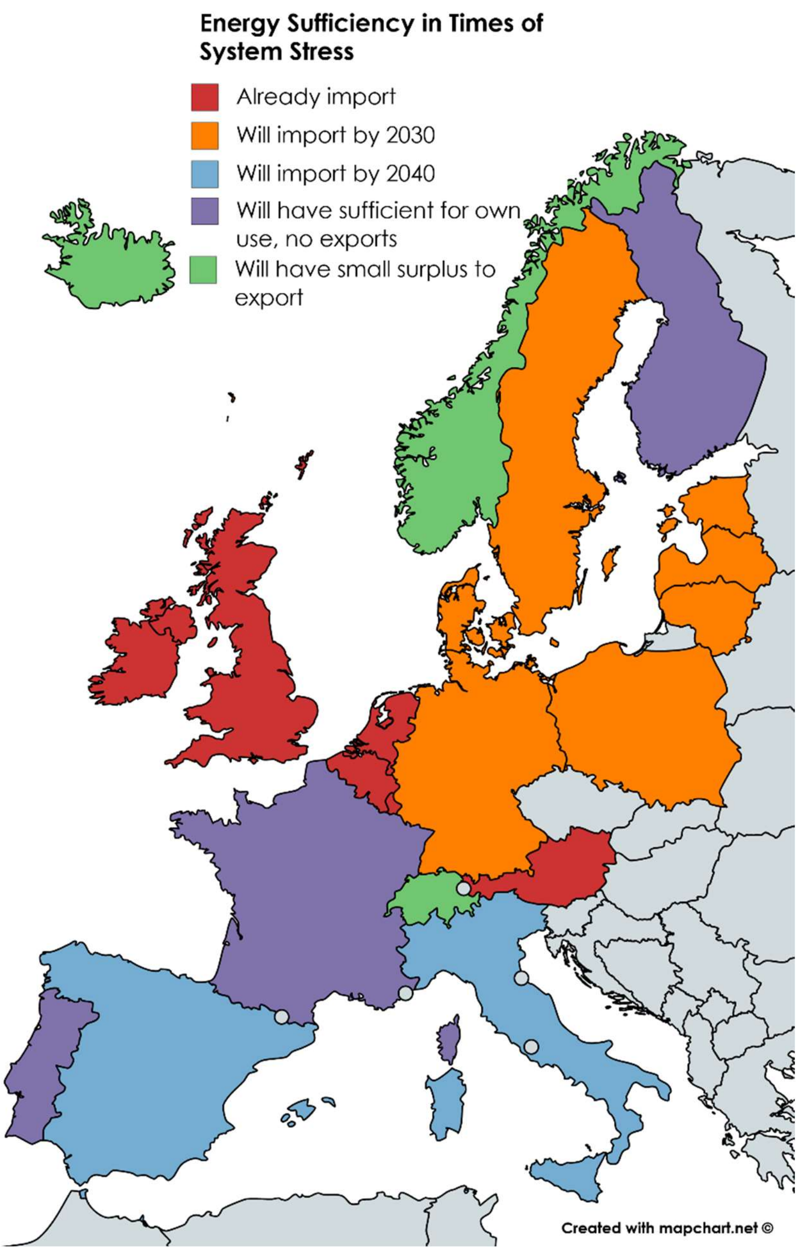
Grid-scale electricity storage
using an innovative form of
Compressed Air Energy Storage

Interconnectors in Europe

The United Kingdom no longer has enough domestically generated electricity for its own peak needs, and relies on imports through interconnectors. As the grid decarbonises, power stations are closing, increasing the country's reliance on intermittent renewable generation. But the sun doesn't always shine and the wind doesn't always blow, so how do we power the grid after sunset on a windless winter evening?

Storelectric has 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 via 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.



Times of System Stress

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, resulting in "enforced DSR", i.e. rolling black-outs and brown-outs, in all of them.

In Brexiting the Single Market and the jurisdiction of the European Court of Justice, the UK is no longer legally treated as domestic custom. This in turn gives them a political imperative to cut off Great Britain (even if breaching contracts) during times of system stress, as no grid operator will politically be able to say “we caused this black-out in one of our major cities because we could earn millions by exporting what we needed”.

Network of Interconnectors

Many have posited that when renewables are not generating in one part of Europe, they are in another, so grid resilience can be built by a large network of interconnectors. Indeed, European Projects of Common Interest are putting billions of Euros behind this concept. However the *kalte Dunkelflaute* (cold dark doldrums) identified by the French and German grids as occurring roughly every couple of years disproves this: it is a weather pattern that allows minimal or no renewable generation over the entire continent for a fortnight. If narrower geographies of a few countries, and shorter timescales of a few days, are considered, then these weather patterns are frequent.

Even if one corner of Europe were generating when another is not, then this would require a network of many hundreds of gigawatts of interconnectors in corridors at every point and half-point of the compass (i.e. 8 such corridors) in order to bring, for example, British and Irish generated wind to Greece and the Balkans, or Iberian solar to Scandinavia. There would heed to be further corridors of similar size framing the continent in case the split is north-south or east-west. This is not only prohibitively expensive but also environmentally very harmful.

Moreover, interconnectors are DC connected and so carry no natural inertia. Grid reliability depends on real inertia which can prevent failures. The synthetic inertia that can be provided by DC connected systems (including wind and solar generation and batteries also) is only good for assisting the speedy recovery from failure, not preventing the failure in the first place.

Massive Over-Build of Generation

Not only that, but every corner of Europe would have to have a massive over-build of renewable generation in order to feed those interconnectors. So, if there is wind and sunshine in Greece and southern Italy while Germany and Poland lack such generation and other countries have sufficient only for their own needs, then Greece and southern Italy would need sufficient wind and solar generation capacity to power Germany and Poland. This applies to every part of Europe, and would require a scale of over-investment in renewable generation that would be financially prohibitive, environmentally catastrophic and politically unacceptable.

Over-Confidence

National Grid publishes an annual Winter Outlook Report (and a summer one) in which they confidently calculate supply margins to be more than adequate. However their figures don’t stand up to scrutiny. While the 2020 report predicts a 4.8GW (8%) supply margin, it relies on 6GW de-rated (i.e. average) renewable generation which is often zero, 10GW “other” (un-defined and mysterious, probably short-duration and therefore quickly exhausted) generation and 2.8GW in-flows through interconnectors. Remove these and the supply margin drops to ***minus 4-14GW*** (-7% to -24%) depending on whether “other” generation is included.

The Solution

So the only way for each of these importing countries to keep the lights on, in every country and grid, is large amounts of large-scale long-duration storage. Storelectric’s CAES is a similar cost per gigawatt (GW) to the BritNed interconnector and can be relied upon in ways in which (as we see above) interconnectors cannot. And the proper role of interconnectors is not to provide resilience and back-up but instead to facilitate the operation of grids and to ensure that energy costs remain affordable throughout the continent.

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About Storelectric

Storelectric (www.storelectric.com) is developing transmission and distribution grid-scale energy storage to enable renewables to power grids reliably and cost-effectively: the world's most cost-effective and widely implementable large-scale energy storage technology, turning locally generated renewable energy into dispatchable electricity.

- Innovative adiabatic Compressed Air Energy Storage (Green CAES ™) will have zero / low emissions, operate at 68-70% round trip efficiency, levelised cost significantly below that of gas-fired peaking plants, and use existing, off-the-shelf equipment.
- Hydrogen CAES ™ technology converts & gives new economic life to gas-fired power stations, reducing emissions and adding storage revenues; hydrogen compatible.

Both technologies will operate at scales of 20MW to multi-GW and durations from 4 hours to multi-day. With the potential to store the entire continent's energy requirements for over a week, global potential is greater still. In the future, Storelectric will further develop both these and hybrid technologies, and other geologies for CAES, all of which will greatly improve storage cost, duration, efficiency and global potential.

About the Author

Mark Howitt is Chief Technical Officer, a founding director of Storelectric. He is also a United Nations expert advisor in energy transition technologies, economics, regulation and politics – invitation here.

A graduate in Physics with Electronics, he has 12 years' management and innovation consultancy experience world-wide. In a rail multinational, Mark transformed processes and developed 3 profitable and successful businesses: in commercialising a non-destructive technology he had innovated, in logistics (innovating services) and in equipment overhaul. In electronics manufacturing, he developed and introduced to the markets 5 product ranges and helped 2 businesses expand into new markets.

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