UK GRID REFORM

Solving the grid stability challenge

Increasing levels of grid-connected renewable energy is presenting a problem for grid operators tasked with maintaining stability. New approaches to grid management are set to match new technology in delivering a grid fit for the future, writes *David Appleyard*.

It wasn't so long ago that opponents of renewable energy were suggesting that as much as 10% renewable generation penetration could make the electricity system unmanageable. Today of course the UK has already far exceeded this notional limit and continues to rapidly expand its renewable capacity. For the end users of the UK's electricity transmission and distribution networks, there's little obvious evidence of the dramatic changes in the country's energy generation portfolio.

Nonetheless, with a steady reduction in the system inertia, the clean energy transition is a major challenge for the country's network planners and operators. It requires a new technical and strategic approach to deliver a stable and reliable power system fit for the future.

Changing times, different approaches

In order to address the challenge of increasing variable output renewable penetration, the UK's transmission system operator adopted a new strategy when it came to grid reinforcement project planning. Julian Leslie, Head of Network Capability for Electricity at National Grid, explains: 'The way the network is operating today is very different from how it was operating even just a year ago.'

Previously the grid would be strengthened and then generators could connect. However, no longer appropriate in the new order, an alternative strategy was developed: The "Connect and Manage" approach introduced for 2010 and 2011 was the real beginnings of how the industry was changing to adapt to these forms of generation,' he says, adding, 'it was the pragmatic approach to efficient development of the transmission network.'

Leslie outlines the benefits: 'It's enabled us to do many more things we wouldn't have been able to do on a pure invest and connect basis. It's opened the door for a cost-benefit assessment of what is the right investment and when the investment should be made on the network.'

The *Network Optioneering Analysis Report*, now due for its third annual publication, makes recommendations on transmission investments which should be taken forward.

'Through that process we save the consumer somewhere between £20mn and £80mn a year in the short term,' says Leslie. 'In the longer term we're saving £600mn to £800mn by looking at the cost-benefit approach, looking at alternatives to network investment and delivering those quicker to alleviate constraints on the network.'

Leslie says: 'Network investment optimising has been one of the key facets that has got us where we are today with the huge amount of renewable generation on the network.'

Getting access to data

Ultimately, good data is key to the development of grid reinforcement as well as alternatives to infrastructure investment.

Leslie explains the scale of the challenge: 'There's now 28 GW of embedded generation on the [UK] network. About 15 GW of that is renewable and the majority of which we have no visibility and no control over. We've been working with the Distribution Network Operators (DNOs) to create transparency of data and information flows. As long as we know what's installed and how big it is, then we can use our weather forecasting tools to predict how much solar and how much wind generation we're going to get.'

Weather forecasting, coupled with conventional demand forecasting tools, allows a reasonable prediction of likely requirements.

By moving to an open approach to procurement of services, National Grid also aims to encourage more market participation – through the Capacity Market or Enhanced Frequency Response (EFR) tender, for example.

'By increasing the transparency around the technical need and the technical requirements, and then opening that up to a very wide market, we really are driving down the cost for the consumer to provide these services for the grid,' says Leslie.

He cites the recent EFR, which tendered for 200 MW but received 1 GW of response from the market. 'It meant that the market price of those devices currently being commissioned and put onto the network is less than £10/MWh.' Almost all of the winning bidders presented storage solutions.

Leslie adds: 'The Electricity System Operator Forward Plan is due to be delivered in the next 12 months and recasts how the grid

is incentivised. We're going to look at bringing new market systems in to solve some of these transmission issues.'

Storage set for big impact

Storage is seen a key route to build synthetic inertia within the system to improve stability. Jonathan Robinson, Principal Consultant, Energy & Environment at Frost & Sullivan, says: 'New wind projects are starting to piggy back off existing infrastructure and renewable operators are already preparing themselves for a renewable plus storage proposition.'

Indeed, last August ABB won an order from DONG Energy (now Ørsted) for a 2 MW battery storage system for the 90 MW Burbo Bank offshore windfarm near Liverpool. ABB says the system will help stabilise grid frequency.

Robinson suggests storage may even become mandated: 'not necessarily at the renewables source but somewhere along the grid to back up renewables,' he says.

With OEMs and automotive manufacturers all piling into the storage sector, industry consolidation, a continuing fall in costs and with that increasing utility engagement, is anticipated: 'As costs continue to fall utilities will probably be less opposed because they'll see it as an opportunity to trade electricity at exactly the right time. If they don't embrace storage there will be other organisations or companies that will step into that role,' adds Robinson.

Nonetheless, some technical challenges remain for batteries to realise their full potential: 'As the capabilities of batteries increase then we might see storage penetrating even more into markets like ancillary services for balancing purposes and frequency response,' says Frost & Sullivan's Energy & Environment Analyst Vasanth Krishnan.

Transmission System Operators (TSOs) and DNOs in the next eight-year investment cycle in 2023 will also be expected to see far more storage investment. Says Robinson: 'There will be an allowance for the DNOs and TSO to actually invest in storage and be able to pass some of that [cost] onto the consumer. That will help incentivise them.'

The role of the market

Changing consumer behaviour can also help to manage some network impacts by using power close to where it has been created. There have already been some trials in the UK. For example, a time-of-use charging trial based on the quantities of solar PV generation on the south-western network of Western Power Distribution has been conducted. Over 10% of Wadebridge homes have solar PV and with its Sunshine tariff, from July 2015 through to February 2017, consumers who signed up through a local energy cooperative were able to adopt a tariff of 5 p/kWh during the summer months from 10am to 4pm.

More recently, in May ScottishPower launched its electric vehicle home charging tariff. Based on 100% renewable energy, the tariff is aimed at an EV market that is still nascent. Neil Clitheroe, CEO of Retail at ScottishPower says in a statement: 'All analysis shows that the shift to electric vehicles will gather serious pace in the coming years. Our growing focus on electric vehicle services and bespoke tariffs reflects the exciting changes.'

Meanwhile, EV leader Nissan launched an offering in May featuring PV and energy storage for the UK consumer market. According to the company the system offers a way for consumer properties to create, store and consume energy, such as when charging EVs, with a home energy management system.

Again it is data that is enabling and delivering changing consumer behaviour with new markets.

Leslie outlines the National Grid approach: 'We're finding out ways in which this can work that allows the distributed energy resources to be compensated and rewarded for the actions they are taking, but also for us to have access to the tools and services that allow us to operate the network more cost effectively.'

Frost & Sullivan's Krishnan also highlights the role of better communications: 'I see a lot of demand side energy from multiple sources: homes, cars, roads; with the customer being at the heart of it all. What comes to mind is IIoT [Industrial Internet of Things]. We could see a lot of IIoT-based models being implemented in the future, where the control room could be remotely located and can monitor everything on the connected system; that's where we're heading.'

This predicates the development of the smart grid in the UK, as Krishnan's colleague Robinson observes: 'With the smart grid it's a very much bottom up approach overall, its incremental, increasing the intelligence of the grid, more at a local distribution level that will ultimately build into a much smarter network.'

The UK is currently rolling out its smart meter programme, albeit with some delays – that will give the DNO greater transparency over what is actually being generated and consumed on the network. It will also open up the range of services that can be offered to residential customers and potentially increase consumer engagement.

As Robinson says: 'As we have more devices moderating demand, as long as it can be done relatively seamlessly – and I think we'll get to the point where that can happen – then there will be some activity. It's not going to dramatically change the profile, but it may tweak the profile to an extent at peak times to the point where the need for peak generation will change.'

The future grid

Looking forward into the later 2020s and 2030s, electric vehicles are set to have a big impact on grid management. The increasing electrification of transport signals both increasing electricity demand and an opportunity to harness both flexible demand and embedded storage capacity. Robinson says: 'For the charging infrastructure in the UK there's been rapid investment in the last six or seven years. I can see a point where that market really takes off and when that happens obviously EVs will really change the demand loads on the grid.'

This is a point noted by Leslie: 'With electric vehicles coming on, if they are deployed effectively, then they are part of the solution. If we have the right time-of-use tariffs in place – we'd need hourly or half-hourly metering to make this work – you'll get to the point where people are charging their cars when it's sunny or windy because it's going to be a lower cost tariff.'

He concludes: 'All of a sudden, this network starts balancing itself because of the live incentives and live tariffs and the smart car, with the smart charger, connected to a smart home just manages all that for you. 'That will be the next evolution, where we see virtual power plants being procured through some sort of tender process and we'll see a whole combination of wind and solar with batteries, with really smart quick-acting power electronics controlling the whole thing.'

From better management, to storage, sophisticated power electronics, consumer behaviour and the rise of electrified transport – ultimately the solution to the renewables integration challenge is 'all of the above'. ●

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David Appleyard is a freelance journalist

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