemism: enforced DSR) in all of them. And no grid operator will politically be able to say "I caused this black-out because we could earn millions by exporting what we needed".

So the only way for each of these importing countries to keep the lights on, and especially for the UK to do so, is large amounts of large-scale long-duration storage. Storelectric's CAES is a similar cost per GW to the BritNed interconnector and can be relied upon in ways in which (as we have seen) interconnectors cannot.

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