Philip Dunne MP
Chair, Environmental Audit Committee
House of Commons
London, SW1A 0AA

15 May 2020

Dear Mr Dunne MP

Evidence on Technological Innovation and Climate Change: Offshore Wind

Summary

Continuing innovation in offshore wind technology and policy are required to deliver on the 2030 targets for offshore wind and Net Zero in 2050 at prices which customers can afford. Innovation has been at the heart of the offshore wind industry's remarkable success in driving cost reductions and will continue to play a critical role.

- Offshore wind has had a major positive impact on the price of power, UK jobs and reducing CO_2 emissions due to continuing technical, regulatory and commercial innovations which have driven down the Levelised Cost of Energy (LCOE). For offshore wind to maximise its contribution to the UK economy and CO_2 reductions requires continued innovation including in the systems for connecting offshore wind effectively and efficiently to the onshore electricity grid and in the permitting process (see paragraph 7)
- When we emerge from the COVID-19 lock-down, offshore wind can make an important contribution to boosting the economy with six projects currently under construction with an estimated capital cost of £11bn which are expected to generate 4,000 jobs (see paragraph 13)
- Throughout the operational life of an offshore windfarm it will continue to generate local jobs, many of them skilled, well paid and in coastal communities. There were an estimated 10,000 jobs in the offshore wind sector in 2017 and the Sector Deal set out a proposal to increase this by building up the lifetime UK content from almost 50% today to 60% by 2030. Thus offshore windfarms have an important economic impact at a critical time (see paragraphs 50 to 51)
- The Government's offshore wind target of 40 GW of operational capacity in 2030 is a considerable stretch and will require major, urgent action by Government to achieve it. Strong and sustained Government commitment to this ambitious target and supportive regulation are necessary if the required £70bn of investment is to be attracted to the UK – especially given the offshore wind investment opportunities elsewhere (see paragraph 42)
- 40 GW of offshore wind will probably require a significant increase in the CfD budget, currently £557m pa for Pot 2. The cost of the additional CfDs to reach this target would be around £1.3bn pa which is more than twice the current budget. (see paragraph 46)
- However, investing in the short term will save money in the medium and long term. Not acting today will result in higher costs in the future when we would face an even tougher challenge to reduce carbon emissions. The dramatic reduction in offshore wind costs demonstrates that low carbon energy can be cheaper than traditional fossil fuels (see paragraphs 6 to 9)

- Increasingly large, far-from-shore windfarms means rising transmission costs and inconvenience for those living near cable landing points. Meshed offshore transmission grids are thus required to best deliver the 2030 targets. Meshed grids will increase resilience, and create opportunities for UK offshore windfarms to export power to the Continent when UK power prices are low (see paragraph 40)
- The production of hydrogen from offshore wind is an exciting opportunity to manage the impact of negative power prices and cut emissions in the hard to decarbonise sectors of heat and transport (see paragraphs 33 to 35)
- There are important synergies between offshore wind and other parts of the energy system including green hydrogen. The benefits of offshore wind will be maximised by recognising these links and taking a whole energy system perspective (see paragraph 11)

Introduction

1. We are pleased to make this submission to provide evidence for your committees on offshore Wind. Our evidence is organised using those of your questions where we feel that we have the expertise and experience to add to the debate.

- How effective has the Government's offshore wind Sector Deal been in moving the sector towards becoming an integral part of a low-cost, low-carbon, flexible grid system and boosting the productivity and competitiveness of the UK supply chain?
- What level of output can the sector deliver in the UK, and what Government support would be needed to achieve this?
- What is the UK industry doing to promote the sustainability of offshore wind arrays throughout their entire life cycle from development through to decommissioning, and to improve maintenance and end-of-life repair?
- How well is the UK industry managing the environmental and social impacts of offshore wind installations, particularly on coastal communities with transmission-cable landing sites?
- How well is Government policy supporting innovation in transmission technology to improve the efficiency of electricity transmission?
- Looking to the future, what can the onshore wind sector learn from the offshore success story?

2. This evidence is submitted by three senior independent energy sector consultants, Mark Hughes, Paul Hallas and me, who are working together to encourage the development and application of policy to support a successful transition to Net Zero by 2050. Collectively, we have more than 100 years of energy sector experience spanning policy, regulation, commercial, financing, project development and other practical challenges. Mark has world-wide experience in power sector regulation and transaction execution, Paul has extensive transaction and regulatory experience in European energy markets. Much of my career has been focussed on regulating and financing renewables, particularly offshore wind. Further information on our relevant experience is in Appendix 1.

3. We are keen to contribute to this enquiry as we agree with the Committee on Climate Change (CCC) that offshore wind has a critical role to play in delivering Net Zero[1] and continuing innovation in technology and policy are required. Offshore

wind exploits sites with high wind resources so allowing large turbines and windfarms to take advantage of economies of scale. Offshore windfarms can be built quickly, at gigawatt-scale, close to densely populated coastal areas and so decarbonise in a cost-effective manner. In the 2019 Contract for Difference (CfD) auction, 5.5 GW of offshore wind capacity won CfDs with record low prices of £39.65/MWh and £41.61/MWh (2012 prices), around 65% lower than prices in the 2015 auction.

4. Driven by cost reductions, offshore wind is a key source of green power. The Crown Estate (The Crown Estate, 2020b) estimates that in 2020, offshore wind will:

- Generate 34 TWh of electricity
- Avoid 14m tonnes of CO_2
- Supply electricity to meet the needs of 8.8m homes, around 32% of the UK total

5. As noted in Ofgem's decarbonisation action plan (Ofgem, 2020), " *investing in the short term will save money in the medium and long term. Not acting today will result in much higher costs in the future as we would face an even tougher challenge to reduce carbon emissions. The dramatic reduction in offshore wind costs demonstrates that in the long term, low carbon energy can be cheaper than traditional fossil fuels*."

6. Innovation has been at the heart of the offshore wind industry's remarkable success in reducing costs. However, further advances are required to deliver our ambitious offshore wind targets at prices that customers can afford. Enhanced technologies such as larger turbines, higher transmission voltages, electrolysis to convert offshore wind power into green hydrogen and floating wind open up high-wind sites in water deeper than 60m and will drive further cost reduction and expansion.

7. Innovation is also needed in the regulation and permitting of offshore wind. Ofgem is looking at meshed grids which are essential to efficiently and with minimum disruption to local communities install 40 GW of offshore wind by 2030. Also critical is streamlining the offshore wind permitting process which currently takes around five years (The Crown Estate, 2019) and so delays projects and creates a significant risk that tens of millions of pounds of development expenditure (Green Alliance, 2014) is devoted to a project which is not approved.

8. As technology advances, support mechanisms such as the CfD need to accommodate technological change. It is encouraging that BEIS is proposing (BEIS, 2020) to adjust the CfD process so that floating wind projects have a much higher chance of winning the support required to make them viable and to develop and scale up the technology to reduce future costs.

9. National Grid's Future Energy Scenarios 2019's (National Grid Systems Operator, 2019) five year forecasts indicate that in 2023 offshore wind generation will total 53.1 TWh which is 17% of total generation and exceeds total thermal generation

[1] The CCC say "Consistently strong deployment of low-carbon generation will be needed in order to quadruple low-carbon supply by 2050 (e.g. including at least 75 GW of offshore wind). (Committee on Climate Change, 2019)

(51.8 TWh). Achieving this 2023 forecast and even more the 2030 target of 40 GW of offshore wind capacity will require innovation, investment at scale, and effective policy and regulation. The ongoing development of offshore turbines, transmission systems and installation processes give confidence that the LCoE from offshore wind will continue to fall significantly.

Question: How effective has the Government's offshore wind Sector Deal been in moving the sector towards becoming an integral part of a low-cost, low-carbon, flexible grid system and boosting the productivity and competitiveness of the UK supply chain?

10. The Sector Deal (HM Government & Offshore Wind Industry, 2019) was launched in March 2019 by the Government and the UK offshore wind sector with commitments to a programme of CfD auctions, building the local supply chain and a target of 30 GW[2] of installed offshore wind generation by 2030. A little over a year later it is early to judge the effectiveness of the deal as several of the commitments such as increasing local content require time, co-ordinated action by many stakeholders and investment to realise.

11. In a full assessment of the Sector Deal's contribution to a low-cost, low-carbon system it is important to take a whole energy system perspective which accounts for the synergies and other linkages within the energy sector. For example, significant effort is currently focussed on producing zero carbon, 'green hydrogen' using power from offshore windfarms. The economics of green hydrogen largely depend on the cost of the electricity used and green hydrogen can play an important role in reducing cannibalisation of the price of offshore electricity. As a use for wind power when generation is high, hydrogen can reduce the incidence of low or negative power prices due to excess supply. It can also 'shave' peak power prices and increase energy security by being stored and then used to generate dispatchable, zero carbon electricity when power prices are high.

12. Another area of potential synergies with offshore wind is direct supplies of electricity from offshore windfarms to nearby oil & gas platforms. This can cut emissions and costs for the oil & gas platform, and provide steady demand for the windfarm at prices fixed by a Power Purchase Agreement. The Norwegian energy company Equinor is currently developing Hywind Tampen: the world's first renewable power for offshore oil & gas. This 88 MW floating wind project will provide electricity for two oil & gas operations in the Norwegian North Sea. The windfarm will meet about 35% of the power demand of the five connected platforms. This project will help reduce the use of gas turbines offshore and offset 200,000 tonnes of CO_2 emissions and 1,000 tonnes of NOx emissions per year.

Using offshore wind projects to accelerate the post COVID-19 economic recovery

13. There is now a valuable opportunity for the sector and the Government to accelerate construction of offshore windfarms and so boost the post COVID-19 economic recovery and help to hit the 2030 target. There are currently six projects under

[2] In the Sector Deal the Government and industry set a target of 30 GW of operating offshore windfarms in 2030. Later in the Queen's Speech, the Government increased its target to 40 GW of operating offshore windfarms in 2030.

construction with total capacity of 4.4 GW and an estimated capital cost of £11bn which are expected to start operations between now and 2023 and could create some 4,000 jobs[3]. By streamlining the processes for permitting and approving generation by new offshore windfarms, Government and project developers can fast-track these projects.

14. COVID-19 has caused a unique economic shock as it has simultaneously cut economic demand and reduced supply. Accelerated development of offshore windfarms can adress both these issues by creating additional demand for goods and labour, while also developing the local supply chain including training skilled workers for the jobs of the future in a rapidly growing, global market. In addition, this investment will reduce CO_2 emissions and contribute towards achieving our 2030 offshore wind target.

15. A current example of offshore wind creating investment and jobs is the plan by SSE and Equinor to use the Port of Tyne as the operations base for the world's largest offshore wind development (Dogger Bank), which will create 200 permanent jobs (The Guardian, 2020). Alok Sharma, the secretary of state for BEIS, said projects like Dogger Bank will be "*a key part of ensuring a green and resilient economic recovery as well as reaching our target of net-zero emissions by 2050*".

16. There is a strong coalition of experts, business leaders and academics advocating green investment, including in offshore wind, as a key part of a rapid and sustainable post COVID-19 economic recovery. A letter from the CCC to the Prime Minister on 6 May 2020 about building a resilient recovery from the COVID-19 crisis, noted "*an urgent need for measures to provide for more orderly and cooperative onshoring of offshore wind energy*" (Lord Deben, 2020). CEOs of more than 60 British organisations called on the government to repair damage to the economy from the COVID-19 crisis by, among other things, invest in infrastructure, technology and skills to create jobs that help sustainability (60 UK businesses and charities, 2020).

17. Analysis of possible COVID-19 economic recovery packages by top economists shows the potential for strong alignment between the economy and the environment (Hepburn, Stern, & Stiglitz, 2020). The team of academics led by Professor Cameron Hepburn from the University of Oxford, included Nobel prize winner, Professor Joseph Stiglitz and climate economist Professor Lord Nicholas Stern. The research found that, in the short term, clean energy infrastructure construction is particularly labour intensive, creating twice as many jobs per pound as fossil fuel investments and leads to increased long-term cost savings, by comparison with traditional fiscal stimulus.

18. In the medium term, constructing a further 30 GW of offshore wind generation by 2030 to achieve 40 GW requires an estimated investment of £70bn. There is also an opportunity for a systematic programme of investment in a meshed offshore grid which would serve new projects and encompass existing offshore windfarms.

[3] Analysis supporting the offshore wind sector deal (HM Government & Offshore Wind Industry, 2019) indicated that deploying up to 30GW of installed capacity by 2030 could support 27,000 jobs. Using this ratio of jobs to installed capacity suggests that 4.4GW would generate 3,960 jobs.

19. Unfortunately, Brexit and then COVID-19 have slowed policy responses including the Energy White Paper originally due to be published in Summer 2019 and now expected in Summer 2020. However, BEIS has consulted on changes to the CfD (BEIS, 2020) before the 2021 allocation round so that it can continue to support new generation, provide value for bill payers and stay broadly on track towards the delivery of Net Zero. As discussed below, Government's proposals to limit CfD payments when power prices are negative, may increase CfD bids as developers try to recoup "lost revenue". Transferring this additional price risk to windfarm owners will mean greater use of expensive project equity, as banks shy away from price risk by reducing the amount they will lend, and so increase the cost of capital.

20. Administrative changes to make the CfD scheme more flexible will help encourage investment in offshore wind particularly from new entrants who are not familiar with the CfD scheme. Broadly, the changes will allow developers more flexibility including to manage projects being transitioned to meshed offshore grids and should cater for the uncertainty around achieving target commissioning dates for new technologies like floating offshore wind. The scale of the investment in offshore windfarms means that new investors will be required including financial investors who will probably buy stakes in existing projects allowing developers to recycle their capital to invest in new projects. The changes will also benefit developers running hard to be ready to bid in a specific auction.

21. Other proposed changes to the CfD particularly relevant to the Sector Deal are:

- Establishing a Pot 3 dedicated to fixed foundation offshore wind and allowing floating offshore wind projects in water deeper than 60 metres to participate in Pot 2 (discussed below)
- Extending the requirement for supply chain plans (SCP) and increasing the penalties for failure to implement a SCP
- Stopping payments under the CfD when the reference price is negative

A competitive UK supply chain

22. The projects in the offshore wind pipeline are expected to tender for CfDs and the scheme rules will require they have a SCP. This will impact on the risk profile of new projects if as proposed Ministers can take account of an applicant's failure to implement a SCP when considering subsequent applications. Potentially, all partners with a 20% or greater share in a project can be excluded from an allocation round. For an offshore wind developer with a pipeline of projects or who may want to rebid unsuccessful projects in the following round, the risk of exclusion will incentivise them to produce conservative SCPs and so may have the unintended consequence of slowing the development of local supply chains.

23. The proposal to reshape the UK supply chain by "considering the carbon intensity within supply chains and how this could be measured and/or reported, and taken into account, as we transition to a net zero economy" is interesting. However, there is again a worrying possibility that novel and strict carbon intensity requirements would lead to more conservative SCPs and be counter-productive. Given the importance of continuing innovation, it may be more helpful if all SCPs had to demonstrate the contribution they will make to further technological development.

24. The more than doubling of the rate of installation of offshore wind required to hit 40 GW in 2030 (see Figure 3) will place significant strain on developers and their supply chain. Forcing growth too quickly may well stretch local companies and result in higher prices, extended delivery times and perhaps even an increase in Health and Safety incidents. If this were to occur it would slow the reduction in the cost of offshore wind and increase the risk of missing the 2030 target.

25. Growth of the supply chain requires support for appropriate training and skills development. Estimates of the future skill mix required could form the basis for a more active engagement with training and education establishments. Post-Brexit immigration policy may have an impact on UK access to skilled workers; but the impact will only be clear once the details of the new policy and its implementation are published. Industry and Government should develop a skills and people requirements plan and engage with Universities, Colleges and training bodies to develop plans to provide the appropriate skills.

26. Maximising the growth of the supply chain requires investment in the UK by key tier one contractors such as turbine manufacturers. An important win for the UK was Siemens building major wind turbine production and installation facilities on the banks of the Humber. The company has invested £160m in Green Port Hull and in a new blade factory in Paull, East Yorkshire. Up to 1,000 jobs will be created at the two sites. Siemens' investment was facilitated by its partner Associated British Ports (ABP) investing £150m in the project.

27. Floating wind is an emerging, as yet high cost technology where there is an opportunity for the UK to grasp early mover leadership. By shielding floating wind from competition with fixed offshore wind for CfDs, the deployment of floating wind is advanced and with it the opportunity to benefit from economies of scale and for the UK to establish the best floating foundation concepts. If floating offshore wind becomes a common form of generation globally this would be a big opportunity for UK industry. Estimates of the future floating wind market by Wind Europe (Wind Europe, 2018) indicate that the capital investment in offshore floating wind installations in 2030 could be more than €100bn.

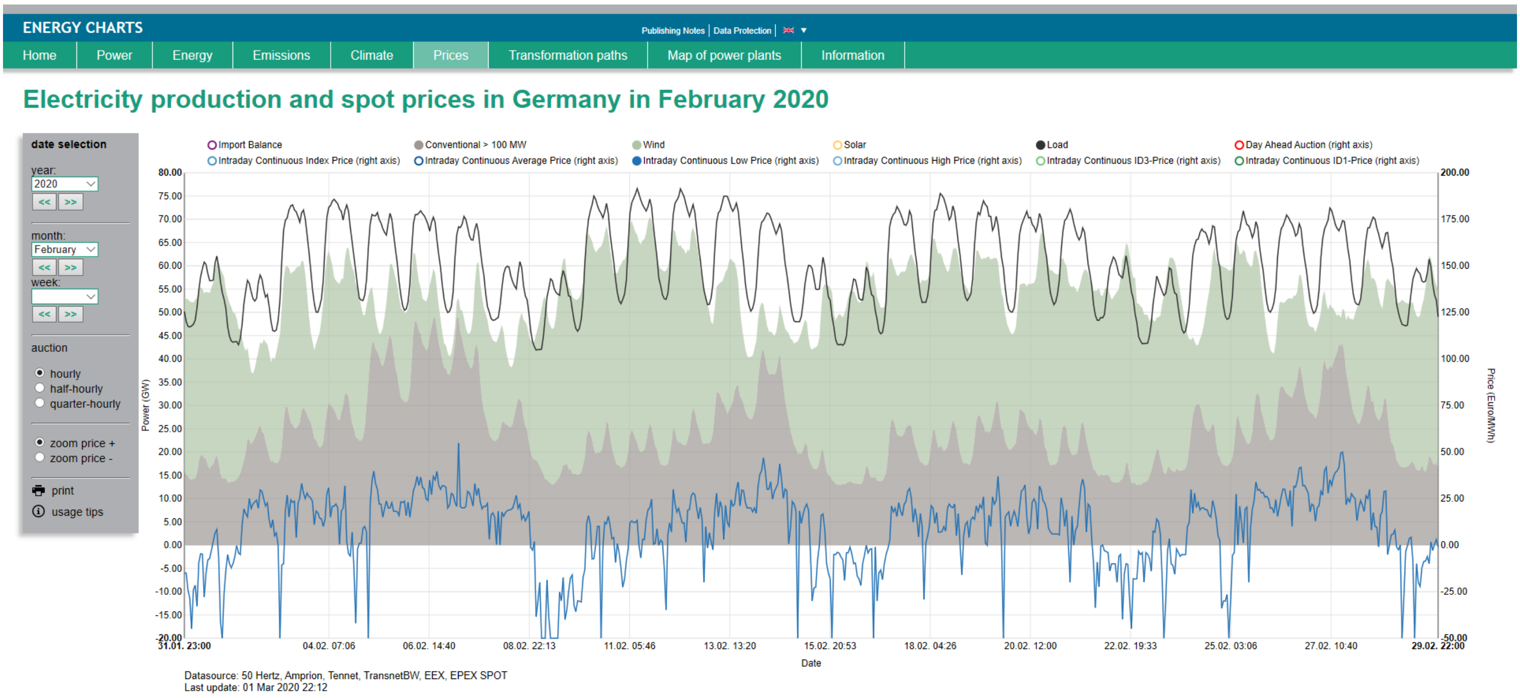
Negative power prices

28. The cannibalisation of offshore wind power prices is a growing problem for windfarm developers and is a barrier to investment. BEIS' CfD proposals on negative prices are designed to improve value for money for consumers but would result in negative prices becoming a problem for projects receiving CfDs. Price cannibalisation is the downward pressure on wholesale electricity prices at times of high output from intermittent, weather-driven generation such as solar and wind. As the output from different offshore windfarms are often correlated – if is windy for one North Sea windfarm it is likely to be windy for many – and offshore wind is an increasing fraction of total generation, we expect to see more periods when wholesale power prices are negative as supply from zero incremental cost renewables exceeds demand. The current low electricity demand due to Covid-19 is giving a foretaste of more frequent negative prices which are likely to be more common by 2030.

29. Experience in Germany earlier this year indicates the extent to which windy conditions and high levels of intermittent generation can lead to frequent negative

power prices. A very windy February 2020 caused German power prices to turn negative for longer than ever before in one month. High winds that month broke renewable energy production records, and power prices were negative for 84 hours or more than 12% of the month – compared to 211 hours (2.4% of the year) in all of 2019. At times power prices were lower than minus €50/MWh and wind power generation alone was almost enough to meet demand as shown in Figure 1. The 21 TWh of wind generation accounted for about 45% of Germany's total power production in February.

Figure 1: Negative power prices in Germany in February 2020



Source: Fraunhofer ISE, https://www.energy-charts.de/price.htm?auction=1h&year=2020&month=2

30. With 30 GW or more of offshore wind, BEIS forecast negative wholesale prices about 4.5% of the time in 2035 and Cornwall Insight forecast 14% in 2034. The latter represents a significant fall in revenue for generators who will find it difficult if not impossible to find a hedge against negative prices.

31. However, if cross-border transmission links and smart charging of electric vehicles (EVs) expands, this will increase the potential for short-term mitigation (e.g. within day). Due to cross-border wind correlations interconnectors will not help when high-wind conditions in NW Europe persist for extended periods. Moreover more storage in the system (including EV batteries) will create new demand when prices are low or negative and reduce the likely incidence and depth of negative prices. It would be sensible for new demand for power to emerge when prices become predictably low or negative at particular times of day or seasons of the year. We counsel against structuring a CfD design response based on negative prices being frequent and deep.

32. Currently, CfD payments are capped at the strike price when prices are negative, and if these persist for six hours or more, payments under the CFD are zero for the entire period. BEIS now proposes that difference payments are not made to CfD generators when the Intermittent Market Reference Price is negative. If this was to

lead to say a 10% fall in payments under the CfD and windfarm developers could not mitigate the impact on their revenue, then an increase of 10% in CfD bids would be required to compensate for the loss of revenue. As noted above, the risk of negative prices reduces project bankability, increases the cost of capital and so further raises the strike price bid in CfD auctions. Irrespective of the actual impact of negative prices, banks lending to offshore wind will structure and price their loans based on a worst-case scenario.

33. In the 2020s and 2030s, negative power prices could have a significant impact on offshore wind revenue unless the power is covered by a price hedge such as a PPA or it can be converted into a commodity such as hydrogen with a positive market value. Major developers such as Orsted are exploring the feasibility of using cheap electricity from offshore wind to power electrolysis and produce green hydrogen. Green hydrogen is expected to become an important zero-carbon fuel for hard to decarbonise sectors such as heating, particularly industrial heat, and transport, particularly heavy goods vehicles. The CCC (Committee on Climate Change, 2019a) sees a major role for hydrogen by 2050.

34. As hydrogen is a good inter-seasonal store of energy and can also be used to generate power, a windfarm can mitigate negative prices by diverting power to hydrogen production when power prices are low and storing the hydrogen till electricity / hydrogen prices are high. As part of the BEIS-funded Gigastack hydrogen supply feasibility study, Orsted and ITM Power have proposed an electrolyser in an offshore wind turbine tower, or very near it, which has a connection to the direct current (DC) generated in the turbine, along with appropriate power flow control and water supply. This arrangement should reduce the costs and energy losses from green hydrogen production.

35. Green hydrogen is currently high cost and requires Government support if it is to be deployed at scale. However, learning by doing and economies of scale will drive down the capital costs of electrolysers so improving the economics of green hydrogen and making it viable with low-cost power and operating at a high load-factor.

A low-cost, low-carbon, flexible grid system

36. The Sector Plan led to the OWIC report "Enabling efficient development of transmission networks for offshore wind targets" (Offshore Wind Industry Council, 2019) which was a call for action for a cost-effective, offshore grid fit to deliver the 2030 offshore wind targets. A response is required now from regulators as changing policy may take some time and the construction or significant modification of offshore transmission arrangements will require a long-lead time. To deliver change by 2030, new frameworks and regimes will be required by the early 2020s.

37. So far, the UK Offshore Transmission Owner (OFTO) system of connecting offshore wind projects to the onshore grid on a point-to-point basis has worked well. However, as offshore wind installation accelerates and windfarms get closer together, this system will no longer be optimal as it leads to physical cable congestion, particularly nearshore, at landfall and onshore. The construction of many point-to-point cables is also leading to unnecessary environmental disturbance and OFTOs are not resilience to cable failures.

38. There is an opportunity to create enduring transmission infrastructure to match the approach onshore and our ongoing need for offshore wind generation. Extending the lifetime of offshore transmission will make it useable by different and successive projects. A strategic review by The Crown Estate of the feasibility and acceptability to key stakeholders of longer life offshore transmission found that it can be cost effective, is supported by stakeholders and can also deliver significant environmental and safety benefits.

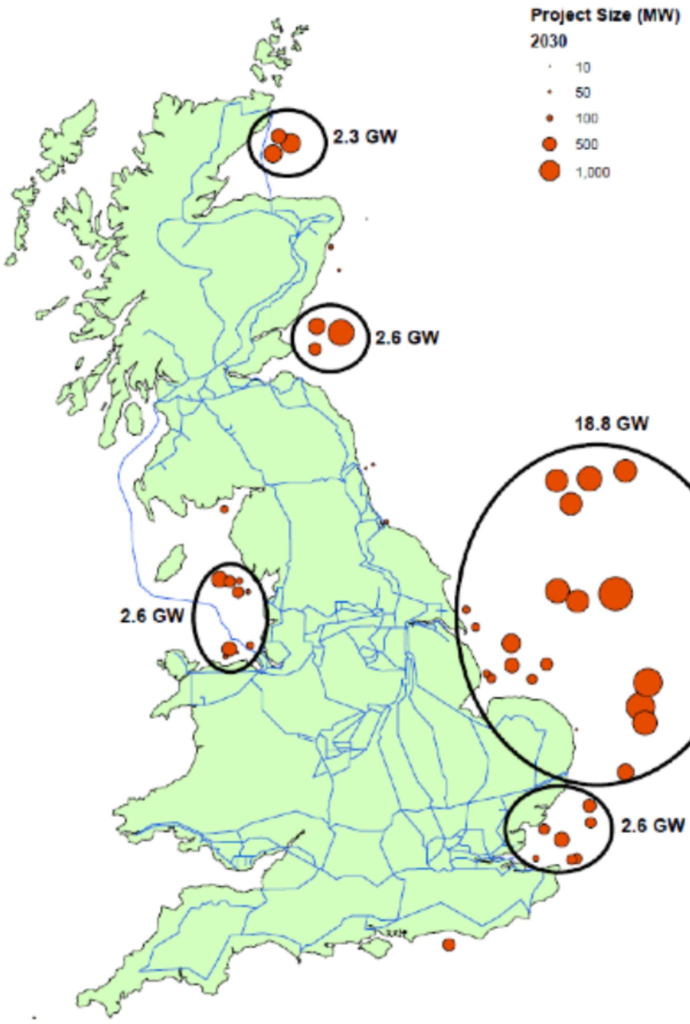
39. COVID-19 has resulted in Ofgem pausing some of its work until 30 June 2020 to allow staff to focus on the more critical issues facing the energy industry. This may slow work on a flexible offshore grid fit to deliver on our 2030 offshore wind targets. In Ofgem's Decarbonisation Action Plan (Ofgem, 2020) action 3 is: "*More effective coordination to deliver low cost offshore networks. We will explore, with government and industry, options for a more coordinated offshore transmission system to connect offshore wind generation, to achieve a rapid and economic expansion of the offshore network. As a first step we will work with the Electricity System Operator (ESO) to ensure it can take forward an options assessment for offshore transmission*." In their Forward Work Programme 2020 (Ofgem, 2019), they expanded on this by saying: "*we will work with government, the Crown Estate, the ESO and industry to develop coordinated solutions for transmission networks linking the windfarms to the onshore grids, while exploring the options for meshed grids rather than radial links*".

40. Meshed grids should be designed to be more resilient, provide connections for offshore windfarms to the Continent and ease permitting and planning. While meshed grids should be the best value option, there are important downsides such as the risk of offshore transmission becoming obsolete, perhaps due to changes in turbine or cable technology, and issues such as how existing OFTOs would be incorporated into meshed grids. There are also important market design choices to be made, e.g. whether the best solution is a single offshore Electricity System Operator (potentially, per offshore region), and/or a single Transmission Owner. Getting from today's OFTOs to an efficient and effective meshed grid is a big challenge but has significant potential benefits. Rapid work on meshed grid policy is essential now as it takes seven years to develop an offshore windfarm, and a windfarm and its transmission link(s) are best developed in close co-ordination.

Question: What level of output can the sector deliver in the UK, and what Government support would be needed to achieve this?

41. The offshore wind industry is committed to and expects to deliver 30 GW of offshore wind by 2030. This Sector Deal target seems to be achievable given rapid and co-ordinated Government support and action to remove bottlenecks to the development, financing and construction of offshore windfarms. A set of windfarms identified by the OWIC (Offshore Wind Industry Council, 2019) which deliver 30 GW in 2030 are shown in Figure 2. As illustrated in Figure 3 achieving this will be stretching as annual additions to offshore generating capacity would have to increase from the forecast in FES 2019 (National Grid Systems Operator, 2019) of 1.3 GW in 2023 to an average of 2.3 GW pa over the period 2024 to 2030. Achieving the target will also be harder if a long COVID-19 lock-down causes a delay in the development and construction of new windfarms.

Figure 2: OWIC 2030 offshore wind capacity



Source: (Offshore Wind Industry Council, 2019)

42. In our view the critical policies needed in the next few years to hit the Sector Deal target of 30 GW by 2030 are:

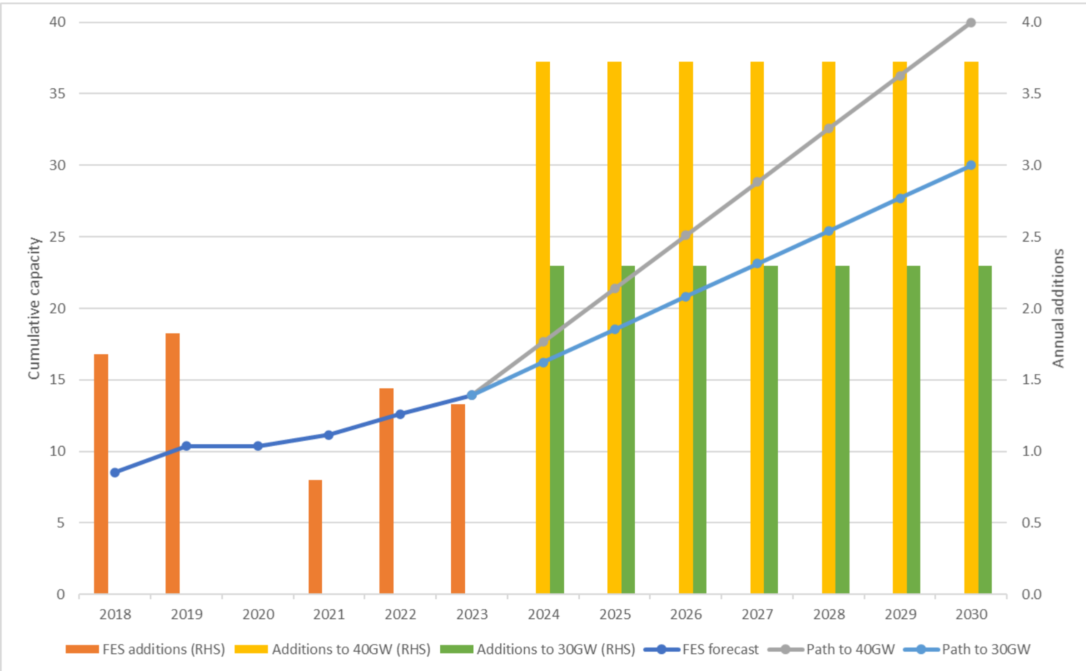
- A strong, cross-party commitment to regular, at best annual, CfD auctions with an adequate budget to give project developers and the supply chain the confidence and time to gear-up for cost effective delivery. Developing and constructing a further 20.6 GW of windfarms by 2030 is expected to require investment of around £50bn[4]
- Streamline and co-ordinate key processes so that it is less expensive and faster to:
    - Apply for leases from The Crown Estate,
    - Get all required permitting
    - Connect to a transmission link (meshed grids may streamline and reduce the cost and time to get a connection approved)
    - Bid for and draw-down CfD payments
- Plans for regulating and implementing meshed grids need to be drawn up and appropriate transition arrangements put in place

[4] The IEA (International Energy Agency, 2019) expects that for fixed offshore windfarms commissioned in the mid-2020s the capital cost including transmission will be $3m per GW.

- Government support for floating offshore wind which will open up additional areas of UK waters. Putting fixed offshore wind into a new Pot 3, with floating wind in Pot 2, will help floating wind win CfD auctions
- Co-ordinated support and skills development from the Government and industry for the supply chain so it can cost effectively meet increased demand

43. Each of these bottlenecks would need to be addressed more vigorously and rapidly to support building 40 GW of offshore wind by 2030. SSE Renewables (SSE Renewables, 2020) have published a list of nine Government actions required to achieve 40 GW of offshore wind which, among other things, addresses each of these bottlenecks. Developing and constructing a further 30 GW of windfarms to achieve 40 GW is expected to cost more than £70bn.

Figure 3: Illustrative offshore wind capacity (GW)



Source: Future Energy Scenarios (National Grid Systems Operator, 2019) and author

44. We have created illustrative paths for offshore wind generation capacity to 2030 by taking forecasts from the FES 2019 five-year forecast and then extrapolating on a straight line to the 2030 target. As shown in Figure 3 to achieve 30 GW requires an average addition of 2.3 GW each year from 2024 to 2030 which is a significant increase. If this is to happen the bottlenecks noted above will have to be resolved quickly, as it takes around seven years to develop an offshore windfarm, a process which includes permitting; winning a sea-bed lease from The Crown Estate; bidding in a CfD auction and then agreeing with contractors and investors to allow an investment decision; and finally building out the project.

45. To achieve the more ambitious target of 40 GW requires an average addition of 3.7 GW pa over the period 2024 to 2030. This is a big jump from the forecast 1.3 GW of additions in 2023. Such a jump would be particularly challenging and would require an almost three-fold increase in supply chain output and annual investment in offshore windfarms of c£9.5bn. A sudden step-up in demands on the supply chain

will tend to push up costs, extend timelines and exacerbate price cannibalisation by offshore wind. Combined these factors would increase CfD bids and lower market prices; and so push-up the cost of CfDs more than in proportion to the increase in annual additions. To pave the way for such a lift in capacity, Government should make clear commitments to ambitious capacity additions to support competitive CfDs auctions which are a crucial step to Final Investment Decisions (FID).

46. If the UK achieves 40 GW of offshore wind the payments under the CfDs could be substantial and well in excess of the existing budget of up to £557m pa[5] for Pot2. For example, assuming future offshore wind projects can secure an average strike price of £40/MWh and the average Intermittent Market Reference Price is £30/MWh, the cost of reaching 40 GW of CfDs would be an extra £1.3bn per year[6] which is more than twice the current budget. Thus to achieve the 40 GW target, or even 30 GW, will require a significant increase in the CfD budget.

Question: What is the UK industry doing to promote the sustainability of offshore wind arrays throughout their entire life-cycle from development through to decommissioning, and to improve maintenance and end-of-life repair?

47. UK industry is keen to increase the sustainability of offshore wind and two current initiatives are:

- The Crown Estate has studied extending the operating life of offshore transmission which reduces construction and decommissioning of the transmission system, cuts emissions and reduces disruption of the seabed. The study found that increasing the life of the transmission to 60 years was technically feasible, offered value for money and is supported by key stakeholders.
- Ofgem and BEIS are looking at moving from point to point transmission connections to meshed grids which should increase reliability, allow access to continental markets and reduce disruption where export cables come onshore

48. Offshore windfarm owners are increasingly focussing on the end of life as their windfarms age. Often when windfarms are 10 to 13 years old, owners start analysing windfarm performance data with a view to determining the best end of life strategy. Depending on how well the farm is performing, the cost of maintaining operations, etc the owner will determine whether the most economic end of life option is:

    - Decommission the project as originally planned; or
    - Extend the life of the windfarm perhaps by replacing / upgrading certain components such as blades which have deteriorated. This could be combined with gradual decommissioning, e.g. switching off individual turbines once they are no longer economic and using them for spares for operating turbines; or
    - Repowering the windfarm by replacing the existing turbines with more modern and powerful models, etc. This may require upgrading of the transmission system to accommodate the additional capacity. This may be an opportunity to

[5] This budget was set out in The Clean Growth Strategy (HM Government, 2017) and is expected to deliver 1 to 2 GW each year throughout the 2020s.
[6] Calculated as 30,000 MW of extra capacity * 50% capacity factor * £10/MWh CfD payment * 365 days * 24 hours = £1.314bn pa.

make other technology updates such as switching from AC transmission to DC transmission or the introduction of electrolysers to produce hydrogen

49. Where a windfarm is owned by a consortium including a utility and financial investor(s) there may be an agreement that the utility will take responsibility for the end of life strategy and its implementation. This seems to be an efficient role allocation as utilities have the capabilities and experience to plan and execute the development and construction of a windfarm, while financial investors value more highly the secure, long-term cashflow from a windfarm which is operating smoothly.

Question: How well is the UK industry managing the environmental and social impacts of offshore wind installations, particularly on coastal communities with transmission-cable landing sites?

50. When we emerge from the COVID-19 lock-down, offshore wind can make a valuable contribution to boosting the economy as there are six projects under construction[7] with an estimated capital cost of £11bn. Their construction will add to the estimated c10,000 full time equivalent jobs in the UK offshore wind sector in 2017 (Cambridge Econometrics, 2017).

51. In the longer term, offshore wind can make a sustained contribution to creating many more skilled and well-paid jobs. The Sector Deal set out a non-binding proposal to build up offshore windfarm lifetime UK content from almost 50% today to 60% by 2030. Rapid growth in the sector and a growing global offshore wind market offer large, short to medium term opportunities for the UK supply chain.

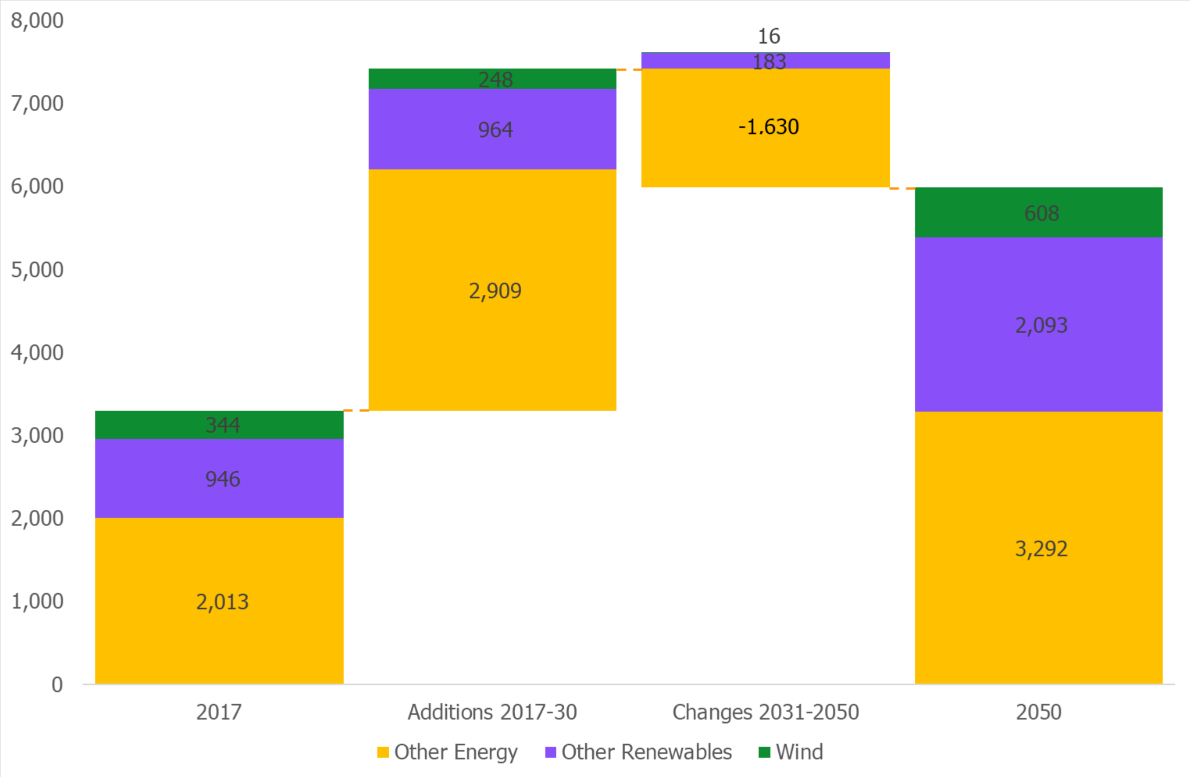
52. The International Renewable Energy Agency (IRENA, 2020) has forecast significant growth in employment by the wind sector in the EU (including the UK). The projected growth in jobs in Figure 4 is based on their 'Transforming Energy Scenario' which is an ambitious but achievable energy transformation pathway based largely on renewable energy which would keep the rise in global temperatures to well below 2°C.

53. Starting with 344 thousand jobs in the EU wind sector (onshore and offshore) in 2017, employment in the sector is forecast to grow to 592 thousand in 2030 (72% growth) and to 608 thousand in 2050, the creation of 264 thousand jobs over the 33 years. Over this period, 1,147 thousand additional jobs are created in 'Other renewables' (largely bioenergy and solar) and 1,279 thousand jobs in 'Other energy' (primarily energy efficiency and power grids). For the whole energy sector, the net impact is the creation of 2,690 thousand jobs between 2017 and 2050, even though 1,630 thousand jobs in 'Other energy' are expected to be lost between 2031 and 2050 as energy production pivots from thermal power plants to renewables.

54. IRENA forecasts 234 thousand offshore wind jobs in 2050 or 38% of the jobs in the wind sector. These forecasts indicate the contribution that the wind sector can make to economic activity with many of these jobs in coastal communities close to the ports serving offshore windfarms.

[7] The projects are East Anglia One; Hornsea 2; Kincardine, Moray East; Neart na Gaoithe and Triton Knoll.

Figure 4: Projected growth in EU wind and energy sector jobs (thousands)



Source: (IRENA, 2020), page 242. Note in this analysis the EU includes the UK

55. Moving to meshed grids should substantially reduce the environmental and social impact of offshore windfarms, particularly on communities which have multiple transmission cable landing sites nearby. The construction of cable landings can cause considerable local disruption to roads and utilities and is a continuing irritation in some areas such as East Anglia where there is consecutive construction of several cable landings. There can also be a cumulative visual impact from construction of several onshore sub stations.

56. Meshed grids can facilitate a single large sub-station and larger cables serving more than one windfarm and so reduce environmental impacts. This is particularly valuable where it avoids routing cables through environmentally sensitive areas.

57. Building cable ducts rather than cable trenches also reduces disruption and allows cables to be replaced, repaired, or added to with reduced environmental and social impact. The ducts can be air-conditioned and engineered to separate the cables, allowing easy access for repairs / maintenance, and keeping them cool and safe from fire.

Question: How well is Government policy supporting innovation in transmission technology to improve the efficiency of electricity transmission?

58. As noted, BEIS and Ofgem are developing policy for meshed grids which reflects innovations to reduce cable failures, switch from alternating current to direct current and extended transmission system life. Analysis by the offshore wind insurance specialists GCube of 12 months of insurance claims from offshore windfarms indicate that 55% of all claims are caused by cable failures, particularly in export cables.

59. Government has been working with industry to analyse cable failures and develop solutions. The UK is well placed to do this as the world's largest offshore wind market but is limited as no offshore export cables are manufactured in the UK.

60. There is an opportunity for Government to co-operate with industry in the switch from AC transmission to DC transmission. DC technology is economic for far offshore windfarms as power losses are lower for DC cable than for AC cable. For far offshore windfarms the savings in losses from DC transmission out-weight the higher costs and potential "teething troubles" from this new to the UK offshore technology.

61. There are major policy and regulatory issues to be resolved quickly for meshed grids to be introduced before 2030. Key issues include:

- Who will plan, manage and own the meshed grids?
- Appropriate incentivisation for the optimum planning, financing, construction and operation of the mesh
- How cases for anticipatory investment will be assessed and funded
- How will existing OFTOs, interconnectors with the Continent and hydrogen production be integrated into the mesh
- The best process for setting, enforcing and updating technical standards for offshore meshed grids

Question: Looking to the future, what can the onshore wind sector learn from the offshore success story?

62. Recognising that there are significant differences between offshore and onshore wind, we agree that some lessons from offshore wind are applicable onshore. However, in applying these lessons allowance should be made for key differences such the relatively small size and older age of onshore turbines, the greater public opposition to wind onshore and relatively easy access for technicians and parts to onshore windfarms.

63. The great success of offshore wind has been driving down the LCoE so that it is competitive with the cost of new onshore thermal generation. Onshore wind can replicate this success to the benefit of the UK by adopting bigger more efficient turbines, capturing the economies of scale from larger windfarms, and innovating with more efficient procurement strategies incorporating better risk allocation.

64. The Government can contribute to achieving this prize by:

- Supporting a "long and strong" pipeline of onshore windfarms which will give developers, their supply chain and financiers confidence to make long-term investments. An important contribution to this would be firm political commitments to onshore wind including in the Energy White paper. These commitments should be embodied in concrete support such as substantial budgets for CfD Pot 1 tenders (broadly for onshore wind and solar PV projects) and a positive stance on planning, particularly for nationally significant projects. The latter could be initiated in the forthcoming National Infrastructure Plan
- Recognising that onshore wind and solar PV are the cheapest types of new build generation and are low carbon. Thus the most bang from the CfD budget would be from allocating all of it to Pot 1. However, this extreme strategy would not deliver

the diversified generation mix the Government is aiming for and therefore should be tempered with support for other low-cost technologies such as offshore wind

- Convening industry and working together to tackle common issues such as interference with aviation radar and engaging better with local communities
- Stream-lining the permitting system to protect the environment while also reducing the cost, time and uncertainty of applying for permits. This will particularly support the development of community and smaller projects
- Support where appropriate the adoption of updated planning rules to accommodate modern, more powerful and economic turbines
- Recognising the potential low-cost contribution from re-powering existing onshore windfarms by allowing these projects to bid for CfDs

65. The Government has a key role to play in ensuring that the UK is an attractive place to invest in onshore wind. The Global law firm Ashurst (Ashurst, 2020) note in a report on the Energy Transition that: "*a clear policy direction from governments is required to make investments in the energy transition economically viable, and this must be associated with valid business models and/or regulatory drivers*.". Ashurst also concluded that "*Many* [renewable energy] *sponsors, contractors and funders are looking to export their European experience to the Asian market*".

66. Large windfarm developers such as Orsted, RES and SSE Renewables are global businesses must allocate limited resources between the UK and other attractive markets such as the USA, Asia and the Baltics. The UK has enjoyed large-scale foreign investment in onshore wind but to rapidly increase investment big new investors are needed to deliver strong competition for CfDs, a healthy pipeline of offshore wind projects, and to bring innovative technology and low-cost capital.

67. We would be happy to provide any clarification and further information you may require or provide oral evidence.

Your sincerely

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Appendix 1- The Net Zero Enthusiasts

We Net Zero Enthusiasts have been contributing to the development and application of low-carbon policies for many years. In 2013, Charles Yates and Mark Hughes sat on DECC's CfD Expert Group during the development and introduction of Electricity Market Reform and the gamut of new policies such as CfDs, the Capacity Market and the Levy Control framework.

Charles Yates is a specialist in financing offshore wind projects, regulating electricity networks, and has worked with DECC, Ofgem and wind investors and banks for over ten years. He has been an investment banker, private equity investor and a project finance lender.

Mark Hughes led the PwC team advising DECC on the first CCUS demonstration project and advised 2Co on its plans to develop CCUS and Enhanced Oil Recovery in the second demonstration project supported by DECC. He has raised finance for re-powering onshore wind projects and introduced secondary investors into operational offshore wind farms Mark brings valuable, detailed experience of energy markets around the globe.

Paul Hallas has over 35 years of relevant energy sector experience. He was Director of Gas Supplies at Centrica and then Director of Strategy & Regulation at Centrica Storage. He played a key role in establishing the regulatory framework for retail gas competition in Great Britain, including the gas transporter licence.

Between them, the Net Zero Enthusiasts have over 100 years of advisory experience in the energy and utility sectors in the UK and globally.

For additional information see:

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