OFFSHORE WIND

COST PREDICTIONS AND COST OUTCOMES

Andrew Montford

The Global Warming Policy Foundation
Briefing 52

Offshore Wind: Cost predictions and cost outcomes

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Summary

Wind-energy advocates – including official bodies – claim that there has been a dramatic fall in the cost of offshore wind power. This paper compares the figures they have presented to support these assertions with three separate comprehensive reviews of the UK offshore fleet, based on audited accounts and actual operating data. It also compares advocates' capital cost predictions for the next generation of windfarms to statements issued by windfarm developers.

Advocates claim that costs for windfarms have been falling quickly for several years, although there is general agreement that the cost is, on average, still several times the cost of power from gas-fired power stations.

However, they suggest that windfarms commissioned in 2019 and 2020 will have dramatically lower costs, and those in future years will be lower still.

The capital cost elements of all these predictions mostly contradict the figures put forward by windfarm developers themselves.

The financial accounts of Beatrice, the only offshore windfarm that was commissioned in 2019, already show that the advocates' estimates cannot be achieved in practice.

The Dogger Bank windfarms, to be built in shallow waters, may have somewhat lower costs. However, for most forthcoming offshore windfarms, costs are likely to remain at around £125–150/MWh, approximately four times the cost of power from a gas-fired power station.

1. Introduction

Since the startling results of the 2017 Contracts for Difference (CfD) auction, when offshore windfarms won bids giving them the right (but not the obligation) to sell electricity to the grid at £57.50/MWh, around half the level of anything that had been seen before, it has become commonplace to argue that there has been a fundamental change in the economics of the wind industry.

Ahead of the recently published Energy White Paper, a series of new reports have repeated and reinforced these claims, including offerings from the Department for Business, Energy and Industrial Strategy (BEIS),[1] National Grid,[2] Bloomberg New Energy Finance (BNEF),[3,4] The Carbon Trust,[5] The International Renewable Energy Agency (IRENA),[6,7] and the merchant bank, Lazard.[8] Note that none of these organisations are involved in the business of developing windfarms themselves, except peripherally. They are all promoters of renewables, and sometimes providers of information too. I will therefore refer to them collectively as the 'advocacy reports'.

For advocates of offshore wind to be insisting on the existence of a cost revolution is not surprising, but involves a considerable degree of chutzpah. In 2017, Hughes et al. pointed out that public data contained little evidence of a fall in the cost of offshore windfarms.[9] Then, in 2019, a review of financial accounts of UK offshore windfarms by Aldersey-Williams et al. gave us the first systematic analysis of hard cost data for the sector.[10] The results were a valuable antidote to the euphoria over the 2017 CfD auction, showing that windfarm costs were barely falling at all. A recent study by Hughes has updated and extended the Aldersey-Williams results, concluding that the situation is, if anything, even worse than was thought:[11] while capital costs are at best static, operating costs are rising quickly. Only financing costs are really falling.

This paper compares and contrasts the different views of the costs of offshore windfarms through consideration of the individual cost drivers and the levelised cost of electricity (LCOE), a measure of the overall cost base. LCOE has been strongly criticised when applied to intermittent energy generators such as offshore wind, because it presents an over-optimistic view.[12] Nevertheless, renewables advocates and the media continue to use it as a way to make claims about the viability of such technologies. However, this paper will show that the claims of renewables advocates are unfounded, even on an LCOE basis.[13]

2. Key drivers

LCOE is a discounted cashflow methodology, which aims to find the selling price that will cover the total costs (capital and operating) over the lifetime of the plant. The key drivers of the cost of electricity from windfarms are therefore:

- capital cost
- operating cost
- capacity factor (i.e. operational performance)

3. Capital costs

Figure 1 shows the past and predicted future of offshore windfarm capital costs per megawatt of capacity, including offshore transmission assets. The small dots are accounts data from Hughes' study. Progressively darker shades indicate windfarms in deeper waters, the factor that appears to be the main driver of capital costs. It is clear that it became more expensive to build an offshore windfarm between 2000 and 2010, although not all of this increase can be put down to the move to deeper waters. Since then, costs have remained in the range £3–5m/MW, with little evidence of a sustained fall. The reality of the steady increase is acknowledged by BNEF[14] and by Aldersey-Williams et al., and IRENA's position appears consistent. The other advocacy sources give only predictions (although readers of the Carbon Trust paper would likely be misled into thinking that they were reading a statement about hard data[15]). Nevertheless, there seems to be a degree of consensus on the history.[16]

On the other hand the predictions made by the advocates are extraordinary. BNEF claim that capital costs for a windfarm completing financing in 2019 (and therefore starting operations in 2021 or

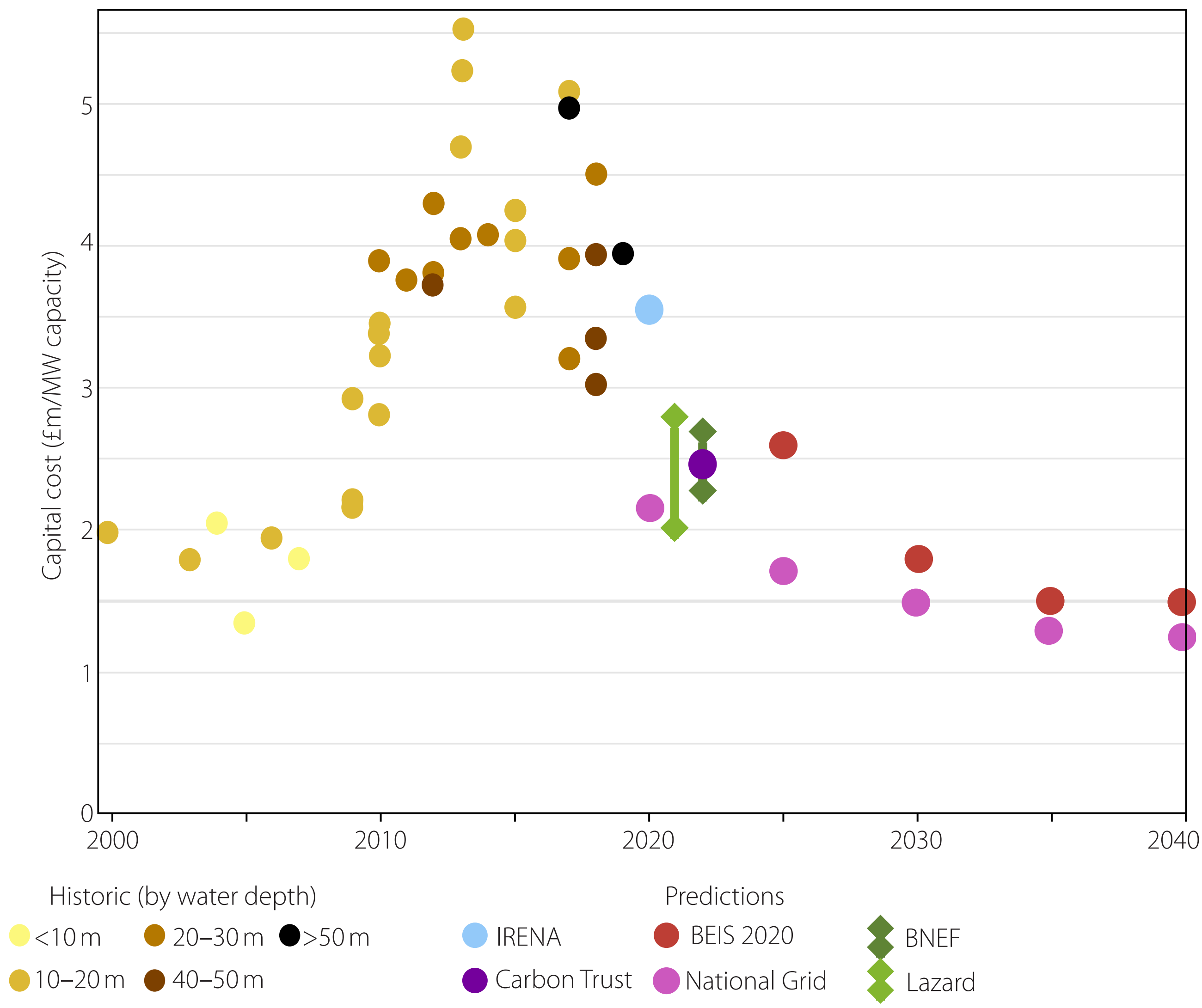

Figure 1: Capital costs: history and predictions

2022) would be £2.3–2.7m/MW. Their position is similar to Lazard. This optimism is echoed by the Carbon Trust[17] and BEIS, the latter predicting, remarkably, that costs will fall to little more than £1m/MW within ten years, a position Hughes correctly notes is 'the product of wishful thinking rather than engineering and economics'. National Grid appears just as optimistic.[18]

The contrast between the history and the advocates' predictions could hardly be more stark. However, it is possible to get further insights, because developers have also given indications of how much they intend to spend on individual sites. Figure 2 shows the same data as Figure 1, but with the addition of crosses representing the announced costs for UK offshore windfarms coming into commission between now and 2025. The different colours split the windfarms into those in shallow water and those in deep water. Clearly, the general view is that capital costs in deep waters will remain largely unchanged, at least until 2024–25.

There is a suggestion of a reduction thereafter, however, but this is because most of the windfarms concerned are to be built in shallow waters on the Dogger Bank. The cost for Hornsea 2, in waters of 40 m depth, remains high. Thus the advocates' predictions would

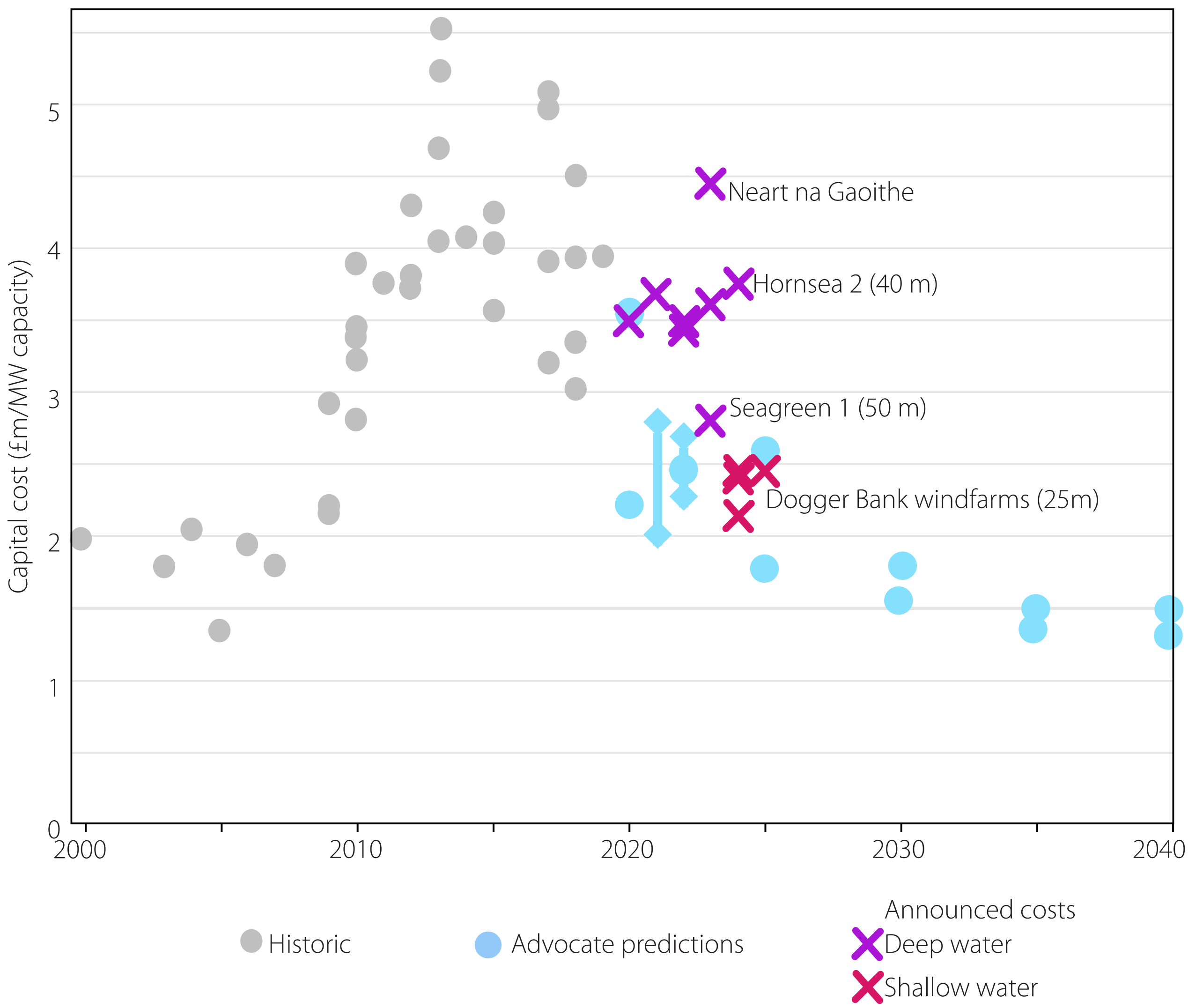

Figure 2: Capital costs: developer announced costs

make sense (although still with a high degree of optimism) if future windfarms were all to avoid deep water. However, the shallow waters of Dogger Bank are highly unusual, so that will not be the case.

The oddity is Seagreen 1, due to become fully commissioned in 2023, and with a somewhat lower cost of £3 billion, or £2.8m/MW. There is currently no explanation for why this project will be so much cheaper than others in deep water, although the announced cost is a suspiciously round number. Moreover, in June 2020, a controlling stake in the windfarm was sold to the oil giant Total for just £70 million. Such a low price strongly suggests that both buyer and seller recognise that the future profitability of the development is, at best, speculative.

The outlier on the high side is the Neart na Gaoithe windfarm, planned for a site off the Fife coast. This development has been subject to considerable delays and may therefore be similarly unrepresentative.

Further indications about future costs can be derived from 2019 accounts of windfarms under construction. These give no indication that the cost outturn will be meaningfully different from what has been announced.[19] Indeed, as Hughes observes, cost overruns are typically 17% of the announced figure. There are suggestions that the Moray East windfarm's announced cost of £3.6m/MW may end up closer to £4m/MW.[18]

If so, there can be little doubt that there has been no revolution in offshore windfarm construction costs in the UK. Indeed, they are probably not falling at all.

It remains unclear what justification the renewables advocates have in claiming that there has been a fundamental change, beyond the CfD auction results described above, and the fact that the Dogger Bank windfarms may be somewhat cheaper than those completed in recent years. However, auction results represent selling prices rather than costs and, while it is not unreasonable to expect the two to move approximately in parallel, it is surprising that none of the advocates have discussed the cost information that is available in the public realm. At the level of capital spend already announced, the next generation of offshore windfarms will, on the face of it, rapidly become insolvent, barring miraculous improvements in operational performance.

4. Operating costs

Unsurprisingly, the shift to deeper waters and sites further offshore has led to an increase in operating costs. However, Hughes shows that opex has been rising in the UK at 5.7% per year for 20 years, even *after* taking into account changes in location, a rate he describes as 'astonishing'. Figure 3 shows opex spending per megawatt of capacity for individual offshore windfarms in the UK. The data is inflation-adjusted, and presented as a moving average. More recent windfarms, which are generally in deeper water, are readily identified as the shorter series. The tendency towards higher costs as windfarms age is obvious, as is the trend towards higher costs in more recent windfarms. Hughes suggests that the lifetime average opex costs for the planned windfarms in 40-m waters might approach £300,000/MW/year, a value that appears plausible in the light of the values for recent windfarms in Figure 3.

By extrapolating the opex data for each windfarm, it is possible to estimate the lifetime annual average cost per megawatt of capacity. Figure 4 shows the results plotted against the water depth, alongside the equivalent figures put forward in the advocacy reports. The rise in costs as windfarms have moved to deeper water is clear in the accounts data.[20] Therefore, the figures put forward in the predictions in the advocacy reports are extraordinarily optimistic, particularly so given the move to still deeper waters in coming years – windfarms commissioning in 2023, for example, will average over 50 m depth.

BNEF and Lazard have issued the most aggressive predictions, suggesting that opex costs of little more than £50,000/MW per year is likely

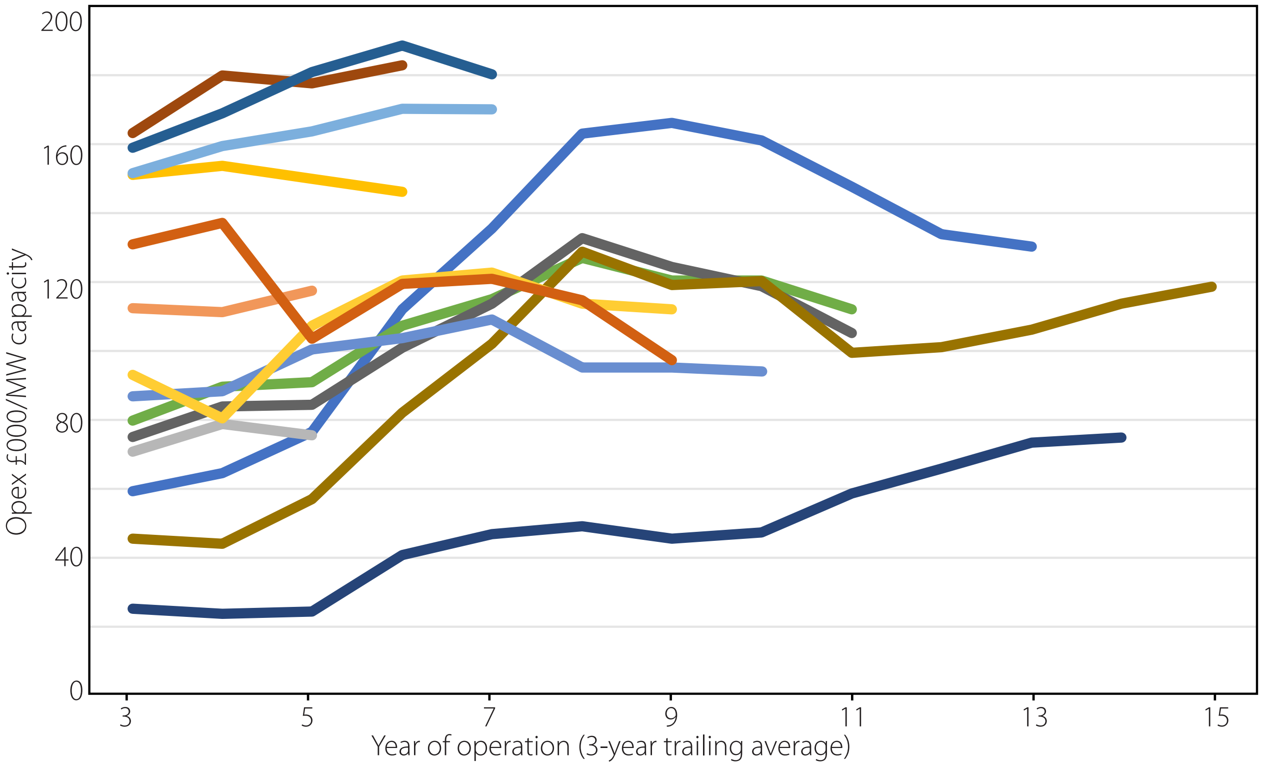

Figure 3: Operating costs: history

The graph shows 3-year trailing average for windfarms where there is sufficient data available, and where there is a single special-purpose financial vehicle used.

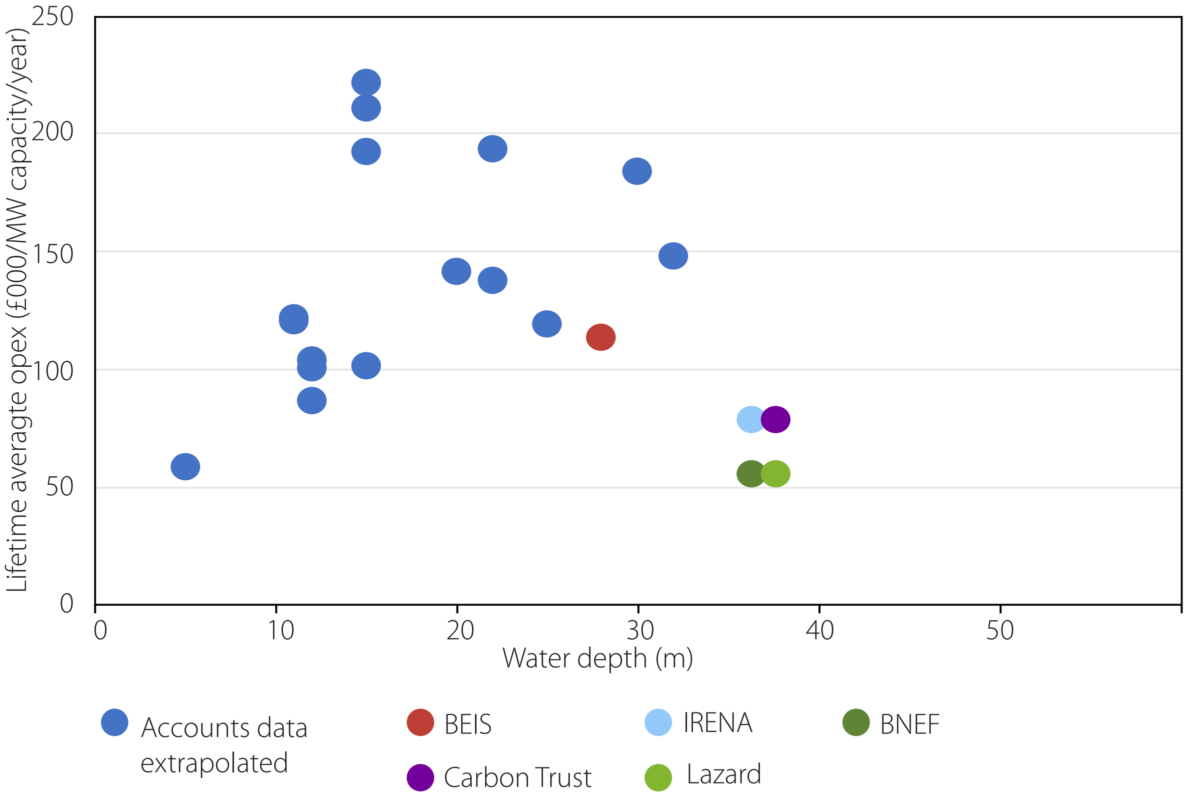

Figure 4: Operating costs: predictions against depth

Linear trends in the historic data are extrapolated and averaged. For the advocates' predictions, the central position is given for each report, against capacity-weighted average depth for the relevant year of commission.

for projects commissioning in the next few years. They offer little justifiation, although BNEF makes a vague allusion to larger turbines 'unlocking capex and opex savings'. This appears to be a statement based on wishful thinking. The data in Figure 3, and Hughes' analysis of financial accounts, shows the trend in offshore windfarm operating costs has been upwards, and it is hard to imagine that the move to deeper waters is going to be associated with anything other than a further rise.

BEIS's figure of £113,000/MW for 2025 has slightly more justification, as the windfarm planned to commission that year is in relatively shallow water on the Dogger Bank. However, in reality, the enormous distances involved – it is nearly 200 km from shore – make it likely that this too will be an underestimate.

IRENA includes some discussion of operating costs, saying:

> For 2018, representative ranges for current projects fell between [£54,000 and £100,000 per MW[19]] per year (IEA et al., 2018; Ørsted, 2019; Stehly, T. et al., 2018).

However, Stehly et al. actually give a representative opex figure for offshore wind equivalent to around £111/MW,[21] and this is based on a modelling study.[22] The Ørsted reference is to an investor presentation, which has some infographics on opex costs, and which claims some elements have fallen dramatically, but the overall change remains unclear and there are no values given that might support IRENA's numbers. Similarly, the IEA study gives a figure equivalent to £57,000/MW, but the origin of this value and its relationship with the real world is obscure.

5. Financing costs

There is general agreement that financing costs have fallen, from 10% to as low as 4% nowadays (Table 1). Windfarm financing has shifted from equity to debt, as perception of the risk to investors has shifted. It it perhaps noteworthy that the rest of this paper suggests that this perception is mistaken. Either way, while the interest rate reduction for windfarms is real, the scope for further reductions in financing costs is necessarily limited.

Table 1: Financing costs of offshore windfarms

	Cost of capital (%)
BNEF	4.2
BEIS	6.3
IRENA	7.5
Carbon Trust	<7

6. Capacity factor

For the purposes of this paper, the capacity factor for any given windfarm can be considered as having three main drivers:

- distance from shore
- size of turbine and hub height
- deterioration with age.

Hughes shows that increasing the size of windfarms has only a rather limited – and diminishing – effect on capacity factor. Doubling the hub height from 80 m to 160 m would only increase capacity factor by ten percentage points. 160 m is the hub height of the Haliade X, the 14-MW turbine that will form the basis of the next generation of windfarms. Larger turbines are not yet economic because of the size of foundations required.

This is borne out by analysis of the early years' performance of recent windfarms in the UK, which suggests an increase of only one percentage point per MW in turbine size (Figure 5, yellow dots). Moreover, some of this increase will be due to moves further offshore.

The advocacy reports are not clear on whether the figures they present represent lifetime averages or something more typical of the early years of a windfarm's operations. However, this can be readily determined, as discussed below. For each report, I have shown the capacity factor on the alternative basis.

Despite the modest improvements in the last two decades, the advocacy reports are predicting remarkable increases in capacity factor in coming years. BEIS says that in 2025, the typical turbine will be 12 MW, like the Haliade-X, delivering a lifetime average 51% capacity factor.[23] Because of deterioration in performance over time, such a windfarm would have to deliver a capacity factor of at least 60% in its early years.

The figure for 2040 is even more implausible. BEIS are predicting that 20-MW wind turbines will deliver lifetime capacity factors of 63%, implying a preposterous 70% in their early years. The best fixed (as opposed to floating) offshore windfarms currently deliver less than 50% in their early years. BEIS's figures suggest that they have failed to take any account of wear and tear in their estimates. While it can be argued that higher maintenance spend can reduce the decline in performance, as we have already seen when considering opex, none of the advocacy reports seem to think that this is going to happen.

In contrast, the figures given by BNEF and IRENA and the Carbon Trust seem to represent early-years' figures and are thus much more realistic, although they are high with respect to what has been delivered by recent windfarms. Nevertheless, a capacity factor of 55% in the early years of a turbine's operation would equate to an average of a little more than 40% over its lifetime, assuming a 2% annual decline in output.[24]

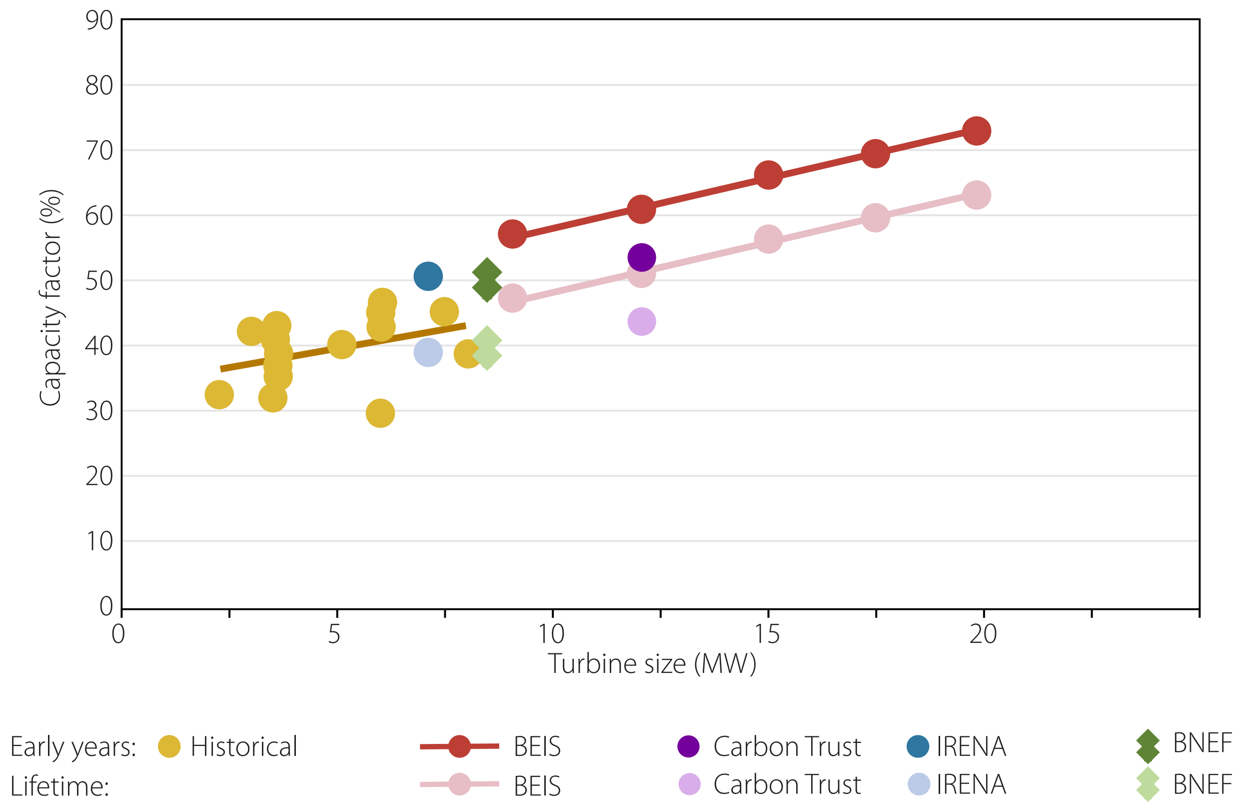

Figure 5: Capacity factors: history and predictions
Historic early years' performance is average of up to first three years' results, excluding outliers. Source: Renewable Energy Foundation data.

7. Levelised cost

The levelised cost of electricity (LCOE) distils the values for spending – both capital and operational – and performance into a single figure that theoretically represents the minimum that the windfarm must charge in order to provide the required return to investors.

In addition to the studies considered in the rest of this paper, this section also considers the LCOE figures presented in papers by the Committee on Climate Change[25] and the energy consultancy Wood Mackenzie.[26] Hughes does not report LCOE figures, preferring to analyse break-even points.

As far as the history of LCOE goes (greyed area), as Figure 6 shows, the advocates believe that offshore wind LCOE has fallen precipitously since 2009. But it is hard to see any justification for this story in the best peer-reviewed data available – that from Aldersey-Williams et al. (brown dots). The discrepancies between those figures and the estimates of BNEF are worthy of further investigation.

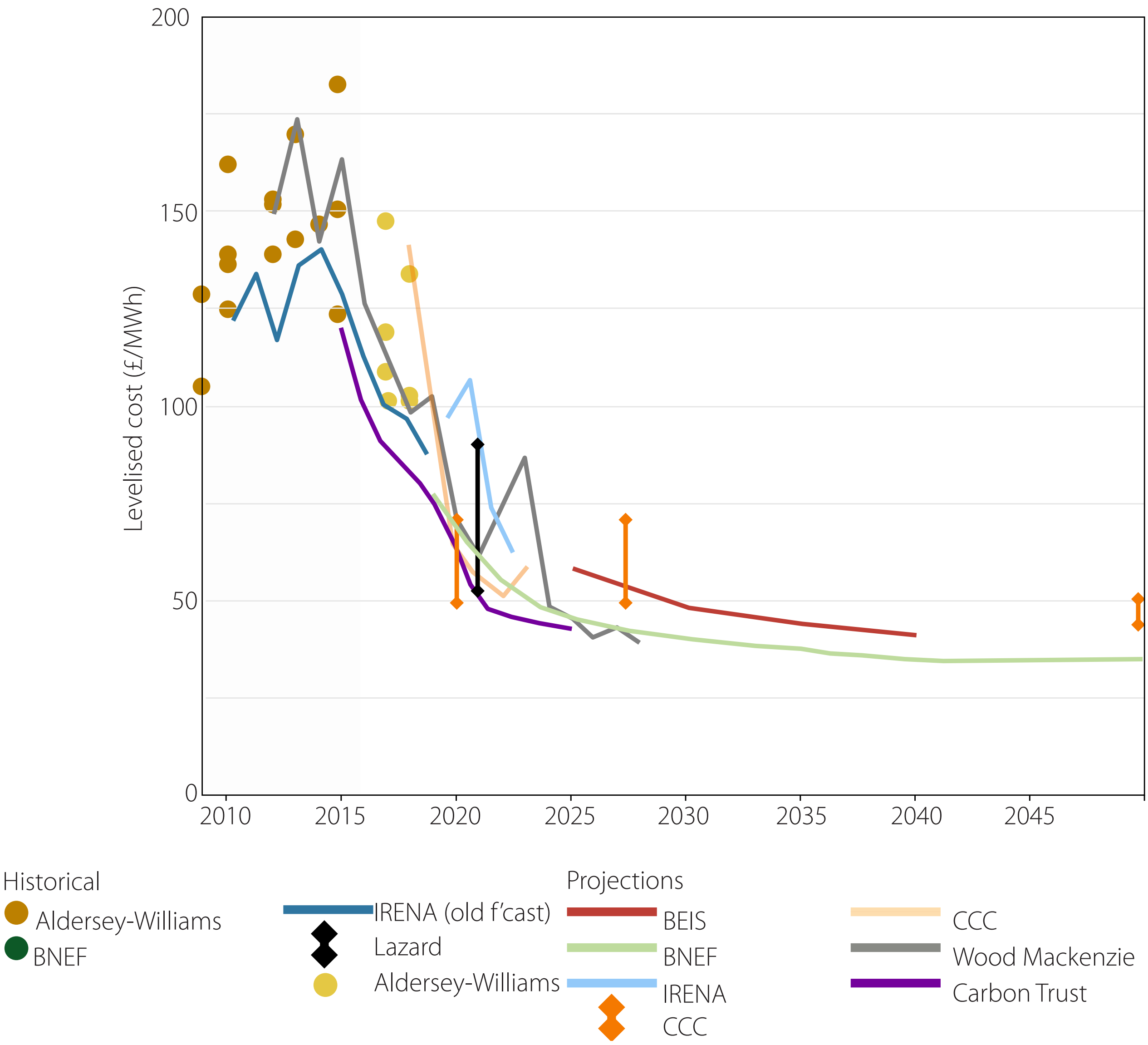

Figure 6: Levelised cost: history and predictions

The Hughes regression model, based on financial accounts data, is compared to predictions.

Aldersey-Williams and the advocates all predicted falling costs for some of the windfarms commissioning after 2015. One notable outlier was the Dudgeon windfarm, with relatively low capital costs of £2.4m/MW. Others, like Burbo Bank Extension, remained much more expensive.

From 2018, the advocates all agree that we will see an extraordinary further decline in LCOE, a position that is, of course, a function of the extraordinary claims they make about future costs and performance, as outlined in the rest of this paper. For example, BNEF predicts for 2023–25 – in other words, the Dogger Bank windfarms – a figure of around £45/MWh. At the announced cost of £3 billion per windfarm, it would require a capacity factor of 80% to reduce the capital element of LCOE to the kind of values required. The predictions of the Carbon Trust, Lazard and Wood Mackenzie are very similar. These papers therefore give the impression that the authors have worked back from CfD prices *assuming* that there must have been an underlying fall in costs. Given that auction bids are not binding, and because bidding strategies are often not straightforward, it is an approach that may well prove to be expensively wrong. It is also somewhat perverse when actual cost data is available. It is worth noting that IRENA caveats its figures with a warning that auction results may not be comparable to LCOE figures.[27]

However, as with the capital costs, it is possible to make a preliminary assessment of how well these predictions are panning out in practice by comparing the estimates of the advocates to ones based on announced capex costs and modelled estimates of performance and opex.

Figure 7 shows three views on the past and future of offshore LCOE in the UK. The two lines represent Aldersey-Williams et al. and a new set of values prepared by the author, which will be referred to as the GWPF estimates. In each case the figures for the individual windfarms have been rolled up into a capacity-weighted annual average, although for the GWPF estimates, I also show individual windfarm values going forward. The green shaded area covers the range of estimates of the advocates.

For operational windfarms, the GWPF and Aldersey-Williams estimates are very similar, in a range between £125 and £150/MWh, suggesting there are no major differences in the modelling or assumptions. But while the advocates' figures are centred on similar values, there is a much wider range of values presented. The reduction in costs predicted for the 2017 windfarms by Aldersey-Williams and the advocates is borne out in the GWPF estimates, although Burbo Bank Extension is much more expensive. For the 2018 windfarms, the figures remain somewhat lower than in earlier years.

Looking forward, however, the dramatic fall in costs predicted by the advocates is in stark contrast to the figures coming from the GWPF model, which suggests, at best, a slow decline. Since this model uses the capital costs announced by the developers, perhaps half of the cost inputs are reasonably firm already,[28] although of course, because the advocates seem to be disputing the developers' own capex estimates, it is perhaps unsurprising that they come out with lower predictions.

Consider the example of Beatrice, the UK's latest windfarm, commissioned in 2019. The capital costs are now known with certainty from the 2019 accounts – it is a rela-

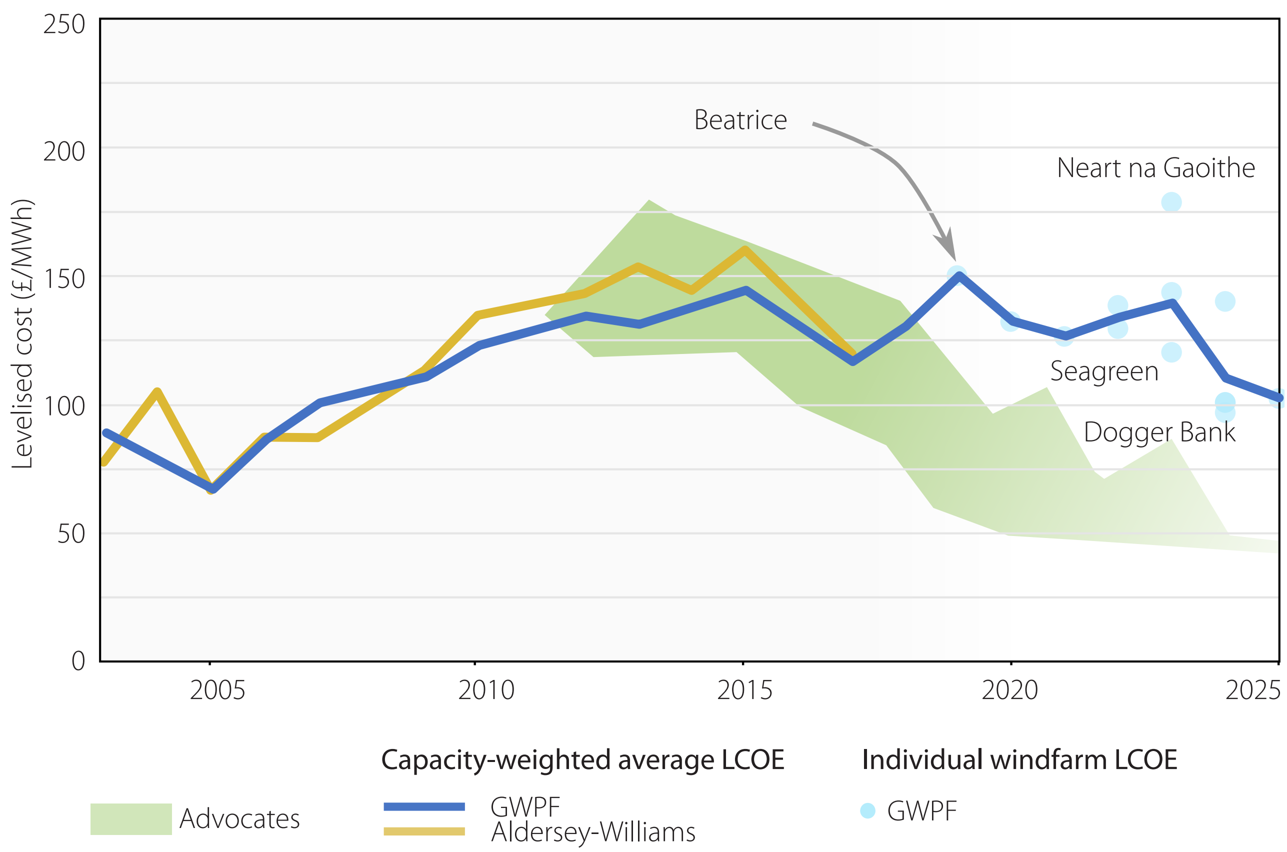

Figure 7: Three views of levelised cost

tively typical £3.2m/MW. With a capacity factor of 48% (the basis of the LCOE value shown), and allowing for a decline in performance over the years, the capex element of LCOE alone will be around £75/MWh. Yet the CCC and BNEF (to take two of the more aggressive predictions from Figure 6) are suggesting that the *total* LCOE – capex and opex – could be around the £75/MWh mark. This is impossible. Even the average of the advocates' predictions would require an extraordinarily low opex figure, and while this is not impossible, it seems unlikely given that Beatrice is in 55-m waters, the deepest for a UK windfarm to date. The accounts for Beatrice's first full year of operation are not yet available at time of writing.

It seems clear that the cost of offshore wind in the UK has not come down signficantly, and that we should expect only incremental changes in future, with the possible (buth highly unlikely) exception of the Dogger Bank windfarms, which may be a step lower in cost. The LCOE of most UK offshore windfarms remain in the range £125–150/MWh, approximately three or four times the cost of electricity from gas turbines running flat out.[29] At this point, it is worth reminding ourselves that comparisons of LCOEs for intermittent generators and dispatchables ones can be misleading because of the extra costs that will be incurred in balancing a grid that uses intermittent generators. In other words, the UK's future electricity system, powered mostly by offshore wind, will be *more than* 3–4 times more expensive than if powered by natural gas alone.

The implications for the industry are devastating. Beatrice's CfD is currently worth £158/MWh, so it may be profitable while its revenues are guaranteed. However, market prices are currently around £40/MWh. It is therefore hard to see how the next generation of windfarms, with CfDs closer to £50/MWh, will ever be profitable.

8. Conclusions

All major political parties endorse the idea that the UK can be almost entirely electrified: heating, transport and industry will allegedly be switched away from fossil fuels, and any sector that cannot be handled the same way is supposed to switch to hydrogen, itself produced using electricity.

The country's future is therefore being wagered on the basis that offshore windfarms are going to produce cheap electricity in the very near future. This paper has confirmed the conclusions reached by Aldersey-Williams et al. and by Hughes that there is no hard evidence that any change in the cost structure of the industry is under way. It has also shown that the views of offshore wind advocates on the potential for cost reductions are incompatible with what windfarm developers themselves have said.

Regardless, the government appears determined to proceed with its 'net zero' project. The prospects for consumers and the UK economy therefore appear extremely dim.

Acknowledgement

I am grateful to Tiefenn Brandily of BNEF for helpful comments on the manuscript.

Notes

1. *Electricity Generation Costs 2020*. Technical report, Department for Business, Energy and Industrial Strategy, 2020.

2. National Grid ESO. *2020 Future Energy Scenarios: Costing the Energy Sector.* National Grid ESO, 2020. https://www.nationalgrideso.com/document/181961/download.

3. Brandily T. *2H 2019 LCOE Update: Solar, wind and power prices at the crossroads*. Technical report, Bloomberg New Energy Finance, 2019.

4. 2H 2019 *Offshore Wind Market Outlook: A blip before the bounce*. Technical report, Bloomberg New Energy Finance,19 December 2019.

5. Jennings T et al. *Policy, Innovation and Cost Reduction in UK Offshore Wind*. Technical report, Carbon Trust, 2020.

6. IRENA. *Renewable Power Generation Costs in 2019*. Technical report, International Renewable Energy Agency, 2020.

7. For IRENA and BNEF, which give global and national values, I cite figures for the UK throughout.

8. Lazard. *Levelized Cost of Energy and Levelized Cost of Storage* 2020. https://www.lazard.com/perspective/lcoe2020.

9. Hughes G, Aris C and Constable J. Offshore Wind Strike Prices: Behind the Headlines. Briefing 26, Global Warming Policy Foundation, 2017.

10. Aldersey-Williams J et al. Better estimates of LCOE from audited accounts – A new methodology with examples from United Kingdom offshore wind and CCGT. *Energy Policy* 128 (2019) 25–35.

11. Hughes G. *Wind Power Economics: Rhetoric and reality. Vol. I, Wind Power Costs in the United Kingdom* Technical report, The Renewable Energy Foundation, 2020.

12. Joskow PL Comparing the costs of intermittent and dispatchable electricity generating technologies. Discussion paper. https://economics.mit.edu/files/6317.

13. The basis of the capital and operational costs for UK offshore windfarms is complicated by the way offshore transmission assets (OFTOs) are handled. Older windfarms operated their own OFTOs; their balance sheets included the cost of the equipment, and their profit and loss accounts incorporated the associated operational costs and depreciation. Since 2010, new windfarms have been required to sell their OFTOs to an independent operating company, thus removing the cost from the balance sheet, while replacing the operational costs with what amounts to a facilities management fee. The capex figures presented here include the cost of building the OFTOs, but for the purposes of the LCOE calculations, this is removed.

14. See BNEF, 2H 2019 Offshore Wind Market Outlook: A blip before the bounce, Figure 8. The rise shown by Hughes is closely reproduced in the UK windfarms shown by BNEF.

15. The report says 'project costs for offshore wind installations have reduced from approximately £4m/MW in 2010 to £2.5m/MW in 2019'. Only by examining one of the cited documents can it be determined that the 2019 figure is actually a prediction for a windfarm being given the go-ahead in 2019, but not becoming operational until 2022.

16. IRENA and BNEF quote all figures in USD, which I have converted to Sterling at a rate of 1.29, the value at time of writing.

17. The authors of the Carbon Trust paper have not responded to emails, but since their figure so closely resembles BNEF's I have assumed it is on the same basis. In addition, Hughes' data and the

figures for windfarms under construction are given in 2018 values. Although the advocacy papers are sometimes given in 2019 terms, I have assumed the difference is immaterial to this analysis.

18. National Grid are silent on the subject of OFTOs, but the values presented in their cost file are entirely implausible if they are supposed to be OFTO-inclusive. I therefore add 20% to the cost so that the data is presented on a consistent basis.

19. Montford, A. Offshore Wind: Definitely Expensive. GWPF Blog, 31 July 2020. https://www.thegwpf.com/offshore-wind-definitely-expensive/

20. Other factors may also be at play. For example, frequent reports of equipment failure suggest that engineering specifications may have been pared back in order to contain the capex spend. This may have impacted opex costs.

21. Translating their dollar figure at a rate of 1.29.

22. Beiter P et al. *A Spatial-Economic Cost Reduction Pathway Analysis for U.S. Offshore Wind Energy Development from 2015–2030*. Technical report, National Renewable Energy Laboratory, 2016. https://www.nrel.gov/docs/fy16osti/66579.pdf

23. Although the BEIS document does not explicitly state that the figure represents a lifetime average, they have confirmed (pers. commun.) that this is the case. In order to estimate the early years' capacity factor, I use Hughes' observation (p. xiii) that 'even if offshore turbines can achieve an average load factor of 55% in their early years, their lifetime average is likely to be little better than 40–45%'. I assume that the early years' load factor is 10% higher than the lifetime average.

24. See Hughes 2020.

25. The CCC's claim that we are currently seeing dramatic falls in costs is shown in Figure 3.7 of *Net Zero: The UK's contribution to stopping global warming*, Committee on Climate Change 2019. The claims about future costs are shown as single values in Table 7.2 of the same document. The ranges are set out in Table 2.2 of the *Net Zero Technical report*, Committee on Climate Change 2019.

26. https://www.woodmac.com/our-expertise/focus/Power--Renewables/global-bottom-fixed-offshore-wind-lcoe-2019-2028/

27. It says on page 24: 'Direct comparisons between the LCOE and [power purchase agreement]/auction data are not always possible, however. This is because in many instances the terms and conditions…mean that the boundary conditions (e.g., the auction price is a 'premium' over spot prices), or underlying contract length or terms diverge from LCOE assumptions. This occurs, for example, when contract periods for the winning bids do not match the economic lifetime of a project, or there are prices that are not indexed to inflation.

28. Future operational performance is of course unknown and has to be based on models. Capacity factors are based on a simple regression model of existing windfarm performance against distance from shore and turbine size, capped at 60% so as to remain plausible for windfarms such as the Dogger Bank developments, that are very great distances away from land. Opex is based on the approach in Hughes' model, which does not treat distance from shore as a driver, and it is likely that the opex economics for the Dogger Bank windfarms, 100–200 km from shore, are likely to be rather different to windfarms closer to land. That being the case, it is likely that the LCOE figures presented for these developments are underestimates.

29. Currently, gas turbines in the UK do not run flat out, of course, but without renewables policies, the grid would undoubtedly have a large percentage of CCGTs operating at high capacity factors.

About the Global Warming Policy Foundation

The Global Warming Policy Foundation is an all-party and non-party think tank and a registered educational charity which, while openminded on the contested science of global warming, is deeply concerned about the costs and other implications of many of the policies currently being advocated.

Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

The key to the success of the GWPF is the trust and credibility that we have earned in the eyes of a growing number of policy makers, journalists and the interested public. The GWPF is funded overwhelmingly by voluntary donations from a number of private individuals and charitable trusts. In order to make clear its complete independence, it does not accept gifts from either energy companies or anyone with a significant interest in an energy company.

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