Saving Billions on Grid Upgrades

The UK government and grid are planning £16bn grid upgrades as part of wider developments to accommodate 35GW new renewable generation, largely from offshore wind. This is to accommodate the peaks of intermittent generation in order to reduce curtailment, and will require many unsightly new transmission lines – primarily up the Eastern side of the country. But it neglects three further challenges, which will cost billions more, in both investment and annual grid operating contracts:

- Sourcing balancing services;
- Sourcing stability services;
- Upgrading the grid to where those services are provided.

Global Applicability

Although this analysis focuses on the UK, that is only because the UK is further advanced than most in the decarbonisation of its grid (and most familiar to the author); the same issues will apply to most grids as they decarbonise.

The cost of getting it wrong is immense: billions in capital costs, and over a billion in annual operational costs – as shown by the first UK Lockdown.

Balancing Services

The balancing services are needed to keep the lights on during "times of system stress", i.e. high demand and/or low renewable generation. Currently the country relies on imports through interconnectors which, as has been analysed before, will not necessarily be available – and Brexit makes it politically unacceptable for neighbouring grids to fulfil their contracts with the UK if doing so would create or exacerbate energy shortages at home. Other sources of balancing services are power stations, which create emissions (and Carbon Capture and Storage is very expensive and imposes significant efficiency penalties and safety hazards) and storage. However, despite recognising a need for 20-40GW of storage, mostly of large scale and long duration, all regulatory and grid activity focuses on short-term investments into short-duration, small-scale batteries.

Stability Services

The stability services are required because power stations are closing. National Grid is at the forefront of dealing with one of their previously unappreciated benefits, namely the inertia that their large rotating generators provided which reduces the rate of change of frequency (RoCoF) when a fault occurs. It is that RoCoF that trips breakers. One of their strategies is to adjust all breakers to relaxed RoCoF criteria, which they proclaim a success, but which actually passes the problem down to customers' equipment. Another stratagem is to contract with "synthetic inertia" from DC connected sources such as batteries, interconnectors, and wind and solar farms. However synthetic inertia is an ultra-fast response time; any response time at all is a spike on the mains and thus a RoCoF event, and it was this reliance on synthetic rather than real inertia that caused the widespread black-outs of 9th August 2019. While synthetic inertia is good for recovering from faults, it cannot prevent them occurring in the first place.

Subsequent Grid Upgrades

Wherever the balancing and ancillary services are provided, if it is not at the point at which their need is created, there needs to be a suitable grid connection to them. This will require large-scale grid reinforcements throughout the system. To avoid this, the optimal place to provide such services is at the renewable generation, or at their point of connection to the grid, or somewhere between these two; failing that, grid upgrades can be minimised by minimising the distance between the service provision and the point of connection of the renewable farm to the grid.

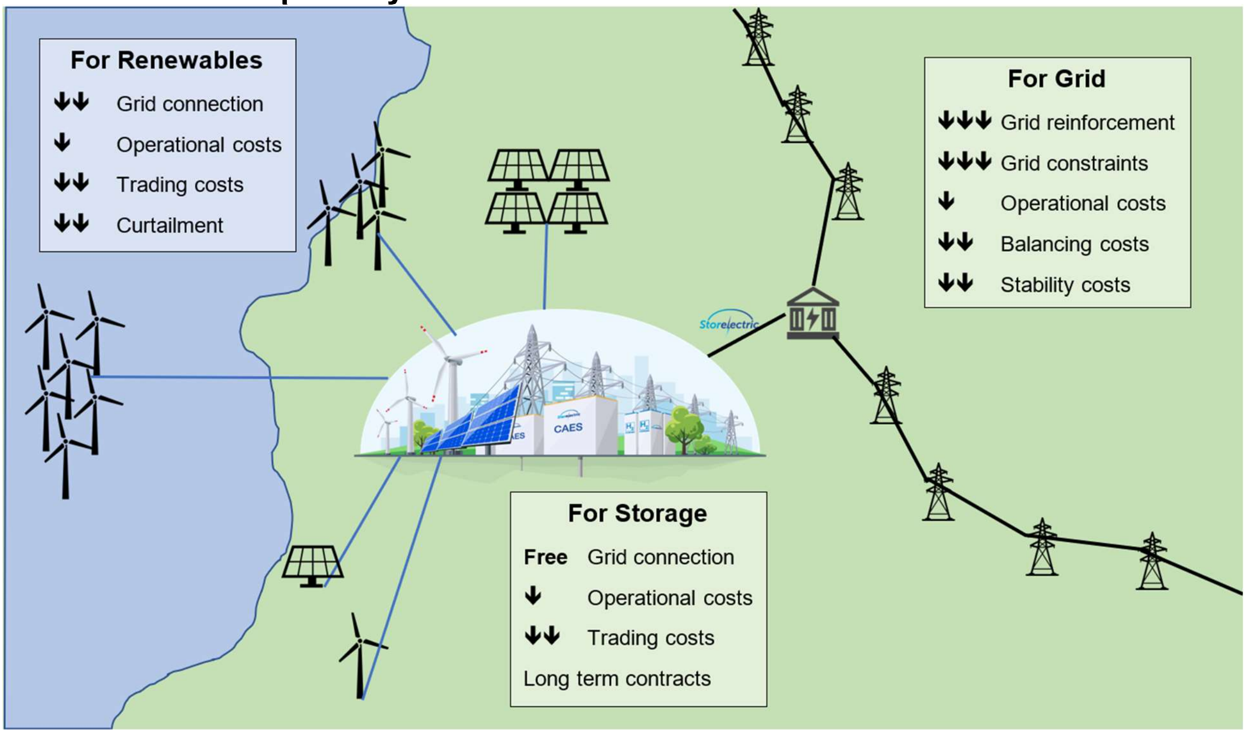
Problems with Distance

Even if the grid were to be upgraded to the point of remote provision of such services, this still leaves a number of problems.

The remoteness reduces the effectiveness of the cover. Each intervening substation reduces effectiveness of most services, including those listed above. This is much worse in cases where there is a transformer (to change the voltage level, e.g. between the transmission and distribution grids, or between layers of the latter) between the service provision and the need. This yields a diminution of the effect with both voltage difference and distance; and this diminution of effect requires increasing amounts of over-provision of the services to counteract it.

Distance and voltage difference also create delays between occurrence of the need and provision of the response, and (as above) any delay is (depending on the type of need) a RoCoF event, i.e. a spike on the mains. It is this which harms or trips further equipment and thereby broadens the failure through the grid.

A Better and Cheaper Way



Connecting large renewable generation to the grid ***through large-scale long-duration storage*** would greatly reduce costs and improve the services. It benefits the grid by:

- ♦ Reducing the size of grid connection and need for grid capacity / reinforcement – by a factor of 2-4 for offshore wind, 3-6 for onshore wind and 4-10 for solar;
- ♦ Providing the balancing services before the energy gets onto the grid, so that remote provision is not needed;
- ♦ Ditto stability services – all types of large-scale long-duration storage are naturally inertial, and Storelectric's can produce double-scale inertia 24/7.

Meanwhile, such a configuration could substantially increase the profitability of both generation and storage, and enable renewable farms to be built where grid congestion would otherwise prevent them. It would therefore be built and operate commercially.

What Needs to be Done

There are a number of things that government, regulator and grid need to do in order to enable all this – most of which cost nothing, and the remainder cost very little in comparison with the billions being planned. These include:

- ♦ Provide a level regulatory playing field for storage, including a regulatory definition of storage as storage and not as a sub-set of generation;
- ♦ Make slight changes to the regulatory setting of OFTOs (which connect offshore wind to the grid), so that wind farms can benefit from the storage;
- ♦ Incentivise and support the construction of first-of-a-kind plants, which have for years been prevented by regulatory and contractual measures;
- ♦ Provide contracts with durations and breadth that enable large, flexible plant to compete with smaller and more narrowly capable ones.

The result will save billions (or tens of billions) in grid upgrade costs, and further billions in both operation / maintenance costs and procuring services, whether for balancing / constraints, for inertia and stability (as shown by the blackout on 8th August 2019), for energy sufficiency in the UK, or for black start and other services. And all this is additional to the benefits in making renewable generation itself cheaper and more profitable.

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.