Offshore Wind (Short) | Britain's a Goner with the Wind

Betting It All on Offshore Wind

Britain has bet everything on wind, mostly offshore wind, to decarbonise the grid by 2035 and reach "Net Zero" by 2050. With 14 GW of offshore wind production and 50 GW planned by 2030, that is enough to theoretically power around half the UK's electricity consumption. It is Britain's only current growing source of energy generation.

And yet, the wind industry is in crisis. New developments are on hold and there were no bids for offshore wind in this September's CFD auction. Offshore wind is simply too expensive to be commercially viable, even with inflation adjusted government-guaranteed prices, which protect against intermittency and already compensate for supply chain challenges.

Wind farm operators are now officially on strike — refusing to save Britain and the world from its "existential climate change crisis" — unless the UK taxpayer ponies-up more cash. Mads Nipper, the CEO of Danish offshore wind pioneer Orsted, told Bloomberg News recently that its now "inevitable" that consumers will have to pay more. "And if they don't, neither we nor any of our colleagues are going to build more offshore[1]", he warned. This is an embarrassing unexplained back-track from previous claims that offshore wind was the "cheapest form of energy."

The British government has long congratulated itself that between 1990 and 2019 carbon dioxide "emissions fell by 44 per cent while GDP rose by 76 per cent, with the UK decarbonising faster than any other G20 country since 2000[2]." This was, however, achieved less by a switch to renewables than by replacing coal with natural gas as the main source of reliable dispatchable power, at half the CO2 emissions, with gas turbine power generation increasing from just 5 per cent in 1990 to 40 per cent in 2021[3].

Since the costs of North Sea gas extraction were significantly lower than the UK's remaining coal deposits, and gas like coal was a source of power on demand, this initial halving of UK emissions would prove an economic boon. In fact, it was the North Sea oil and gas industry which had given the country energy independence from the 1970's OPEC embargoes and underpinned its economic renaissance in the 1980's.

Energy transitions have previously seen market forces support the triumph of an economically superior product: during the Industrial Revolution, coal replaced wood, dried dung, and wind as the dominant fuels; in the twentieth century, oil and gas replaced coal[4]. A more natural evolution might see nuclear — which has more "bang for buck" energy density, if not yet lower cost or ease of use — eventually replace fossil fuels.

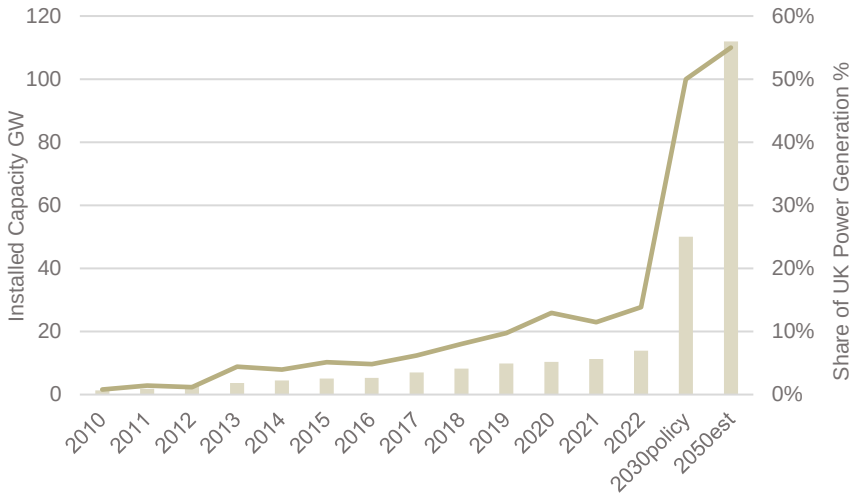
Instead, for the first time in the history of human civilisation we are seeking to replace a superior economic source of energy, with an inferior product — wind power, which previous generations had discarded as being too weather dependent, too expensive and generating too little surplus energy relative to the upfront investment and energy costs. Since the free market would never embrace an economically inferior product, this transition requires constant government subsidy and coercion to ensure the survival of the unfittest.

[1] Source: Bloomberg 5th September 2023
https://www.bloomberg.com/news/articles/2023-09-05/orsted-ready-to-abandon-wind-projects-as-it-calls-on-us-for-help?leadSource=uverify%20wall
[2] Source: UK Government Department for Business, Energy & Industrial Strategy 7th October 2021 https://www.gov.uk/government/news/plans-unveiled-to-decarbonise-uk-power-system-by-2035
[3] Source: BP Statistical Review of World Energy 2022
https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf
[4] See Vaclav Smil "Energy and Civilization A History" 2017. Also "Energy Revolutions Take Time" 2019
https://vaclavsmil.com/wp-content/uploads/2019/11/WE2019.pdf

In contrast with the 1990's "Dash for Gas", the "Renewable Grid by 2035" and "Net Zero by 2050", now enshrined in statute, requires a command economy that diverts much of the nation's financial resources into less productive economic activity with disastrous consequences for standards of living.

Building an additional 36GW of offshore wind, with capital costs now running at £5m per MW[5], will cost an estimated £180 billion, equivalent to 8 per cent of GDP. Assuming a generous load factor for new projects of 50 per cent (above the historic average of 42 per cent) this extra capacity would equate to theoretical TW/h generation of 159 TW/h (around 50 per cent of UK current demand) – see Fig.1.

Fig.1 | Betting it All on Offshore Wind: UK Offshore Wind Installed Capacity



Source: Digest of UK Energy Statistics July 2023 (DUKES): renewable sources of energy - GOV.UK (www.gov.uk) & Argonaut Capital

But since the government is also planning for a doubling of electricity demand by 2050, at least 492 TW/h of additional renewable power generation will be required (an 8-fold increase from today). To put the capital cost of this offshore wind capacity into perspective: 112 GW of deep-water offshore wind to decarbonise the grid would cost roughly £560 billion or 25 per cent of UK GDP.

This is not a one-off cost since the useful economic life of wind turbines is officially just 25 years, though some industry reports suggest that the high cost of repairs and technical obsolescence of offshore wind turbines in deep, salty waters, may make it uneconomic to continue to operate them after just a decade without the pre-2017 legacy overly generous UK subsidy schemes[6]. This means a future environmental impact of decommissioning mineral intensive turbines[7] in addition to the ongoing threat to bird[8] and mammal[9] life from wind's area intensity[10].

[5] See Gordon Hughes "Wind Power Costs in the United Kingdom" 3rd November 2020 P8-9
https://www.ref.org.uk/ref-blog/365-wind-power-economics-rhetoric-and-reality
The exact build costs of offshore wind will vary according to site and vintage but have been subject to considerable cost inflation (e.g., +50% on turbines) since 2020 meaning that Hughes' £4.5 MW estimate in 2020 (and arguably our £5m MW) is now likely too low for projects being built today.
[6] See for instance Gordon Hughes "Wind Power Economics – Rhetoric and Reality" 3rd November 2020
https://www.ref.org.uk/ref-blog/365-wind-power-economics-rhetoric-and-reality
Also, Andrew Montford "Offshore Wind: Cost Predictions and Cost Outcomes" Feb 2021
https://www.thegwpf.org/content/uploads/2021/02/Offshore-Wind-LCOE.pdf
[7] The IEA has estimated that an onshore wind farm has nine times the mineral intensity per unit of generation than an equivalent gas-powered plant. See IEA "The Role of Critical Minerals in Clean Energy Transitions" 2021
https://iea.blob.core.windows.net/assets/24d5dfbb-a77a-4647-abcc-667867207f74/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf
[8] See for instance "The Impact of Wind Energy on Wildlife and the Environment" GWPF 2019
https://www.thegwpf.org/content/uploads/2019/07/wind-impact-1.pdf
[9] See for instance "Thrown To The Wind" September 2023 on whale deaths in NE USA claimed to be caused by offshore wind noise.
https://www.youtube.com/watch?v=km78wMHt9d8
[10] The size of the proposed mega offshore wind projects is vast: Dogger Bank 1,675KM2 Hornsea (1-4) 2,057 KM2; East Anglia (1-3) 823KM2 for stated combined output of 13.1GW. This works out at 85 acres per MW (considerably above median estimates for onshore wind of 20 acres per MW). At 50% capacity utilisation this means that an area of 1.12m acres equivalent to 3 times the size of Greater London is generating on average 17% of annual

And yet in practice, these construction estimates are just scratching the surface of the true costs of a renewable grid, since they do not factor in the costs of intermittency (the stop/go nature of weather dependent power generation) which increase exponentially at higher market shares of wind dependent power. Over the course of economic history, it is rare for so much of a nation's wealth to be spent replacing an historically cheap and efficient product with a more unreliable substitute that depreciates rapidly and will always require ongoing taxpayer support.

The Consumer (Not the Wind Farm) Pays for Intermittency

There are almost no offshore wind projects in the UK currently operating in the free market - without Renewable Obligation (RO) subsidy, Contracts for Difference (CFD), or above market Power Purchase Agreement (PPA). The wind industry and its advocates previously made ludicrous claims about its cost competitiveness relative to gas. This was based on the decline in headline CFD auction prices (from £140 MW/h in 2014 to £37 MW/h in 2022[11]), this being the level at which wind operators estimated they could make an adequate profit on the project with a guaranteed government price. This would prove a vainglorious folly.

The CFD process misleads the public, since headline prices are quoted at 2012 levels (operators currently receive at least one third more than the advertised price to compensate them for post 2012 inflation) and are automatically adjusted higher each year by inflation (and grid costs) for the 15 years of the contract. So, for instance, the 2014 CFD is currently actually now worth £196 MW/h (+40%) and the 2022 £45 MW/h (+21%)[12].

Assessing the economic viability of wind projects by simply looking at the declining prices of guaranteed CFDs in new auctions over time is misleading: it is a trap, which UK politicians have unwittingly fallen into time and time again. Most importantly, through achieving a guaranteed price for its output, the wind industry protects itself from its own intermittency, the costs of which are transferred elsewhere, largely to the consumer. System balancing costs published by the National Grid are now in the region of £4bn a year, up from £400m 20 years ago[13], and are set to rise further in a non-linear manner as wind market share increases.

Let's consider why wind farms won't operate without a government guaranteed price[14]. If the wind is blowing in the North Sea, it is usually also blowing in the Irish Sea, so that UK wind farms tend to only produce power at the same time as their peers. As with all commodities, the market price is set by the marginal cost of switching on supply to meet demand, so that when the wind doesn't blow the grid must bid up supply from producers of reliable, dispatchable power (gas, nuclear, hydro, coal, biomass) to match supply with demand to avoid blackouts. Conversely, when there is too much supply of wind power that cannot be used (or stored) the grid makes low or even negative bids to discourage this production. This means that as the UK increases its wind generation, power prices will become even more volatile, which is not a sign of a well-functioning grid.

The UK's Wind Problem

Although the price of power will reflect a number of considerations, the analysis I have undertaken of ½ hour system settlement prices since the beginning of 2021 and the corresponding market share of wind within these 47,000 discrete time periods[15] – which fluctuates between 0% and 60% according to the weather See Fig 2. *"From 0% to 60% Market Share in 30 Minutes": UK Wind Intermittency 2021-23*- suggests that wind generation is already significantly above its optimal UK market share: extremely high-power prices occur during low wind market share periods See Fig 3: *"A Glut*

electricity demand. Put another way on this intensity, an area equivalent to 11% (22%) of the UK land mass would be required to power 100% on the UK's 2023 (2050 projected) demand. It is difficult to debate the area intensity of wind when wind enthusiasts deny that the space between the turbines counts. We think it matters, especially for birds and mammals.

[11] See UK Government Department for Energy Security and Net Zero 8th September 2023
https://www.gov.uk/government/collections/contracts-for-difference

[12] See Settlement Data for CFD Generators Strike Price Adjustment Calculation 2018-2023
https://www.emrsettlement.co.uk/settlement-data/settlement-data-cfd-generators/

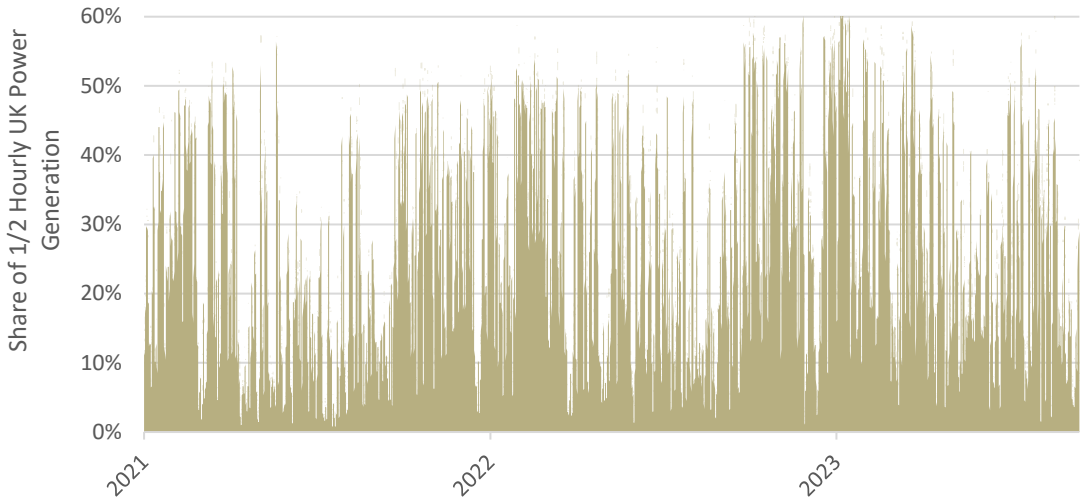
[13] See National Grid System Balancing Costs
https://www.nationalgrideso.com/industry-information/balancing-costs

[14] See SSE comments that Offshore Wind "will fail without subsidies" July 2021
https://www.thetimes.co.uk/article/offshore-power-will-fail-without-subsidies-bx8908gm5

[15] For ½ hour wind market share data see Elexon BMRS generation reports
https://www.bmreports.com/bmrs/?q=generation/fueltype and for corresponding ½ hour Settlement Prices see https://www.elexonportal.co.uk/SPNIV

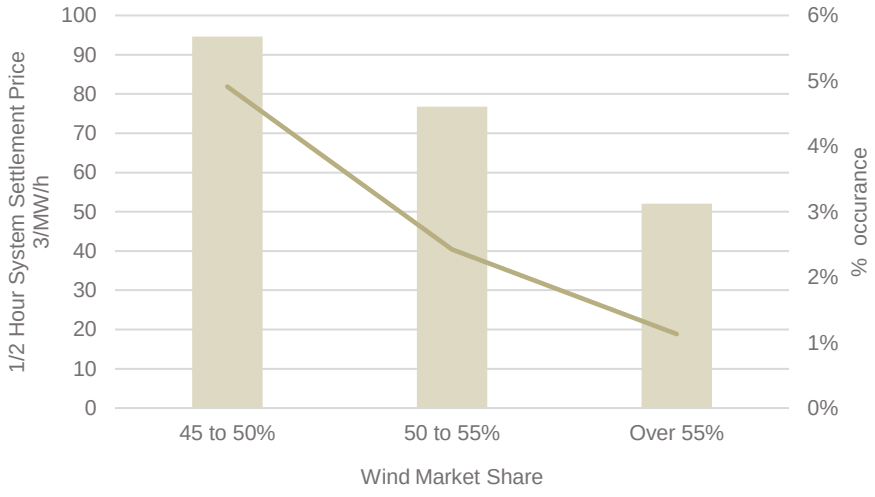
When the Wind Blows": UK Power Price at High Wind Market Share and Fig 4: *"A Glut When the Wind Blows": UK Wind Market Share at Low Power Price* and low and sometimes negative power prices at high market shares during windy periods See Fig 5: *"High Prices on Still Days": UK Power Price at Low Wind Market Share* and Fig 6*: "High Prices on Still Days": UK Wind Market Share at High Power Price*, indicating excess wind energy that cannot be used or stored and is essentially wasteful economic activity.[16]

Fig.2 | "From 0% to 60% Market Share in 30 Minutes": UK Wind Intermittency 2021-23



Source: Elexon BMRS generation reports & Argonaut Capital.

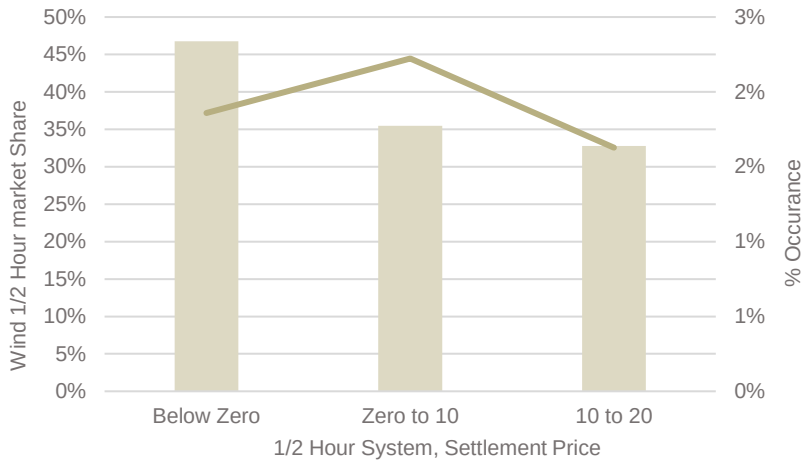
Fig.3 | "A Glut When the Wind Blows": UK Power Price at High Wind Market Share



Source: Elexon BMRS generation reports & Argonaut Capital.

[16] For a similar debate on the consequences of solar overbuild in California and its impact on power prices see U.S. Energy Information Administration, "As solar capacity grows, duck curves are getting deeper in California," June 21, 2023. https://www.eia.gov/todayinenergy/detail.php?id=56880

Fig.4 | "A Glut When the Wind Blows": UK Wind Market Share at Low Power Price



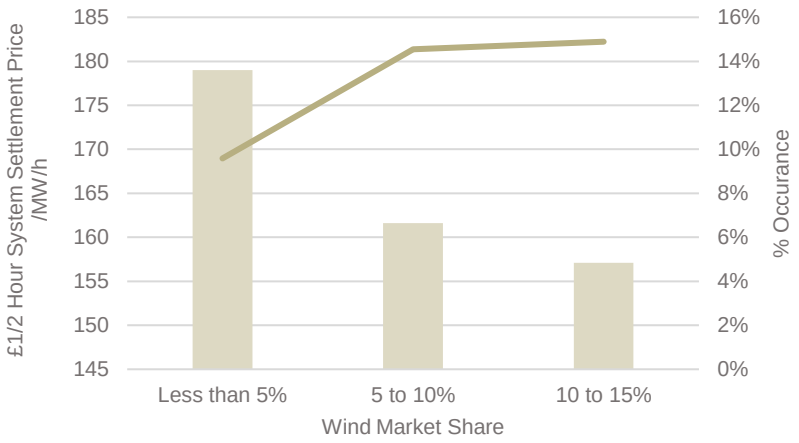
Source: Elexon BMRS generation reports & Argonaut Capital.

More Wind Won't Work

In other words, the weather rather than the number of wind turbines installed is already the constraining factor and we already have a glut of capacity when the wind blows. Adding more wind generation will only make UK power prices more volatile with weather dependent surpluses or gluts. The National Grid has paid windfarms, mostly in Scotland, over £1.4bn since 2010 to reduce their output on windy days, a payment that is justified as compensation for lost subsidy but with the result that the wind farm makes more when not generating than when selling to customers.[17] The cost of this is borne by the consumer and these costs will increase with more volatile power prices that will result from more wind power being built.

Crucially the price achieved by excess wind generation does not adjust to reflect this low value since it is still guaranteed by the CFD. In other words, the market value of wind power will always be less than the average power price. Conversely, when the wind doesn't blow during peak demand periods, the UK has exceptionally high prices, because there is a scarcity of reliable power, which is of higher economic value.

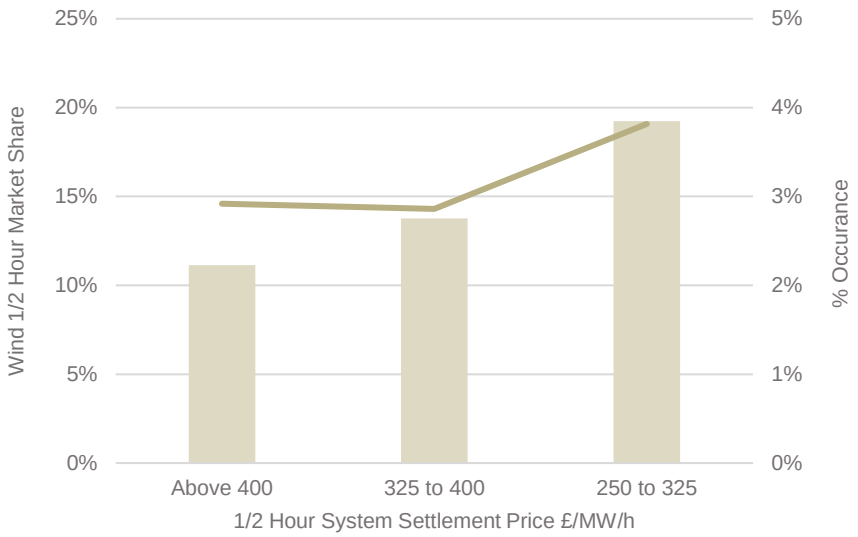
Fig.5 | "High Prices on Still Days": UK Power Price at Low Wind Market Share



Source: Elexon BMRS generation reports & Argonaut Capital.

[17] See REF "Why are "Unsubsidised" Wind Farms Receiving Constraint Payments?" 4th November 2022 https://www.ref.org.uk/ref-blog/372-why-are-unsubsidised-wind-farms-receiving-constraint-payments

Fig.6 | "High Prices on Still Days": UK Wind Market Share at High Power Price



Source: Elexon BMRS generation reports & Argonaut Capital.

Unlike Denmark, which can operate - albeit with abnormally high average power prices - at a high share of wind power because it can trade (at prices that reflect the lower value of intermittent power) its sporadic surplus with Sweden's nuclear or Norway's hydro, or with the larger German market, the size and remoteness of the UK offshore wind farms – with bigger surpluses and higher transmission costs - will prevent a similar model championed by those advocating wind overbuild as an export industry (who presumably will also have to explain why British consumers would effectively be subsidising foreign electricity consumption) . Wind farms operating on a large scale without guaranteed prices would either be forced to find a solution for their intermittency or realise much lower prices than average in the market.

Building more wind capacity in the UK today is like a factory owner deciding to hire additional workers who guarantee to only turn up when they are not needed: to give those unreliable workers long-term guaranteed contracts and by contrast, pay the existing workers — gas power plants in this analogy — who agree to turn up to work at specified hours, less; whilst insisting on the ability to fire these reliable workers without notice. The outcome would encourage all workers to become unreliable and the factory owner would end up having to employ far more workers overall than needed to compensate for unreliability, with no guarantee of being consistently adequately resourced.

This unsolved intermittency problem is why over $3.8 trillion has been invested in renewables globally over the last decade but the market share of fossil fuels has decreased from 82 per cent to just 81 per cent.[18] The "Renewable Grid" is a political indulgence that can never provide the reliable, dispatchable power that an electricity grid requires.

"Miraculous" drop in post 2017 UK CFD Prices

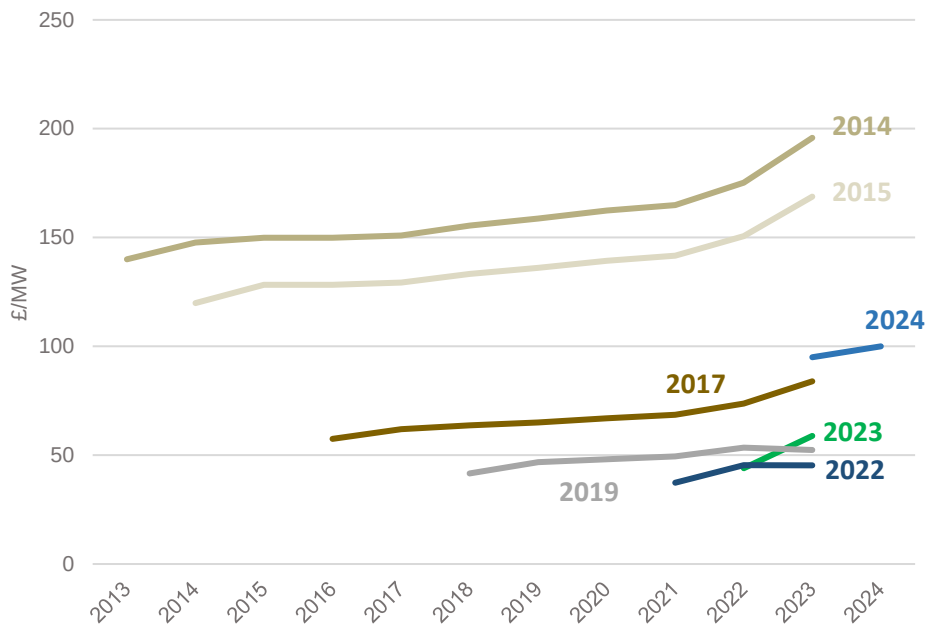
The failure to attract a single bid in September's fifth CFD auction at a headline price of £44 MW (actually £59 MW) means that the prospect of building 50GW of offshore wind by 2030 now looks dead in the water. Consider that the "winners" of the fourth CFD auction in 2022, at a superficially low £37 MW (now £45 MW), have suffered buyer's remorse and have refused to build the projects they were awarded — notably Vattenfall's £1.4GW Norfolk Boreas project[19] and Orsted's 2.9GW Hornsea 3[20] (the two largest projects from the 7/GW awarded to offshore wind in 2022).

We also believe that the offshore wind farms currently under construction awarded in the 2017 and 2019 auction would, at the CFD prices awarded, fail to generate an adequate return over their stated economic life for their investors,

[18] Source: Jeff Currie, Global Head of Goldman Sachs Commodities Research, CNBC 3rd October 2022 https://twitter.com/SquawkCNBC/status/1576921977754902528?lang=en
[19] Source: Vattenfall, July 2023
https://group.vattenfall.com/uk/what-we-do/our-projects/vattenfallinnorfolk/norfolk-boreas
[20] Source: Reuters, 3rd March, 2023
https://www.reuters.com/business/energy/orsted-says-huge-uk-hornsea-3-wind-project-risk-without-government-action-2023-03-03/

meaning that the miraculous post-2015 drop in UK CFD prices See Fig 7: "Miraculous" Drop in CFD Prices from 2017 will prove unsustainable, with break-even instead likely more than double current estimates of gas turbine generator all-in cost (ex-carbon tax) of £50 GW/h.[21]

Fig.7 | "Miraculous" Drop in CFD Prices from 2017 – UK Offshore Wind CFD Strike Price Development



Source: Argonaut Capital & Bloomberg

Whilst it is doubtful whether offshore wind projects built post-2015 on sub £100 MW/h CFD's were ever sustainably financed, including those actually built, several factors have now resulted in a deterioration of their viability. The costs of building a wind farm, composed of large turbines, which don't seem to offer much greater productivity, have risen by up to 50 per cent[22], partly due to cost inflation but also owing to higher liabilities from turbine unreliability. The best sites in shallow seas have also already been taken.

Perhaps more importantly, wind projects were typically funded by as much as 80 per cent debt, meaning that the 500bps rise in global interest rates since 2021 has resulted in a £4 annual increase in debt servicing costs for every £100 of capital expenditure, which would add up to £100 for every £100 spent over the course of a 25-year project.[23]

Silly Season for Storage

As befits a parasitical industry, wind enthusiasts have reacted furiously to the failed auction, blaming the government for its parsimony, biting the hand that feeds it and hoping that a new Labour government – with Ed Miliband recently confirming the goal to build four times as much offshore wind - might prove more malleable, rather than accepting that it became a prisoner of its own propaganda in ever claiming that wind power was an economically feasible, scalable and above all a sustainable solution for powering Britain's electricity grid.

[21] We estimate £50 MW/h LCOE for Gas MW/h (pre carbon tax) based on £10-15 MW construction costs and £35-40 MW/h fuel cost (which will fluctuate according to gas price). Note not only do "official" LCOE costs assume that intermittent power has the same value as dispatchable power and has dubious assumptions around cost of capital, capacity utilisation and Opex/MW for wind but figures for gas fired power include the cost of a carbon tax which more than doubles official LCOE, clearly an absurd assumption for a "levelised" cost. See Department for Energy Security & Net Zero "Electricity Generation Costs"2023
Electricity Generation Costs 2023 (publishing.service.gov.uk)
[22] Source: Argonaut Capital research from meetings with Vestas, Siemens Energy, Orsted, OX2, 2023
[23] Source: Argonaut Capital research from meetings with Vestas, Siemens Energy, Orsted, OX2, 2023

"Net-Zero" disciples will continue to advocate that Britain plough on regardless with their unsustainable economic model and continue to over-build wind, requiring ever higher subsidies, in the hope that surplus energy generated on windy days can in future be efficiently exported or stored over useful time periods in a cost-effective, scalable manner. Whether it be lithium-ion or vanadium batteries, or the latest fad of green hydrogen, this is a hopeful delusion.

Current battery technology is unable to offer an industrial scale solution for longer than a few hours. The building of "the world's largest" lithium-ion industrial battery in Trafford, Manchester, recently hit the headlines: costing £750m[24], the battery would store 1 GW for 2 hours, (2 GW/h) enough to power Britain's grid for 3 minutes and 17 seconds. At higher shares of wind power, electricity will need to be stored over weeks and months, not days and hours. It is easy to see how building an electricity grid powered solely by renewables could end up costing the UK more than 100 per cent of GDP.

Hydrogen is the latest unfeasible storage fad touted to justify wind overbuild. Expensive industrial electrolysers would have to operate at very low-capacity utilisation given the intermittency of renewable energy, which is why weather dependent hydrogen will never be cost competitive. Since hydrogen is extremely flammable and difficult to store, it must be chilled to -253 degrees Celsius to liquify and safely transport, with energy subject to high losses on conversion, meaning that the energy costs of hydrogen storage will outweigh any benefits.[25]

Bye-Bye, Britain!

Whereas the "Renewable Grid" is a political indulgence, achieving "Net Zero" is truly only for those who either still believe in fairies and unicorns or want to reembrace pre-industrial standards of living. It is worth remembering that the electricity grid currently still only powers less than 20 per cent of total UK final energy consumption, over 70 per cent of which is still reliant on fossil fuels.[26] Most politicians seem to think our energy consumption relates solely to the grid.

"Net Zero" therefore must involve attempting to electrify all economic activity: manufacturing, agriculture, transportation, home heating; forcing consumers to change their behaviour; relying on products that haven't yet been invented, and probably won't be unless the laws of physics and chemistry change. And all of this powered by a dysfunctional grid, that only works when the wind blows, requiring a blank cheque of taxpayer or consumer subsidy.

Even if full electrification could be achieved, a mere doubling of electricity generation would appear to imply that per capita primary energy consumption would need to fall by at least 60% to reach "Net Zero", presumably with a commensurate fall in standards of living. UK electricity consumption has already declined by 20% since 2005[27], owing to high prices and deindustrialisation, and our total energy consumption is down 30%, now at levels last seen in the 1950's[28], reversing a trend that since 1650 has seen our energy consumption rise by 20 times per capita, the real cost of energy fall by 90% and our standard of living rise 30-fold[29].

We were told that a fossil fuel-free future would have few costs and a positive economic benefit. Whilst the costs of decarbonisation are now becoming clearer, what constitutes success remains elusive. Like a doctor who measures success solely by the quantum of medicine administered, the UK is now locked into a financially ruinous path of full

[24] Source: See "Green light for world's biggest battery storage plant", The Times, 25th July 2023
https://www.thetimes.co.uk/article/green-light-for-worlds-biggest-battery-storage-plant-550ldhvqf
[25] See "Hydrogen. The once and future fuel?" John Constable GWPF 29th October 2023
https://www.thegwpf.org/content/uploads/2020/06/Hydrogen-Fuel.pdf
[26] Source: BP Statistical Review of World Energy, 2022
https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf
[27] Source: UK Government Department for Energy Security and Net Zero 27th July 2023
https://www.gov.uk/government/statistical-data-sets/historical-electricity-data
[28] Source: BP Statistical Review of World Energy, 2022
https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf
[29] See "Energy Consumption in England & Wales 1560-2000" Paul Warde, 2007
https://histecon.fas.harvard.edu/energyhistory/data/Warde_Energy%20Consumption%20England.pdf
Our World in Data "Energy Production and Consumption"
https://ourworldindata.org/energy-production-consumption
Argonaut Capital "What Have Fossil Fuels Ever Done For Us?" 2022
https://ourworldindata.org/energy-production-consumption

decarbonisation, without ever being able to rigorously evaluate whether the patient is responding to treatment. It resembles a medieval leeching. And it threatens to return Britain to medieval standards of living.

When the decarbonisation of the West fails to produce a measurable change to global climate, the solution, like that of the medieval doctor with his bag of leeches, will inevitably be to administer more medicine — whose efficacy can never be measured — locking us into a green policy doom-loop. No one ever asked Britain's electorate if they wanted to live in a country which wasn't bankrupt but might be 2 degrees warmer.

Britain's economic future is being sacrificed on the altar of "Net Zero". A renewable grid will produce abundant electricity for a few days annually and prohibitively expensive, unreliable power the rest of the time, resulting in demand destruction, supply rationing, and deindustrialisation. Building more wind now has no economic value and ironically has an unjustifiable environmental cost: it is a monumental misallocation of capital and a generational policy folly. Britain is a goner with the wind.

Barry Norris

October 2023

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