OLD GRID, NEW POWER: ADAPTING TO RENEWABLES

The renewable energy industry is largely focused on the technologies involved in harnessing and converting wind, solar or marine power. However, there is another vital element that is often overlooked – getting the product, clean electricity, to the grid.

- By Mike Scott

Most electricity grids date from the 1950s and 1960s and are designed to cater for a small number of large power plants, for the most part situated near to centres of demand. With renewables, completely the opposite situation applies – capacity comes in the form of a large number of smaller projects, often remote from centres of demand and currently ill-served by the grid system.

In the UK, much of the renewables capacity, in the form of wind, wave and tidal power, is located in Scotland while electricity demand is concentrated in the south of England. "One of the key constraints is the weakness of the connection between England and Scotland," says Dr Graham Sinden, technical manager at the Carbon Trust. But plans to upgrade the grid have become bogged down in planning wrangles.

Scottish Power has plans in place to upgrade the Beauly-Denny transmission line, the backbone of the Scottish distribution network. This should have been a year in the planning and taken two years to build, but it is now the subject of a public inquiry and the upgrade is unlikely to be completed until 2016, says Graeme Cooper, head of grid, health & safety and technical affairs at the British Wind Energy Association. This means the plentiful wind and wave resources of the north of Scotland and the tidal resources of the Pentland Firth, between the North of Scotland and Orkney (which contains 50% of the UK's tidal energy resource) cannot be fully exploited because of the lack of grid capacity.

This is one example of how the planning system slows down the development of renewables – some 14GW of renewables projects remain stuck in the pipeline, mostly in Scotland, according to Chris Lock at Ofgem, the UK regulator. The system urgently needs reforming, he adds.

Grid issues are not unique to the UK. In the US, the American Wind Energy Association says that one of the biggest constraints on wind energy's growth "is the capacity of the transmission grid to deliver wind energy to customers", while the China Wind Energy Association recently announced that only 4GW of its 5.6GW of installed capacity was connected to a grid, meaning that more than a quarter of its wind turbines are sitting idle.

The problem of grid access is often exacerbated by landowners who refuse to allow pylons on their land. The cost of installing offshore cables is much greater than on land, but because the impacts of laying cable at sea are minimal and it is relatively easy to do, developers may prefer to take this more costly option if it means they can bypass some landowners, according to Chris Jenner, technical director, renewables at RPS Energy.

Last December, the UK government announced an ambitious target to install 33GW of offshore wind capacity by 2020. In January of this year, the proposals edged closer to reality when the national electricity and gas regulator Ofgem and the Department for Business Enterprise and Regulatory Reform announced there is to be a competitive tender for the connection of 8GW of offshore wind capacity to the national grid.

Paul Birkinshaw of Econnect Consulting, who is carrying out a study funded by Npower Juice, says prices for onshore wind connection vary significantly, from GBP 50,000 per MW to more than GBP 100,000 per MW but logistical challenges add significantly to the costs for offshore projects. A 2005 report by Econnect said: "The average cost for the best mix of connections [for offshore wind projects] is GBP 167,000/MW." Costs will have risen considerably since then because of an increase in the cost of commodities and a skills shortage in the engineering sector. But Jenner says: "the biggest barrier to installing wind capacity – particularly offshore – remains turbine supply and the availability of installation vessels. There is a 3-4 year waiting list for offshore turbines at the moment."

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In large markets such as the UK and the US, the proportion of renewable energy on the grid is unlikely to be an issue for some time, but in smaller markets with lots of renewable potential, grid operators are facing a situation they have never had to deal with before, according to Hugh Sharman of Danish energy consultancy Incoteco. Conventional fossil fuel plants cannot compensate quickly enough for the variations caused by large amounts of renewable power, so a number of locations with more than enough wind resource to provide all their electricity needs – such as the Shetlands or the Faroe Isles – can only exploit a small proportion of their potential because diesel generators cannot cope with the variations caused by high levels of wind.

Unfit for purpose: The grid systems of many countries need a radical overhaul if they are to connect remote sources of renewable power to customers. *Source: Terna*

Denmark, which has one of the highest levels of installed wind capacity per capita in Europe, deals with this issue by exporting surplus wind to its neighbours Sweden and Norway. If the wind turbines are generating more power than the grid can cope with, the power is exported to its neighbours where it displaces hydro power, which is 'stored' for future use. But because the electricity is surplus, it is sold very cheaply. However, when the wind is not blowing and Denmark needs to import electricity – by definition at peak times – it has to pay a lot more than it gets for its exported wind, says Sharman.

Airtricity, the Irish wind generator that has just been bought by Scottish and Southern Energy, has proposed a European 'supergrid' that would initially connect offshore wind farms in Germany, the Netherlands and the UK, with the potential to be extended to installations from the Baltic Sea to the Mediterranean. Such a grid would make it easier to integrate renewables into the grid and exploit the fact that weather systems that produce no wind in one part of Europe generally create wind elsewhere on the continent. In fact, such a grid is being put together in a piecemeal fashion already. An interconnector between Germany and Norway has been proposed that would allow Germany to export its wind power to Norway in the same way that Denmark does. It is one of a number of proposed interconnectors in Europe, including links from Norway to both the Netherlands and the UK.

Ireland has relatively high levels of wind penetration – 700MW installed capacity last year, and is adding 250MW a year – but it does not have the same outlets for surplus renewable energy as Denmark because it is on the edge of the European grid and has only a weak connection to the UK. What Sharman calls 'uncurtailed' wind costs about EUR 70/MWh in Ireland, against more than EUR 100/MWh for electricity generated by gas, but once you start to 'spill' wind generation to keep the system stable it becomes less economical. To make the most of its huge wind potential, Ireland is looking at energy storage, which allows a significant increase in the proportion of renewables on a grid, improves their economic potential by allowing them to sell power at peak times and provides the basis for a range of ancillary services such as peak shaving.

Apart from pumped hydro, which has severe geographical limitations, other forms of power storage are in their infancy. Flow batteries made by companies such as VRB, or compressed air storage championed by General Compression are still on the drawing board. Ultimately, it may be possible to use surplus renewable electricity to charge electric cars or generate hydrogen to power fuel cells either for cars or the home. Variations will also be smoothed by the expansion of different sources of renewable energy – wind and wave power are both variable, but they are not perfectly correlated, which would help compensate for the variability, while tidal energy and solar power have no correlation to wind and wave patterns.

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The development of significant amounts of distributed generation capacity will also help to smooth output. In the UK, this is likely to come initially through the use of micro-CHP, but in countries such as Germany, solar power already plays a significant role, with 1GW a year being installed on homes, farms and commercial buildings, according to Jon Slowe, a director at consultancy Delta Energy.

The International Energy Agency says investments of almost USD 5,000bn globally are needed in transmission systems by 2030, so there are significant opportunities related to connecting renewable energy projects to the grid. These range from consultants such as Econnect and RPS to companies such as ABB, which is working on the HVDC connection between the UK and the Netherlands.

Companies working on ways to improve the efficiency of the grid itself are well placed to benefit. American Superconductor, for example, is one of the leaders in developing high-temperature superconducting wires, while Raymor, a Montreal company, is working on carbon nanotube wiring that, in theory, could conduct 100m amps of current over thousands of miles without losing efficiency, compared with today's wires, which can conduct only about 2,000 amps for hundreds of miles, but lose 6-8% electricity in the form of heat. They would be much lighter than existing wires, too, meaning they could be much less intrusive than current pylons. On a smaller scale, companies that can help integrate distributed generation into the grid – those involved in demand management, load management and smart metering – will see strong demand.

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