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SUMMARY AND KEY MESSAGES

The UK has made enormous progress in the deployment of offshore wind energy, which supplied 14% of the country's electricity in 2020. However, the sector now faces a series of challenges in scaling up capacity to meet the Government's new target of 50GW of offshore wind by 2030 – close to four times current levels – in just eight years. This scaling up has taken on a new urgency with energy prices reaching record high levels, and the challenge of reducing the UK's dependence on imported gas.

The rollout of offshore wind in the UK has so far been a major policy success. The UK's experience in this area to date can help in the development of future policies and can provide lessons for renewables policy in the rest of Europe and elsewhere. This briefing examines the role of government policy in the growth of UK offshore wind to date, and the challenges facing the sector out to 2030 as it seeks to achieve unprecedented further growth.

WHAT LED TO UK OFFSHORE WIND'S SUCCESS?

In this paper, we identify the following key developments and policy approaches that have enabled the UK to achieve rapid growth in offshore wind energy:

Fixed prices provide effective incentives for investment. Contracts for difference (CfDs), which guarantee revenues for offshore wind generators, have proved vital to supporting investment in new offshore wind capacity. Several design features of CfDs have contributed to the policy's success:

1. The use of auctions has led to competition driving down costs.
2. The guaranteed revenue per MWh provided through the CfDs reduces investment risks associated with renewable electricity projects, further contributing to cost reduction.
3. The contracts are governed by private law, with a counterparty at arm's length from government. This increases investor confidence by reducing the risk of political interference in the delivery of CfDs.
4. Auctions are held at regular, predefined intervals, giving renewable energy developers a clear timeline to prepare bids to supply capacity. Between 2015 and 2022, CfD auctions were held at roughly two year intervals. The Government will now start annual auctions from March 2023 to enable an accelerated rollout.
5. Two-way CfD contracts are a hedge against price fluctuations in both directions. As a result, renewable energy projects generate revenue to the government when electricity prices are higher than the strike price, as they are at present. This enhances their political acceptability.
6. By dividing CfD funding into different pots for different technologies, a diverse portfolio of low-carbon generation has been incentivised.

While the UK approach to delivering CfDs looks set to evolve as part of ongoing electricity market reforms, it seems likely that many of the characteristics of the present regime will be retained, including competitively allocated, long-term, private law contracts between generators and a government-owned counterparty. The majority of options considered involve such long-term contracts, as this is judged likely to be the best way of delivering the volumes of investment required at least cost.

Other policies have also contributed to the success of the programme.

Carbon pricing can be an effective means of supporting investment.

Carbon pricing acts as a financial disincentive for fossil fuel power which in turn makes low-carbon electricity generation more competitive. The UK's carbon price support (CPS) scheme led to the rapid decline of coal generation and helped signal a shift of investment towards renewables.

Electricity markets need to be designed to perform efficiently in a renewables-dominated system. Most electricity markets in Europe were created to deliver dispatchable fossil-fuel generation. This presents a challenge for increasing the share of renewable generation because the functioning of electricity markets strongly influences which technologies are deployed. Reforms undertaken in the UK almost a decade ago supported a rapid expansion of offshore wind and other renewables, but further changes will be needed in future to continue deploying renewables at pace.

FUTURE CHALLENGES

Despite its successes to date, the UK's ambitious goals for renewable energy expansion face several important challenges.

Permitting. Currently, it can take up to four years to approve the development of an offshore wind farm in the UK. The Government now plans to update planning rules to cut the approval time down to one year, and to streamline environmental assessments for offshore wind projects.

Increased grid capacity, flexibility and storage. At a national level, electricity transmission infrastructure will need to be expanded to accommodate increased electricity flows, particularly between northern and southern regions of the UK, and to deal with more variable supply in an energy system dominated by renewables. Alongside this, the growth of energy storage and demand-side response will provide important grid-balancing services, helping reduce the costs of electricity supply. Increased interconnection with electricity markets elsewhere in Europe can play a valuable role. A coordinated approach to developing grid connections will also greatly reduce the costs of connecting offshore wind farms to the electricity network.

Skills. The UK will need to invest in and retain a skilled workforce. There are opportunities to leverage skills from adjacent sectors - including offshore oil and gas, subsea, automotive and aerospace - to support the growth of offshore wind. The UK Government has committed to supporting the transition of North Sea workers to green jobs as part of the North Sea Transition Deal it agreed with the oil and gas industry in 2021. However this plan lacks specific detail on the nature or pace of the transition. The Government has also recognised the threat that the skills shortage poses to achieving renewable energy deployment targets and, in 2021, established the Green Jobs Taskforce with the goal of supporting the creation of two million jobs by 2030.

Supply chain capacity. The UK lags behind other countries in terms of its domestic turbine manufacturing capacity and has historically relied on imported turbine components. However, the UK has recently begun to see investment in domestic wind turbine manufacturing and, in early 2021, the Government invested in two new offshore wind ports to be constructed in the Humber region and Teesside. It is yet to be seen whether the UK's most recent target for offshore wind deployment will lead to significant new investment in UK turbine manufacturing.

Electricity Market Arrangements need to be modified to function effectively with a predominance of very low marginal cost capacity on the system. Some reform was undertaken about a decade ago but more is now needed, and are arrangements are currently under review. Any arrangements will need to maintain the features of the system that have led to success so far, while adjusting to the new circumstances.

INTRODUCTION

The UK is a world leader in the deployment of wind energy and has achieved remarkable growth in offshore wind generation during the last decade. Between 2009 and 2020 electricity generation from domestic offshore wind energy increased by a factor of 23 – from 688MW of capacity producing 1.75 TWh (0.5% total UK electricity generation) to more than 11GW of capacity producing 40.68 TWh (14% to total UK electricity generated in 2020).[1,2] By the autumn of 2022, the UK had around 14 GW of offshore wind capacity in operation.[3]

As the Government embarks on a process of modernising the power sector, offshore wind can deliver a win-win-win outcome in the form of reduced emissions, enhanced energy security and lower prices for consumers. These objectives have taken on a renewed urgency within the last year as energy prices continue to rise due to volatility in natural gas markets, placing an enormous financial burden on consumers. And while offshore wind capacity being planned today will not be deployed in time to alleviate the immediate energy crisis, **the technology will nonetheless play a role in preventing future price shocks while contributing to increasing the share of the UK's energy mix which is indigenous, and displacing gas power.**

Key to achieving this vision is the creation of a political and economic climate that supports the deployment of renewables. UK energy policies have played a significant role in the expansion of UK offshore wind capacity during the last decade. Today, unprecedented levels of political support and private capital are driving the expansion of UK offshore wind energy and continued rapid growth of the sector seems readily achievable.

However, this success was not a foregone conclusion. Only five years ago, investment in the UK renewable energy sector appeared to be in decline[4] following government cuts to green policies, and the UK ranked behind most other European nations in developing renewable energy capacity.[5]

The rapid expansion of UK offshore wind capacity has been accompanied by wind energy technologies having fallen in cost much faster than predicted[6] (Figure 1). Clearing prices (also referred to as "strike prices") for UK offshore wind projects - that is the guaranteed price per MWh awarded to wind developers through the UK's Contracts for Difference (CfD) scheme - have dropped by more than two thirds since the first

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[1] Figures derived from BEIS. (2022). Supplementary data for Annex O (Feb 2022): Energy & Emissions Projections. Retrieved 26 July 2022 from https://www.gov.uk/government/publications/energy-and-emissions-projections-net-zero-strategy-baseline-partial-interim-update-december-2021

[2] 2022 offshore wind capacity data from Renewable UK. Retrieved 8 August 2022 from https://www.renewableuk.com/page/UKWEDhome/Wind-Energy-Statistics.htm

[3] Buljan. A. (2022 September). BREAKING: UK Puts Massive Amount of New Offshore Wind Capacity on Fast Track. OffshoreWIND.biz https://www.offshorewind.biz/2022/09/26/breaking-uk-puts-massive-amount-of-new-offshore-wind-capacity-on-fast-track/

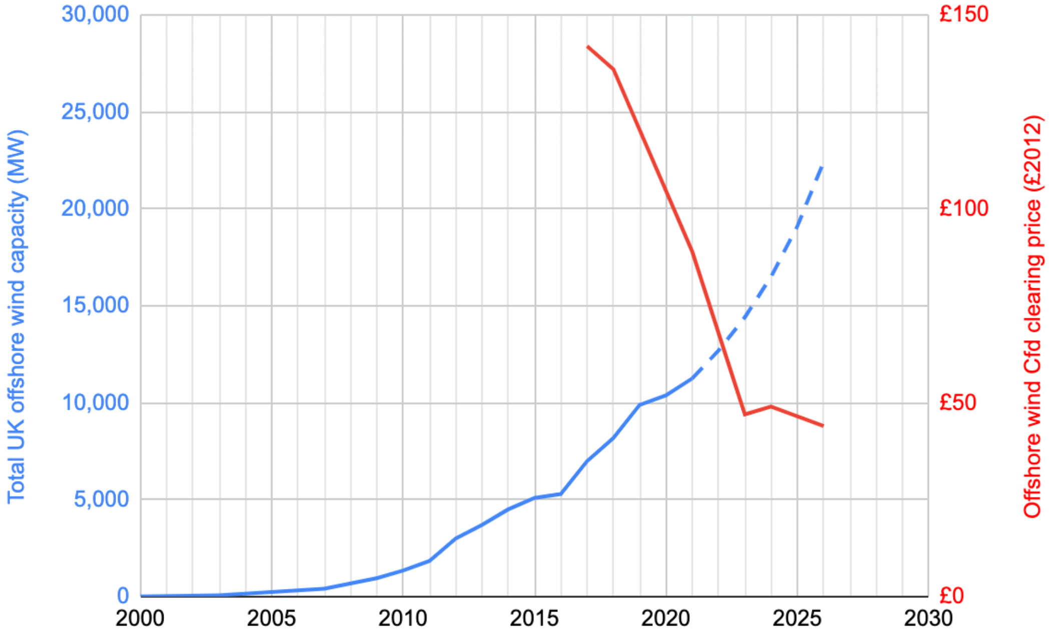
[4] Vaughan A. (2017 January). Renewables investment in UK will fall 95% over next three years – study. The Guardian https://www.theguardian.com/environment/2017/jan/04/renewables-investment-uk-fall-95-percent-three-years-study-subsidy-cuts-emissions-targets

[5] MarketLine. (2018). UK lags behind the rest of the EU in renewable energy consumption. Power Technology Retrieved 31 July 2022 from https://www.power-technology.com/comment/uk-lags-behind-rest-eu-renewable-energy-consumption/

[6] Milborrow, D. (2021). WindEconomics: Cost of wind falling faster than predicted. Windpower Monthly https://www.windpowermonthly.com/article/1718149/windeconomics-cost-wind-falling-faster-predicted

CfDs were awarded in 2015.[7] The 2022 CfD auction saw projects starting in 2026/27 awarded supply contracts at a clearing price of £37.35/MWh.[8]

FIGURE 1: HISTORIC AND PROJECTED OFFSHORE WIND ENERGY CAPACITY IN THE UK AND CFD CLEARING PRICES BY PROJECT START YEAR.



Historic and projected UK offshore wind capacity (blue), and CfD clearing prices for allocation rounds one to four (red) according to project start year.

Sources: historical offshore wind capacity from irena.org. Projected offshore wind capacity (dotted lines) based on official UK targets from gov.uk.

Under plans announced by the UK Prime Minister earlier this year, domestic offshore wind power capacity is targeted to grow to 50 GW by 2030[9], almost five times existing capacity, and 20GW more than was planned just two years ago. Installing close to 40GW of additional offshore wind in just eight years is a highly ambitious target as historically it has taken at least a decade to bring an offshore wind farm to commercial operation.[10]

This briefing examines the role of government policy in the growth of UK offshore wind to date, and the challenges facing the sector out to 2030 as it seeks to achieve unprecedented growth.

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[7] Based on offshore wind project clearing prices for CfD Allocation Rounds one and four.

[8] BEIS. (2022). Contracts for Difference (CfD) Allocation Round 4: results. Retrieved 28 July 2022 from https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-4-results

[9] BEIS. (2022). British energy security strategy. Retrieved 27 July from https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy

[10] Bourne, S. (n.d.). Can the UK achieve its 50 GW offshore wind target by 2030? DNV. https://www.dnv.com/article/can-the-uk-achieve-its-50-gw-offshore-wind-target-by-2030--224379

UK POLICIES AND THE GROWTH OF OFFSHORE WIND TO DATE

UK renewable energy policy dates back to the nineties[11], with the introduction of the Non-Fossil Fuel Obligation (NFFO) in 1990. The NFFO subsidised both nuclear and renewable power generation via an obligation on the country's newly privatised energy companies to purchase power from non-fossil generators at a premium price. Over time, it became apparent that, while certain forms of renewable energy were more investable in the short term, a more diverse portfolio of low-carbon electricity generation would be needed to meet the UK's emissions reduction targets.

This led to the creation of the Renewables Obligation (RO) which replaced the NFFO in 2002. Rather than offering contracts to renewable energy generators, the RO set an obligation on energy suppliers to purchase and supply a certain amount of generated electricity from renewable sources. The amount of renewable electricity was certified by Renewables Obligation Certificates (ROCs). Suppliers negotiated their own contracts with renewable electricity generators, or bought ROCs on the secondary market.

RO funding was later divided into several bands with different technologies attracting different numbers of ROCs. This enabled early expansion of offshore wind energy, which grew by a factor of 22, from 60MW in 2003 to 1.34GW of total capacity by 2010.[12]

While RO helped establish the UK's commercial offshore energy industry, the rapid acceleration of offshore wind power installations in recent years can be largely attributed to a series of policy changes that took place from 2013 – the introduction of contracts for difference in particular – which are detailed in the sections that follow.

Well-designed contracts for difference have by far been the most important driver of growth in offshore wind energy. However, several other policies played an important supporting role in paving the way for this rapid growth. Together, these policies have enabled offshore wind to become a highly competitive source of electricity generation through:

- ◊ **supporting first-of-a-kind projects** through creating demand for early-stage renewable energy technologies by the RO;
- ◊ setting a **clear long-term policy direction** for the UK electricity sector and discouraging investment in carbon emitting forms of electricity generation (carbon price floor, and the 2015 coal-phaseout announcement);
- ◊ **incentivising the switch to low-carbon power generation** by ensuring fossil generators face greater carbon costs and steering investment towards renewables;
- ◊ structuring the electricity market in a way that **enables the transition to a low-carbon electricity system** (electricity market reform).

The remainder of this section examines the impact that contracts for difference, the capacity mechanism, and carbon price support have had on the development of offshore wind energy.

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[11] See Annex 1 for a more detailed discussion of UK renewable energy policy up to 2010

[12] DECC. (2010). Digest of United Kingdom energy statistics 2010. Retrieved 1 August 2022 from https://webarchive.nationalarchives.gov.uk/ukgwa/20101209110222/http:/www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx

CONTRACTS FOR DIFFERENCE

A central feature of reform was the establishment of Contracts for Difference (CfD). CfDs are contracts for low-carbon electricity supply awarded by a government backed counterparty, the Low Carbon Contracts Company[13] (LCCC) via a competitive bidding process. They pay the difference between the wholesale electricity price and a strike price set in the contract. They are thus designed to ensure stable prices for low-carbon electricity generation.[14]

Developers who participate in CfD auctions bid to supply low-carbon energy at the lowest price, with the winning bidders awarded contracts to supply electricity at a fixed price per MWh. The fixed price is indexed to inflation, though this is not a necessary feature of CfDs. Setting price by auction contrasts with Feed in Tariffs (FITs) where the contract pricing was set by the government.

CfDs have been the single largest driver of investment in offshore wind deployment since 2015.[15] Each successive auction has seen the capacity of offshore wind contracted significantly increase,[16] as can be seen in Figure 2, below. CfDs have also been instrumental in bringing down the cost of offshore wind projects and the cost per MWh has fallen substantially since 2015. In allocation round 1 (2015), the strike price stood at £114 - £119 per MWh but this had fallen to £37 per MWh in the fourth allocation round (2022).[17] Recent auction results indicate the costs of offshore wind have remained at similar levels, despite upward cost pressure, for example from rising materials costs.

FIGURE 2: CFD RESULTS FOR ALLOCATION ROUNDS 1 TO 4 (HELD BETWEEN 2015 - 2022)

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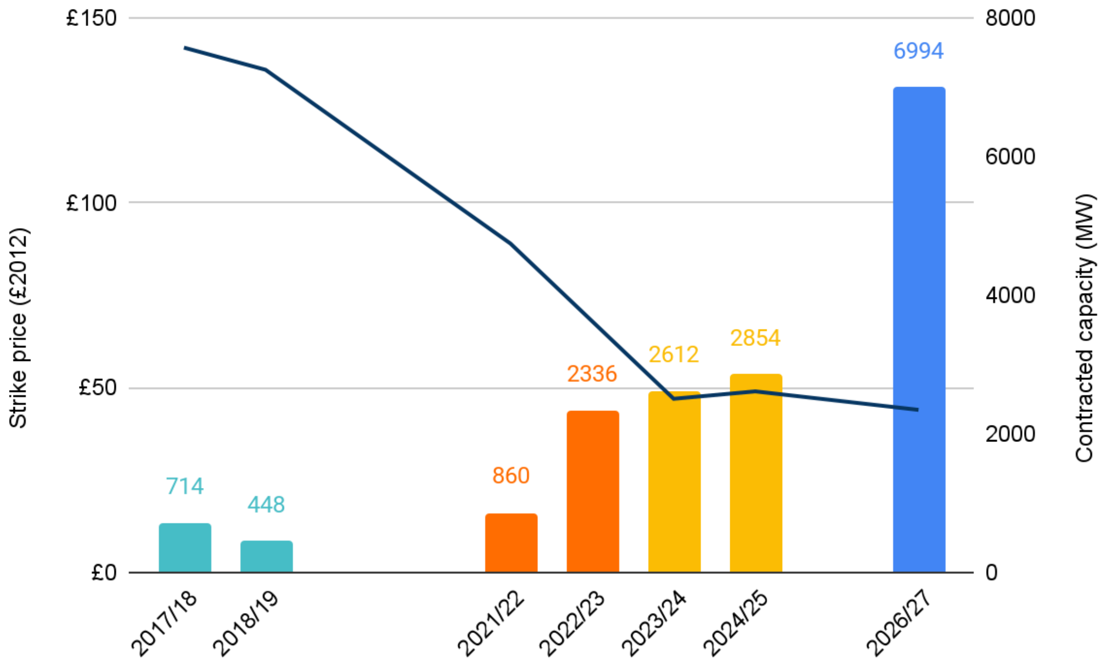
[13] The LCCC is a government-owned entity which independently administers CfD contracts

[14] For further explanation of CfDs, visit https://www.blog.renewableuk.com/post/cfdexplainer

[15] Grubb, M. (2022). Opinion: Renewables are cheaper than ever – so why are household energy bills only going up?. UCL News. Retrieved 8 August 2022 from https://www.ucl.ac.uk/news/2022/jan/opinion-renewables-are-cheaper-ever-so-why-are-household-energy-bills-only-going

[16] In the most recent CfD auction (AR4), almost two thirds of the 11GW of contracted low-carbon capacity was awarded to offshore wind projects.

[17] Strike prices shown in Figure 2 are in 2012 prices and so the overall real-terms cost reduction in offshore wind is more modest after accounting for inflation.



Strike prices (£2012) shown as solid line. Contracted capacity (MW) at each auction shown in columns - AR1 (teal), AR2 (orange), AR3 (yellow), and AR4 (blue).

Source: data from gov.uk

Several design features of CfDs have contributed to the policy's success:

1. The use of auction has led to competition driving down costs.
2. The guaranteed revenue per MWh provided through the CfDs reduces investment risks associated with renewable electricity projects. This has, by one estimate, lowered the cost of capital from about 6% to 3%.[18] Anecdotal evidence separately suggests that CfDs have led to a 1-2 percent reduction in hurdle rates for offshore wind projects.[19]
3. The LCCC's position as an arms length government entity with independent oversight increases investor confidence by reducing the possibility of political interference in the delivery of CfDs.
4. Auctions are held at regular, predefined intervals, giving renewable energy developers a clear timeline to prepare bids to supply capacity. Between 2015 and 2022, CfD auctions were held at roughly two-year intervals. The Government will now start annual auctions from March 2023 to enable an accelerated rollout of renewables.
5. Two-way CfD contracts are a hedge against price fluctuations that balances the interests of both the developer and the LCCC (acting on behalf of consumers). As a result, renewable energy projects generate revenue to the government when electricity prices are higher than the clearing price, as they

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[18] Grubb, M., & Newbery, D. (2018). UK electricity market reform and the energy transition: Emerging lessons. The Energy Journal, 39(6). https://www.eprg.group.cam.ac.uk/wp-content/uploads/2018/06/1817-Text.pdf

[19] BEIS. (2021). Evaluation of the Contracts for Difference scheme. Phase 3. Final Report. p.14 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1076185/CfD_evaluation_phase_3_final_report.pdf

are at present.

6. By dividing CfD funding into different pots, the government has avoided pitting emerging technologies against mature ones, ensuring the UK maintains a diverse portfolio of low-carbon generation technologies.

However, as described in a later section of this paper, CfDs may not be all that is required to deliver the continued expansion of renewable energy needed to decarbonise the electricity system by 2035.

OFFSHORE WIND SUPPORT IN EUROPE

EU Member States have taken varying approaches to supporting offshore wind over the last decade. There appears to be a general trend towards contracts similar to the UK's CfD mechanism.

Since 2012, Germany has operated a top-up support regime for offshore wind. The so-called market premium guarantees offshore wind operators a minimum price (the 'reference value') for electricity supplied to the grid. Unlike the UK's CfD, the premium is one way rather than two way. When electricity prices are high the operator is not required to pay the difference between the actual price and the reference value. This has led to large windfall profits for operators due to current high wholesale prices.[20] Moreover, since electricity prices are high and the costs of offshore wind have fallen, the tender process has become increasingly dominated by zero subsidy bids which has led to contracts for oversubscribed sites being awarded through a lottery process. The German Government recently proposed new legislation that would move to a CfD regime.[21]

Until 2017 the Netherlands operated a scheme in which bidders applied for a subsidy and permit. However, from 2018 the country awarded its first subsidy-free contract for an offshore wind farm.[22]

France completed the tender processes for its first offshore wind farms in 2011 which offered Feed In Tariffs (FITs) lasting for a period of 20 years.[23] However, in 2016 the French Government moved to a feed-in premium model which is a type of CfD.[24]

Between 2003 and 2018, Denmark subsidised offshore wind using a market premium system similar to that of Germany's.[25] In 2019 Denmark adopted an asymmetric CfD scheme with profits obtained split between the operator and the government.[26]

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[20] Allen & Overy. (2022). CFD regime for offshore wind in Germany. https://www.jdsupra.com/legalnews/cfd-regime-for-offshore-wind-in-germany-1077582/

[21] Allen & Overy. (2022, May 26). CfD regime for offshore wind in Germany. https://www.allenovery.com/en-gb/global/news-and-insights/publications/cfd-regime-for-offshore-wind-in-germany

[22] WInd Europe. (2018, March 20). World's first offshore wind farm without subsidies to be built in the Netherlands. https://windeurope.org/newsroom/press-releases/worlds-first-offshore-wind-farm-without-subsidies-to-be-built-in-the-netherlands/

[23] EU Commissions. (2019). State aid: Commission approves support for six offshore wind farms in France. https://ec.europa.eu/commission/presscorner/d tail/PT/ip_19_4749

[24] Ministère de la transition écologique et solidaire. (2017). Regulatory framework and support schemes for wind energy in France. https://energie-fr-de.eu/fr/manifestations/lecteur/conference-sur-les-mecanismes-de-soutien-pour-lenergie-eolienne-etat-des-lieux-et-perspectives.html?file=files/ofaenr/02-conferences/2017/171010_conference_eolienne_mecanismes_de_soutien/Presentations/02_Louis_Orta_MTES_DFBEW_OFATE.pdf

[25] IRENA. 2013. Denmark. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2013/GWEC/GWEC_Denmark.pdf?la=en&hash=C14BEEC4FFEEBA20B2B1928582AA23931F092F48

[26] OffshoreWIND.biz. (2019, November 15). Denmark Rolls Out New Subsidy Scheme for Offshore Wind. OffshoreWIND.biz. https://www.offshorewind.biz/2019/11/15/denmark-rolls-out-new-subsidy-scheme-for-offshore-wind/

THE CAPACITY MECHANISM

Introduced alongside CfDs, the capacity mechanism (CM), is the Government's primary means of ensuring security of supply for electricity in order to prevent blackouts (i.e., 'keeping the lights on'). It is used to contract dispatchable electricity generation capacity in advance which is not required under normal circumstances but can be called upon at short notice during periods of high stress in the electricity grid. The CM therefore acts as an insurance policy for managing the risk of variable generation from renewables and unplanned plant outages. At present, gas power makes up the vast majority of capacity contracted via the CM.[27]

As with CfDs, the LCCC awards CM contracts through competitive auctions that take place every year. Although the CM has no direct influence on the deployment of offshore wind, by ensuring grid stability, it has enabled far higher penetration of renewables into the electricity system than would otherwise have been possible.

ONSHORE WIND'S FALL FROM FAVOUR

In contrast to the experience of other countries, onshore wind faced major obstacles in the UK after the initial rush of NFFO-backed projects in the 1990s and early 2000s. Subsequent projects were held back in large part by local opposition to onshore wind developments. Opposition was based on concerns about the visual impact of wind turbines and the top-down planning strategies often employed by developers of early projects, which lacked proper engagement with local communities.[28]

In an attempt to win over rural communities, the Conservative party ruled out supporting onshore wind in their 2015 election manifesto. Following their election win, changes to the National Planning Policy Framework and the removal of subsidies for onshore wind projects established a de facto moratorium on new developments unless they had the full backing of local communities.[29] This led to a 97% decrease in the number of wind turbines that were granted planning permission in the period 2016-2021 compared to the period 2009-2014.[30]

The misfortune of onshore wind may have actually helped the success of offshore wind: reduced competition for funding among different low-carbon electricity sources, combined with the 2015 coal phaseout announcement, focussed resources on a more limited set of options. This allowed offshore wind to win funding in subsequent CfD rounds where it might otherwise have been outbid by onshore wind projects.

The economics of offshore wind power have since vastly improved and project developers have built up considerable experience around the associated technologies and business. Offshore wind farms also have certain advantages over onshore ones as the former can support larger turbines that generate power more cost efficiently, and benefit from more consistent wind speeds which support higher load factors,[31] meaning the same amount of electricity can be generated from fewer turbines.

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[27] See results for T-1 and T-4 Capacity Market Auctions: https://www.emrdeliverybody.com/CM/T12022.aspx, https://www.emrdeliverybody.com/CM/T42022.aspx

[28] Jones, C. R., & Eiser, J. R. (2010). Understanding 'local' opposition to wind development in the UK: how big is a backyard?. Energy policy, 38(6), 3106-3117. https://eprints.whiterose.ac.uk/95729/2/WRRO_95729.pdf

[29] Brown, P. (2022). "England is failing to capitalise on its onshore wind potential". The Guardian. https://www.theguardian.com/news/2022/jun/10/england-is-failing-to-capitalise-on-its-onshore-wind-potential

[30] UWE Bristol. (2022). "National planning policy limiting creation of new onshore wind farms in England, research finds". Retrieved 8 August 2022 from https://info.uwe.ac.uk/news/uwenews/news.aspx?id=4220

[31] Figures published by National Grid suggest the average onshore wind turbine produces around 2.5 to 3 megawatts (MW), in comparison to the offshore average of 3.6 MW. This is due to planning restrictions on the allowable height of onshore wind turbines. For further information, see https://www.nationalgrid.com/stories/energy-explained/onshore-vs-offshore-wind-energy

CARBON PRICE SUPPORT

In 2013 the UK Government also introduced Carbon Price Support (CPS) to provide a floor on the carbon price in power generation. This quickly led to coal being priced out of the electricity market and helped stimulate demand for low-carbon generation. The CPS is a carbon tax levied on electricity generators in addition to the ETS carbon price. In 2014, the CPS was set at £4.94/tCO_2e, rising to £18/tCO_2e in 2015 where it has remained since.[32] This significantly raised carbon costs for coal-fired power plants (and, to a lesser extent, gas-fired power plants).[33] Electricity generated from coal fell from 40% in 2013 to 3% in September 2019 as a result.[34]

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[32] Gissey, G. C., Guo, B., Newbery, D., Lipman, G., Montoya, L., Dodds, P., ... & Ekins, P. (2019). The value of international electricity trading. A project commissioned by Ofgem. https://www.ucl.ac.uk/news/2020/jan/british-carbon-tax-leads-93-drop-coal-fired-electricity

[33] The EUETS carbon price was at levels below €10/tCO_2 over the same period.

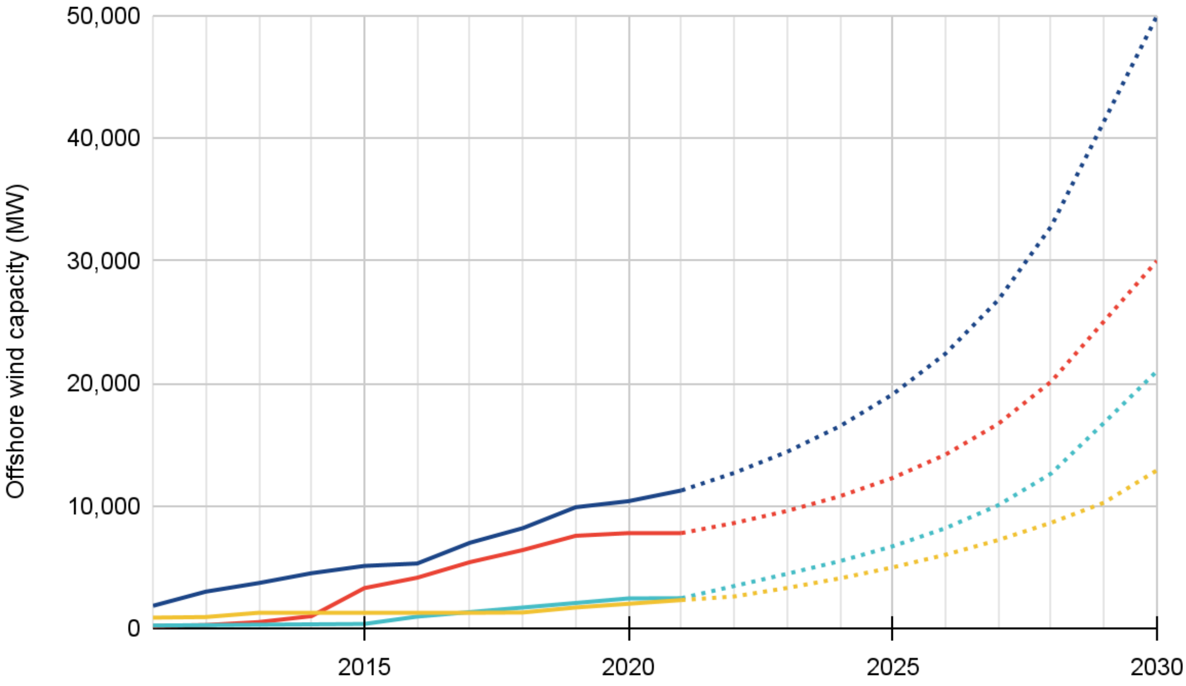
[34] Gissey, G. C., Guo, B., Newbery, D., Lipman, G., Montoya, L., Dodds, P., ... & Ekins, P. (2019). The value of international electricity trading. A project commissioned by Ofgem. https://www.ucl.ac.uk/news/2020/jan/british-carbon-tax-leads-93-drop-coal-fired-electricity

THE FUTURE OF OFFSHORE WIND

In April 2022 the UK Government committed to increasing the pace of renewables deployment, raising its 2030 target for offshore wind capacity from 40GW to 50GW.[35] To put that in context, it has taken the UK a decade to increase offshore wind capacity from 1GW to 11GW and the rate of deployment would thus need to increase more than fourfold to add almost 40GW in additional capacity within eight years. As such, it is a highly ambitious target.

Nevertheless, the current pipeline of offshore wind projects suggests the UK can achieve its 50GW target[36] which at present exceeds those of other European countries by a considerable margin (Figure 2).

FIGURE 2: HISTORIC AND PROJECTED OFFSHORE WIND ENERGY CAPACITY IN THE UK, GERMANY, NETHERLANDS, AND DENMARK



Offshore wind capacity in the UK (dark blue), Germany (red), the Netherlands (turquoise), and Denmark (yellow). Dotted

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[35] BEIS, 10 Downing Street. (2022). British energy security strategy. https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy

[36] Buljan. A. (2022 September). BREAKING: UK Puts Massive Amount of New Offshore Wind Capacity on Fast Track. OffshoreWIND.biz https://www.offshorewind.biz/2022/09/26/breaking-uk-puts-massive-amount-of-new-offshore-wind-capacity-on-fast-track/

lines denote official capacity forward projections.

Sources: historical offshore wind capacity from irena.org, rvo.nl, and turbines.dk. Projected offshore wind capacity (dotted lines) based on official targets and estimates from gov.uk, government.nl, enerdata.net, and offshorewind.biz.

TABLE 1: OFFSHORE WIND ENERGY CAPACITY AS % OF TOTAL GENERATION CAPACITY IN THE UK, GERMANY, NETHERLANDS, AND DENMARK IN 2021

Country	Offshore wind (MW)	Total capacity (MW)	% offshore wind
United Kingdom	11,256	105,000	**10.72%**
Germany	7,774	223,138	**3.48%**
Netherlands	2,460	46,737	**5.26%**
Denmark	2,306	16,177	**14.25%**

Sources: BEIS, irena.org

As Table 1 shows, the UK is currently among the leading installers of offshore wind in Europe, both in terms of actual capacity and as a percentage of its overall electricity mix.

To realise its offshore wind energy target, the UK will need to overcome a series of challenges that limit the speed of renewables deployment. These include issues relating to permitting, skills shortages, supply chain capacity, and electricity grid infrastructure - each of which is briefly discussed below.

As part of its Review of Electricity Market Arrangements the Government is also considering how to redesign the electricity market to support continued growth of renewables, a topic briefly outlined at the end of this section.

PERMITTING

Permitting is the process of gaining local and/or national authority approval for the construction of wind farms at a given site. The process includes securing construction permits, performing environmental impact assessments, and obtaining planning consent. Currently, it can take up to four years to approve the development of an offshore wind farm in the UK. The Government now plans to update planning rules to cut the approval time down to one year, and to streamline environmental assessments for offshore wind projects.[37]

Permitting is an issue that also affects renewables deployment in the EU. The vast majority of Member States currently exceed the two-year limit for permitting processes set down in the 2018 Renewable Energy Directive - with some taking up to 10 years to approve projects.[38] However, there are now plans to reduce this to one year for projects located in certain areas.[39]

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[37] Ibid.

[38] Ember. (2022). Ready, Set, Go: Europe’s race for wind and solar https://ember-climate.org/insights/research/europes-race-for-wind-and-solar/

[39] Abnet, K. (2022, May 9). EU plans one-year renewable energy permits for faster green shift. Reuters. https://www.reuters.com/business/sustainable-business/eu-plans-one-year-renewable-energy-permits-faster-green-shift-2022-05-09/

SKILLS SHORTAGES

To achieve 50GW of offshore wind capacity by 2030 the UK will need to invest in and retain a skilled workforce. The UK offshore wind industry is expected to employ close to 100,000 people by 2030, compared to a current headcount of 31,000 (direct and indirect),[40] and competition for skills with overseas wind energy developers will only increase as other countries set ambitious plans for offshore wind development. Skills shortages threaten to create a bottleneck for renewable energy deployment which could limit the UK's ability to meet its targets.

There are opportunities to leverage skills from adjacent sectors - including offshore oil and gas, subsea, automotive and aerospace - to support the growth of offshore wind. As of 2019, there were 30,600 people employed directly in the UK's offshore oil and gas industry[41] and many are keen to retrain in offshore wind.[42] The UK Government has committed to supporting the transition of North Sea workers to green jobs as part of the North Sea Transition Deal it agreed with the oil and gas industry in 2021,[43] although this plan lacks specific detail on the nature or pace of the transition. The Government has also recognised the threat that the skills shortage poses to achieving renewable energy deployment targets and, in 2021, established the Green Jobs Taskforce with the goal of supporting the creation of two million net zero jobs by 2030.[44]

The EU is facing a similar shortage of workers to support its wind energy ambitions and is expected to employ some 450,000 people in the sector by 2030, 50% more than the current headcount.[45] Competition for skilled workers will likely increase in the coming years as investments in training programmes will take time to fill the skills gap.

SUPPLY CHAIN CAPACITY

Despite the considerable number of wind energy developers active in the UK - Ørsted, Vattenfall, SSE, Iberdrola, and Innogy - the UK lags behind other countries in terms of its domestic turbine manufacturing capacity and has historically relied on imported turbine components, typically from German, Danish and Dutch manufacturers that have well-established commercial offerings.[46] Siemens Gamesa and MHI Vestas are the two major manufacturers of wind turbine generators supplying to UK projects and, while GE Renewable Energy is now competing for market share with a new generation of large turbines, this is nonetheless a relatively small pool of suppliers.[47]

However, the UK has recently begun to see investment in domestic wind turbine manufacturing and, in early

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[40] Memija, A. (2022). UK Offshore Wind Sector Expected to Employ Almost 100,000 People by 2030. OffshoreWIND.biz https://www.offshorewind.biz/2022/06/13/uk-offshore-wind-sector-expected-to-employ-almost-100000-people-by-2030/

[41] Bills, G. (2021). A global skills shortage threatens UK offshore wind. Infrastructure Investor. https://www.infrastructureinvestor.com/a-global-skills-shortage-threatens-uk-offshore-wind/

[42] Harrahill, K., Douglas, O. (2020). We want green energy jobs, say North Sea oil and gas workers – what they need to make the leap. The Conversation. https://theconversation.com/we-want-green-energy-jobs-say-north-sea-oil-and-gas-workers-what-they-need-to-make-the-leap-147612

[43] Gov.uk. (2021). North Sea deal to protect jobs in green energy transition https://www.gov.uk/government/news/north-sea-deal-to-protect-jobs-in-green-energy-transition

[44] BEIS. (2020). Energy white paper: Powering our net zero future. https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future/energy-white-paper-powering-our-net-zero-future-accessible-html-version

[45] Jones, A. (2021, September 2). WindEurope launches educational hub to plug skills gap. Industry Europe. https://industryeurope.com/sectors/energy-utilities/windeurope-launches-educational-hub-to-plug-skills-gap/

[46] Gross, R. and Heptonstall, P. (2010). Time to stop experimenting with UK renewable energy policy. https://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/icept/Time-to-stop-experimenting.pdf

[47] Whitmarsh, M. (2019). The UK Offshore Wind Industry: Supply Chain Review https://cdn.ymaws.com/www.renewableuk.com/resource/resmgr/publications/supply_chain_review_31.01.20.pdf

2021, the Government invested £95 million in 2 new offshore wind ports to be constructed in the Humber region and Teesside.[48] The same year GE Renewable Energy announced plans for an offshore wind tubular rolling facility at Port of Nigg in Scotland.[49] Plans for a Teesside factory were, however, subsequently cancelled with the company citing insufficient orders to justify the facility's existence.[50] It is not yet apparent whether the UK's most recent target for offshore wind deployment will lead to significant new investment in UK turbine manufacturing.

GRID INFRASTRUCTURE AND STORAGE

Under plans unveiled by National Grid (ESO) the UK's electricity network infrastructure will be expanded to connect new renewables to the network and provide increased capacity, both within the UK's transmission network and with adjacent electricity grids.[51] In addition to supporting higher loads, the grid will also need to become more flexible, integrating electricity storage, and managing fluctuations in electricity supply due to the intermittent renewable generation.

Additional transmission infrastructure will be needed in the UK to avoid grid capacity constraints becoming a bottleneck to the expansion of renewable generation and the possibility of curtailment (where generators are paid to constrain their output). National Grid's Network Options Assessment estimates that up to £16bn of transmission investment will be required over the next two decades,[52] particularly between Scotland and northern England where the net flow of electricity is from north to south[53] - investments that will be paid for by electricity consumers.

The development of offshore transmission networks in particular will be critical to delivering an additional 40GW of offshore wind by 2030. To reduce the cost of connecting each offshore wind farm to the grid, National Grid is pursuing a Holistic Network Design approach which seeks to connect multiple windfarms with fewer cables, saving of up to £5.5bn compared to individually connecting each site,[54] a strategy that will require close coordination between different stakeholders in the supply chain.

Under existing plans, UK interconnector capacity will more than double by 2025 from an existing capacity of 7.4 GW[55], and is expected to reach 20 GW by 2030[56]. This will provide opportunities to export surplus electricity and import electricity during periods of high demand. These developments are also beneficial to renewable energy developers due to the reduced likelihood of curtailment.

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[48] Gov.uk. (2021). Second wind for the Humber, Teesside and UK energy industry. https://www.gov.uk/government/news/second-wind-for-the-humber-teeside-and-uk-energy-industry

[49] GE Group. (2022). The UK's Largest Offshore Wind Tower Manufacturing Facility to Be Built at Port of Nigg. https://gegroup.com/latest/nigg-offshore-wind-announcement

[50] Mathis, W. (2022). GE Scraps Plan for Offshore Wind-Turbine Blade Factory in UK. Bloomberg. https://www.bloomberg.com/news/articles/2022-07-12/ge-scraps-plan-for-offshore-wind-turbine-blade-factory-in-uk

[51] National Grid ESO. (2022, July). ESO publishes Pathway to 2030 – major step to deliver 50GW of offshore wind by 2030. Retrieved 23 November 2022 from https://www.nationalgrideso.com/news/eso-publishes-pathway-2030-major-step-deliver-50gw-offshore-wind-2030

[52] National Grid ESO. (n.d.). Modelled Constraint Costs 2020/21. https://www.nationalgrideso.com/document/194436/download

[53] National Grid ESO. (2022). Network Options Assessment 2021/22 Refresh. https://www.nationalgrideso.com/document/262981/download

[54] National Grid ESO. (2022, July). ESO publishes Pathway to 2030 – major step to deliver 50GW of offshore wind by 2030. Retrieved 23 November 2022 from https://www.nationalgrideso.com/news/eso-publishes-pathway-2030-major-step-deliver-50gw-offshore-wind-2030

[55] Ofgem. (n.d.). Interconnectors. Retrieved 8 August 2022 from https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/interconnectors

[56] NationagridESO. (n.d.). Downloadable Future Energy Scenarios Resources. Retrieved 8 August 2022 from https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021/documents
Regen. (2022). Go West! https://regensw.wpenginepowered.com/wp-content/uploads/Regen-Go-West-Oct-2022.pdf

The timescales required to plan and construct major transmission infrastructure is, however, typically much longer than the pace of renewables deployment and this creates a challenge for the Network Operator which must anticipate the future rate of deployment and geographic distribution of renewable generation assets.

WHERE WILL OFFSHORE WIND BE BUILT?

Close to three quarters of the UK's existing offshore wind capacity is sited along the east coasts of England and Scotland where developers can take advantage of large areas of shallow water and well-established port infrastructure, which reduce construction costs. However, with offshore wind set to become the mainstay of the UK's electricity system, a geographically diverse wind energy portfolio regulated by different weather systems will be important for reducing intermittency. Both the System Operator's and project developers' needs therefore need to be considered in developing new transmission infrastructure.

Electricity storage will also become increasingly necessary for grid balancing in a decentralised electricity system. Between 2021 and 2022, the UK's pipeline of energy storage projects doubled to 32.1GW (as of March 2022 1.6 GW of energy storage was operational).[57] Battery storage is rapidly growing and National Grid ESO estimates that it will comprise the largest share (69%) of electricity storage capacity by 2050.[58,59] It is estimated that flexible assets could save up to £2bn in reduced system costs by 2040 through facilitating grid balancing, reducing the need for peaking capacity, and avoiding curtailment.[60]

Increasing network capacity and storage results in more efficient grid balancing, supporting investment in renewables. Similarly, improvements in the UK's electricity transmission infrastructure can unlock investment in renewable generation at sites where development was previously limited by network constraints.

Both interconnection and storage enable more efficient grid balancing and reduce the need to curtail renewable energy generation at times of low demand, giving confidence to renewable energy investors. Similarly, improvements in the UK's electricity transmission infrastructure can unlock investment in renewable generation at sites where development was previously limited by network constraints.

Developments in demand-side response (DSR) and smart metering technologies are also driving efficiency in grid utilisation through shifting electricity demand away from peak periods. This is necessary for managing demand as large segments of the economy undergo rapid electrification. Moreover, small scale distributed electricity storage, such as home and EV batteries, may also provide flexibility to the grid

REVIEW OF ELECTRICITY MARKET ARRANGEMENTS (REMA)

In mid-2022, with electricity prices still rising in the midst of a squeeze on incomes and living standards, the Government announced plans to overhaul the UK's marginal pricing system for electricity with the aim of decoupling electricity and gas prices.[61] As part of this process, it recently consulted on changes to electricity market arrangements, including proposals for delivering mass low carbon power, of which offshore wind is

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[57] George, S. (2022, April 22). UK's energy storage pipeline doubles within a year, surpassing 32GW. edie. https://www.edie.net/uks-energy-storage-pipeline-doubles-within-a-year-surpassing-32gw/

[58] National Grid ESO. (2022). Future Energy Scenarios 2022. https://www.nationalgrideso.com/document/263951/download

[59] SMS. (2022). Battery energy storage continues rise as critical net zero technology. https://www.sms-plc.com/insights/battery-energy-storage-continues-rise-as-critical-net-zero-technology/

[60] LCP. (2022). Impacts and implications of the British Energy Security Strategy (BESS) https://www.sse.com/media/xv1ajv-jh/221010-lcp-bess-impacts-and-implications.pdf

[61] BEIS. (2022). Review of Electricity Market Arrangements: Consultation document. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1098100/review-electricity-market-arrangements.pdf

expected to be by far the largest component.

At present, wholesale electricity prices are set by the marginal costs of gas power generation, which have increased with gas prices. In contrast newer renewables are not making additional profits due to the operation of two-way CfDs.

The current marginal pricing system was developed at a time when electricity generation was dominated by coal and gas plants. However, with renewables comprising a growing portion of the electricity system, there are challenges for how market prices are formed. It has also been recognised that the current CfD model gives rise to price competition among renewable generators[62] and increasing renewable deployment may make offshore wind farms unprofitable once their CfD expires. Although the outcome of the REMA process and its implications for offshore wind are uncertain, several of the approaches under consideration are outlined below.

MARGINAL PRICING

A range of options for reforming marginal pricing are under consideration by the Government[63], including:

Splitting renewable generation and firm power into separate markets with different pricing regimes. This rewards consumer flexibility and allows energy users (or energy companies acting on their behalf) to choose the amount of firm power they want to purchase at a price premium.[64]

Developing a 'green power pool' to isolate renewables from the rest of the market and passing cost savings onto consumers.[65] This would provide some of the benefits of splitting the market but renewable power purchase agreements would only be available to commercial and industrial consumers that are willing to accept greater variability of supply in return for lower prices.

Locational wholesale pricing to encourage market participants to operate in ways that support grid balancing and enable more efficient use of the electricity network. This could have a significant influence on the development of grid storage.

Moving from pay-as-clear wholesale pricing (where all generators receive the price of the highest bid) to pay-as-bid pricing where participants receive the price of their bid.

Separating the electricity market, as outlined above, results in a trade-off between price and consistency of supply which in turn promotes grid flexibility. However, the UK is in uncharted territory as both models are untested and its experience is likely to inform decisions taken by governments in Europe in the years ahead.

CfDs

The outcome of the reform process is currently uncertain. However, the majority of options considered for delivering mass low carbon power involve long-term contracts with the government, as this is judged likely to be the best way of delivering the required volumes of investment at least cost.

It is recognised that the existing CfD scheme has been hugely effective at driving down the cost of capital. The current "pot" structure, where different technologies (e.g. offshore wind and solar PV) have different pots of funding ensures that a range of technologies, with diverse generation profiles, are supported. The contract

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[62] Such problems can arise when multiple sources of renewable energy are seeking to supply limited consumer demand (for example, when the wind is blowing and the sun is shining). Consequently the overall market price of electricity falls during those periods, leading to a reduction in the revenues for wind farms without CfDs.

[63] Ibid.

[64] Keay and Robinson. (2017). The Decarbonised Electricity System of the Future: The 'Two Market' Approach, Energy Insight.

[65] Grubb and Drummond. (2018). UK Industrial Electricity Prices: Competitiveness In A Low Carbon World. https://www.ucl.ac.uk/bartlett/sustainable/sites/bartlett/files/uk_industrial_electricity_prices_-_competitiveness_in_a_low_carbon_world.pdf

structure also provides some consumer protection against high electricity prices, as generators pay back revenues above their strike price. The scheme has been hugely successful in delivering renewables to date, meaning it would retain investor confidence, and should help to keep financing costs down for developers, and therefore consumers. It is well-tested and familiar to industry, helping to ensure a steady flow of investment.

Nevertheless, the current design of the CfD has some limitations as the proportion of renewables on the system increases. These are likely to become more prominent as CfD-supported assets become a greater proportion of the generation mix. Among the limitations are that current CfD designs limit exposure to market signals for a significant portion of asset life, incentivising assets to run whenever possible. Also, they do not facilitate competition with low carbon flexible assets. Market separation reduces signals to innovate or behave more flexibly, and so reduces the incentive for generators to respond to the needs of the system or to adapt to future changes. This may increase the risk of oversupply in the market.

There is also a risk that as periods of zero or negative pricing become more common, additional uncertainty is created and the CfD becomes less effective at de-risking investment. From Allocation Round 4 (July 2022), generators are no longer paid in these periods, as insulating them from the market here creates perverse incentives for them to generate when the grid is already over-supplied. Schemes that pay on output can only de-risk investment by encouraging plants to generate, which limits options when we also want to prompt more flexible behaviour.

The main approaches being considered for addressing these challenges are:

a supplier obligation;

- the current CfD scheme;
- CfD variants with increased price exposure
- a revenue cap and floor; and
- CfDs based on deemed generation

Apart from the supplier obligation, these options are CfD variants. All except the current design would increase the role of the market, whether through greater exposure of those contracts to prices, or in the allocation of those contracts, in order to minimise costs which are passed to consumers. They retain competitively allocated, long-term, private law contracts between generators and a government-owned counterparty, as such contracts seem likely to remain the most cost-effective way of delivering investment requirements. The lower borrowing costs that come with a bankable long-term contract, combined with competition for those contracts, work to keep the cost of capital low.

A CfD with a strike range: instead of a single price, plants could be guaranteed a maximum and minimum price per MWh output, with market exposure within that range.

Changes to the reference price methodology. The reference price could be changed, for example, by setting CfD top-up payments for an entire week, with opportunities for profit or loss if plants do better in the market than the weekly average.

A revenue cap and floor. Under this option, which follows the precedent of the interconnector cap and floor, generators would be guaranteed a minimum revenue in each period. They would compete in the full range of markets (capacity, wholesale, balancing, ancillary services), and if they do not meet their minimum revenue, then they would be topped up at the end of the period. There would be no transfer if their revenue was between the floor and the cap. If their revenue was above the cap, a proportion of the excess would be paid back. The floor would be set competitively, likely on a £/MW basis. This option could enable cross-technology competition: a cap and floor scheme could support both renewable and flexible assets, and it is possible that, in the longer run, they could compete against one another for the floor.

This option would provide investors with confidence, as their minimum revenue would be guaranteed – this kind of guarantee has been sufficient to unlock 10.9GW of investment in interconnectors since 2013.

A CfD based on deemed generation. Under this option plants are paid based on their potential to generate in a particular period, rather than their actual generation. This means generators would not have to export energy to receive their CfD top-up payment, as they do currently. Where there is more value in participating in ancillary service markets, or charging on-site battery storage for times when demand is higher, they will be incentivised to do so. While this should incentivise innovation and more efficient operation, by exposing plants to market signals for dispatch, this option comes with significant delivery challenges.

FLOATING OFFSHORE WIND

The UK Government has pledged to create 5GW of floating offshore wind (FOW) - raised from a previous target of 1GW - as part of its ambition for 50GW of offshore wind by 2030. FOW technology allows turbines to be sited farther out to sea, where wind resources are typically more abundant, but where seabed conditions are poorly suited to fixed foundation turbines. Indeed the vast majority of potential offshore wind capacity can be found in areas unsuitable for fixed-foundation turbines. A twin track approach to deploying fixed and floating wind may therefore enable more rapid growth of offshore wind than might otherwise be possible, particularly as fewer sites become available to lease in shallow water.

FOW technology is still in its infancy with limited operational experience to draw from. However, the scale of floating offshore wind projects has grown rapidly – from a few megawatts in 2017, to planned developments of 1 GW or more having been announced earlier this year[66][67] – demonstrating confidence in the technology. The UK's 5GW floating offshore wind target represents a considerable leap of faith in the technology but one that is nonetheless achievable. Proving the technology works well is not the only challenge to this target. The skills shortage and need for additional transmission infrastructure to connect new offshore wind sites, as discussed earlier in this paper, will require enormous investments from an industry whose entire value chain is already under strain.[68]

Nevertheless, as developers gain experience, the costs of floating turbines are also expected to reduce sharply[69] with the levelized cost of energy (LCOE) falling by around 59% by 2030[70], though there remains some uncertainty over when, or whether, floating offshore wind will achieve cost parity with fixed foundation offshore wind in the foreseeable future.

While the initial 5GW of floating offshore wind planned for 2030 will be grid-connected, it is anticipated that some subequent offshore

Responding to the ongoing energy crisis remains a priority for policymakers both the UK and the EU, particularly as the continent heads towards winter. Ongoing volatility in natural gas markets is expected to push up

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[66] EDF Energy. (2022, April). Early consultation begins on Gwynt Glas floating wind Celtic Sea project. Retrieved 24 November 2022 from https://www.edfenergy.com/media-centre/news-releases/early-consultation-begins-gwynt-glas-floating-wind-celtic-sea-project

[67] Buljan, A. (2022, August). Scotland Adds Three More Floating Wind Projects, ScotWind Capacity Now Almost 30 GW. Offshore-WIND.biz. https://www.offshorewind.biz/2022/08/22/scotland-adds-three-more-floating-wind-projects-scotwind-capacity-now-almost-30-gw

[68] Bourne, S. (n.d.). Can the UK achieve its 50 GW offshore wind target by 2030?. DNV. https://www.dnv.com/article/can-the-uk-achieve-its-50-gw-offshore-wind-target-by-2030--224379

[69] ORE Catapult. (2021). Floating Offshore Wind: Cost Reduction Pathways to Subsidy Free. p.16 https://ore.catapult.org.uk/wp-content/uploads/2021/01/FOW-Cost-Reduction-Pathways-to-Subsidy-Free-report-.pdf

[70] Bourne, S. (n.d.). Can the UK achieve its 50 GW offshore wind target by 2030?. DNV. https://www.dnv.com/article/can-the-uk-achieve-its-50-gw-offshore-wind-target-by-2030--224379

SUMMARY OF LESSONS LEARNED

electricity prices for several years[71] and this has prompted more aggressive expansion of renewable energy technologies in the UK and internationally as governments attempt to reduce their energy dependence.

The EU is now preparing new measures to accelerate the rollout of renewable energy technologies across Member States, many of which are lagging on their renewable energy targets. When it comes to offshore wind energy, the UK's experience can provide valuable lessons in policy delivery.

The key developments that have enabled the UK to achieve rapid growth in offshore wind energy are as follows:

STABLE REVENUES (OR GUARANTEED MINIMUM PAYMENTS) ARE AMONG THE STRONGEST INCENTIVES FOR RENEWABLE ENERGY INVESTMENT

Guaranteeing revenues to offshore wind generators is a well-established principle for delivering growth in offshore wind capacity and has been applied successfully in Europe and internationally. Using CfDs or FITs provides a predictable and long-term source of revenue which vastly reduces investment risks and the cost of capital for renewable energy projects. FITs that set prices years in advance can, however, lead to renewables developers being overcompensated. In contrast CfDs allocated by auction can be structured in a way that shares price risks fairly between the taxpayer and the generator.

The UK was among the first countries to adopt a two-way CfDs model and, although this approach looks set to evolve as part of ongoing Review of Electricity Market Arrangements (REMA), it is nonetheless an essential instrument for delivering renewables growth.

CARBON PRICING CAN BE AN EFFECTIVE MEANS OF SUPPORTING INVESTMENT TOWARDS RENEWABLE ENERGY

Carbon pricing acts as a financial disincentive for fossil fuel power which in turn makes low-carbon electricity generation more competitive. The UK's carbon price support scheme effectively doubled the carbon price for power generation when first introduced which led to the rapid decline of coal generation and shifted investment towards renewables. The price floor created by the CPS also reduced the risk to renewable energy investments if ETS prices fall in future. Although EU ETS prices have risen in recent years, price floors remain an effective signal to investors in renewable energy.[72]

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[71] Guénette, J. and Khadan, J. (2022). The energy shock could sap global growth for years. Worldbank.org. Retrieved 28 July 2022 from https://blogs.worldbank.org/developmenttalk/energy-shock-could-sap-global-growth-years

[72] Whitmore, A. (n.d.). 3. Carbon price floors and ceilings. On Climate Change Policy. https://onclimatechangepolicydotorg.wordpress.com/carbon-pricing/price-floors-and-ceilings/

THE IMPORTANCE OF MAINTAINING A PORTFOLIO OF TECHNOLOGIES

Supporting a diverse and sustainable portfolio of renewable generation technologies can lead to more cost-effective decarbonisation compared to deploying only the cheapest forms. While onshore wind is less expensive than offshore wind power, the latter benefits from being highly scalable thanks to relatively low barriers to development. The higher cost of offshore wind can thus be offset by a more rapid shift away from costly fossil fuel power generation.

A diverse portfolio of renewable technologies is also more robust in the face of unexpected changes in costs or disruption to supply chains. In creating a balanced generation portfolio, governments should adopt clear requirements for the sustainability of renewable technologies to avoid creating incentives for activities that damage natural ecosystems, particularly in the case of hydropower and biomass-based energy sources.

Many EU Member States have achieved high rates of solar PV and onshore wind installations. Reaching 2030 targets with the same strategy may, however, prove challenging as areas suitable for development become scarce. Supporting a broader set of renewable energy technologies is likely to prove more cost-effective in the long-term.

ELECTRICITY MARKETS NEED TO BE EQUIPPED TO PERFORM EFFICIENTLY IN A RENEWABLES-DOMINATED SYSTEM

Most electricity markets in Europe were created to deliver dispatchable fossil-fuel generation and this has created an inherent bias in favour of incumbent fossil fuel-based electricity generation technologies. This presents a challenge for increasing the share of renewable generation because the functioning of electricity markets strongly influences which technologies are deployed. A fundamentally different market structure is required to support the continued growth of offshore wind and maintain efficient pricing in a renewables-system dominated with variable output. The UK is now undergoing a second iteration of major electricity market reforms in the space of decade and this process will be informative for developments in other electricity markets.

INCREASED GRID FLEXIBILITY IS REQUIRED TO SUSTAIN THE GROWTH OF RENEWABLES

Timely investments in electricity transmission and storage infrastructure are critical to sustaining the large-scale deployment of renewables and providing grid-balancing services which help reduce overall costs of electricity supply.

Grid infrastructure will need to be expanded to accommodate increasing offshore wind capacity. This not only means connecting new offshore wind farms to the grid, thereby widening its geographical extent, but also reinforcing existing networks to enable electricity to be transmitted to where it is needed.

Consideration also needs be given to the sustainability of each type of renewable energy. For example, the use of biomass lacks scalability, may have associated lifecycle emissions, may risk unsustainable sourcing, may reabsorb carbon over a long timescale and can result in land use changes that reduce the effectiveness of natural carbon sinks.

Similarly, energy storage is important for short-term grid balancing. The UK has an ambitious pipeline of electricity storage projects.

ANNEX 1: MAJOR UK RENEWABLES POLICIES 1990 - 2010

In 2000 the UK's first offshore wind turbines began generating electricity off the coast of Blyth in Northumberland.[73] At that time, environmental concerns had already been receiving considerable attention from UK policymakers but were not yet a central driver of energy policy.

The earliest legislation to promote renewable energy in the UK came in the form of the Non Fossil Fuel Obligation (NFFO). Introduced in 1990, the NFFO subsidised both nuclear and renewable power generation via an obligation on the country's newly privatised energy companies to purchase power from non-fossil generators at a premium price.[74]

However, early NFFO rounds lumped different forms of renewable energy under the same funding pots, creating an inherent bias towards the cheapest forms of renewable energy generation as developers could cherry-pick projects that would yield the greatest returns. While a number of onshore wind projects were awarded subsidies through the NFFO, the scheme lacked a facility to support emergent technologies, including offshore wind which has higher associated costs and risks.[75]

In 1997, the Labour Government came to power with a manifesto pledge to supply 10% of the UK's electricity from renewables by 2010, replacing the previous government's target of achieving 1,500 MW of new renewable energy capacity by the year 2000. At that time, a major barrier to developing renewable energy projects was planning consent.[76] The rush to build onshore wind projects in the early years of the NFFO with relatively little input from local stakeholders sowed the seeds of a community-led backlash against onshore wind farms[77] - a source of tension which continues to the present day.

THE RENEWABLES OBLIGATION (2002 - 2017)

The Renewables Obligation (RO), which replaced the NFFO in 2002, sought to apply lessons from its predecessor. Rather than offering contracts to renewable energy generators, it set an obligation on energy suppliers to purchase and supply a certain amount of generated electricity from renewable sources. This allowed suppliers to negotiate their own contracts for renewable electricity and avoided the government being seen to 'pick winners'.

However, the RO also created new risks for generators, who no longer had certainty around the price or quantity of electricity that they would be able to sell. Furthermore, it capped the price of eligible technologies at 6–7p/kWh, in effect limiting participation to more mature technologies. To overcome the latter issue, the then government introduced a capital subsidies bidding mechanism to support emerging technologies and

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[73] BVG Associates. (n.d.). UK offshore wind history. Retrieved 31 July 2022 from https://guidetoanoffshorewindfarm.com/offshore-wind-history

[74] Gross, R. and Heptonstall, P. (2010). Time to stop experimenting with UK renewable energy policy. https://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/icept/Time-to-stop-experimenting.pdf

[75] Mitchell, C., Connor, P. (2004). Renewable energy policy in the UK 1990–2003. Energy Policy (32). http://aoatools.aua.gr/pilotec/files/bibliography/EP_renewablesUK_mitchell-3820549121/EP_renewablesUK_mitchell.pdf

[76] Kettle, R. (1999). Promoting Renewable Energy: Experience with the NFFO. UK Department of trade and Industry. https://www.oecd.org/unitedkingdom/2046731.pdf

[77] Gross, R. and Heptonstall, P. (2010). Time to stop experimenting with UK renewable energy policy. https://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/icept/Time-to-stop-experimenting.pdf

between 2002-2005 £102 million in capital grants were awarded to offshore wind energy projects.[78]

The RO has been modified numerous times since its inception. In 2004 and 2006 the scheme was expanded to include forms of renewable energy generation which were not previously covered. And in 2009, the Government introduced banding into the RO which enabled higher-cost renewable technologies to earn more RO credits per unit of electricity than lower-cost technologies.[79] This raised RO support for offshore wind and other nascent renewable technologies enabling them to play a more prominent role in the scheme.

Despite its drawbacks, the RO had the desired effect of creating momentum behind renewable energy development. Between 2003 and 2010, offshore wind capacity grew from 60MW to a little over 1GW.[80] However, this achievement came at a cost. In its early years, the RO secured renewable electricity at a higher rate of subsidy per unit of electricity than elsewhere in Europe but without achieving a higher installation rate.[81] Indeed, the RO was criticised for creating an extra burden on household energy bills in the short-term,[82] yet it also supported technologies that would ultimately become a source of low-cost energy.

FEED-IN TARIFFS (2010 - 2019)

Driven in large part by its commitment to achieving 10% of gross electricity consumption from renewables by 2010, in April 2010 the Government introduced the Feed-In Tariff (FIT) scheme which was designed to encourage deployment of small-scale (5MW or less) electricity generation. The scheme provided fixed payments per MWh to small renewable installations for both electricity generation and export to the grid. It led to 3,567MW of small scale renewable capacity being installed during the first five years of the scheme[83], most of which was solar photovoltaic (PV) with a modest amount of (onshore) wind generation.

The popularity of FIT led to the scheme becoming a victim of its own success and the government slashed tariffs to a fraction of their original levels[84] within two years of its launch in a bid to reduce the financial burden of the scheme. A 2015 review of FITs by DECC acknowledged that "original projections failed to foresee the rapid uptake of domestic solar PV, due to the unexpectedly large reductions in module costs".[85] The scheme was eventually wound down in 2019.

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