University of Nottingham
Institute for Policy and Engagement

Policy Brief:
Making the most of the UK's offshore wind

Ensuring UK energy policy supports flexible and more economical renewable wind-powered energy production.

Executive Summary

For the UK to achieve its now-legal commitment to achieving "Net-Zero" by 2050, it is not sufficient simply to generate the same amount of low-carbon electricity each year as is consumed. Energy policy must also cater for flexibility. The need for flexibility is cumulative with the penetration of low-carbon generation. Late consideration of how to provide this flexibility will cause substantial unnecessary cost. Current UK support mechanisms for low-carbon generation impede the early adoption of affordable flexibility. This policy brief proposes a slight policy change that resolves this problem with no downsides.

Recommendation

Modify the Contracts for Difference (CfD) mechanism so that low-carbon generation that could provide substantial flexibility would be rewarded additionally for that service.

This modification will reduce both cost and the time required to achieve Net-Zero. Parties not choosing to provide flexibility could still enjoy the certainty of returns from CfDs.

Key findings

One increasingly-likely set of possibilities for achieving "Net-Zero" can be described as "100% renewable" – where all energy consumed is drawn from renewables. For this, it is not enough for a country or corporation to generate the same amount of electricity from renewable energy (RE) as it consumes each year. If each UK nation did only that, the frequent mismatch between electricity supply and demand would require much generated RE to be discarded when generation exceeded demand and would need some non-renewable generation to supply electricity when RE resources were insufficient to meet demand.

A country or company can claim to be truly "100% renewable" only when it either (a) does not rely on an external electricity grid to absorb excess energy and provide power during times of shortfall or (b) it pays proportionately for this flexibility service.

There are two elements of cost in delivering electricity: (i) generation and (ii) flexibility. Existing designs of RE generators provide no intrinsic flexibility except that one may turn down any output.

The total UK offshore wind resource is huge – enough to power all our energy requirements and more. Moreover, since costs of generation from wind have fallen very dramatically, (£39.65/MWh was bid in Sept. 2019) an RE-powered UK is clearly viable so long as the flexibility to reconcile electricity supply and demand previously provided by fossil-fuelled generation can be replaced with zero-carbon options.

Several different technologies are in development (see *Emerging Technologies* overleaf) that could allow a wind turbine to collect energy when the wind is blowing and (effectively) generate electricity on demand. The CfD scheme stands in the way of such technologies being adopted because it rewards net generation at an almost-completely flat rate.

Levelised Cost of Flexibility (LCoF)

The levelised cost of energy (LCoE) describes only the cost of generating electricity. When RE provides only a small proportion of total generation and fossil-fuelled generation is significant, marginal costs associated with flexibility are negligible because sufficient flexibility is available from coal/oil/gas plant. However, as the penetration of renewables rises, the costs associated with flexibility also rise.

These costs are real and significant. Figure 1 illustrates how the total cost of electricity will vary with increasing penetration of renewables and nuclear energy. With high levels of RE penetration, the levelised costs of flexibility (LCoF) may exceed those of primary generation. The dashed green line indicates that LCoF may be lowered if flexibility is integrated with generation. Conceivably in 2050, the

LCoE from RE may be £25/MWh and LCoF could easily be £25/MWh-£40/MWh depending on whether or not that flexibility is achieved in clever ways.

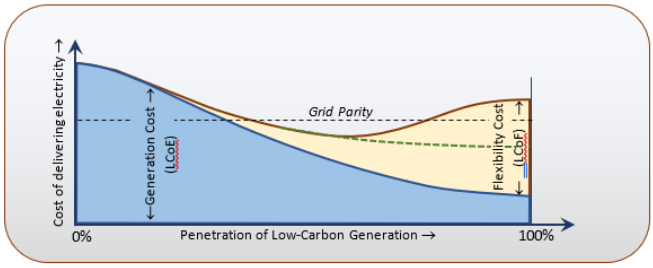

Figure 1: The cost of delivering electricity comprises costs of generation and flexibility.

UK Policy

Governments and corporations worldwide have recognised the need to achieve net zero greenhouse gas emissions to prevent further harmful climate change. There is some widespread and serious misunderstanding of what that entails

The UK has enough RE resources to power its own requirements fully and still export power. High penetrations of RE in our electricity system will happen. By 2050, if we have electrified most heating and transport, total generation might be 1000TWh/year (1 billion MWh). The difference between good and bad treatments of flexibility could equate to ~£15bn each year.

The original support mechanisms for low-carbon generation (renewable obligations certificates and feed-in tariffs) provided fairly flat rewards per unit of energy generated. Specifically, generators would get largely the same reward whether they produced energy at a time of peak demand (~17:30 on a cold winter day), as they would during a warm summer night, when the marginal value of energy on the system is extremely low. These mechanisms were entirely appropriate while the penetration of RE was small, but they are already unsuitable for purpose now and are becoming ever more unsuitable.

The present support mechanism for low-carbon generation is the Contracts for Difference (CfDs) scheme. The CfDs provide flat reward for each 1MWh generated. In the most positive interpretation, the CfDs enable the RE project developer to have relatively high levels of confidence about the returns on investment. The UK energy system must find (and pay for) solutions to the flexibility issue entirely separately. In the most negative interpretation, the CfDs actively prevent the RE project developer from accessing income from flexibility services and they force all costs of flexibility to be carried elsewhere.

A change in the CfD scheme is obviously called for. It is straightforward to think of modified schemes in which RE project developers who might not wish to avail of income streams associated with flexibility could still bid as before for flat-rate support but other developers might explore technology options that they would not otherwise do.

Emerging Technologies

Since storage is needed for time-spans of >12 hours, a battery storage system would cost several times more than the wind turbine it served (and the cost of flexibility would thus be several times greater than the cost of generation). The alternatives are systems that can store large amounts of energy in the form of heat (& coldness), compressed air, liquid air or raised water.

A technology called *WindTP* from University of Nottingham enables large wind turbines to store up to 100 hours of output power in the form of heat and coldness for a marginal cost of <30%. The University of Birmingham has advanced a competing concept originally developed in Japan that converts wind turbine rotor power directly into heat. The University of Virginia is one of several parties developing integrated energy storage systems for turbines using air compression and the Norwegian certification company, DNV-GL, is progressing a concept based on offshore pumped hydro energy storage. In all cases, these concepts can be realised using existing materials, processes and design methods.

The potential for such integrated storage technologies to be transformative is straightforward to illustrate: A 4kg mass of any gravel heated up to 600°C has the potential to release more electrical energy than 1kg of the best lithium-ion battery in the world today.

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