Trident Economics

Briefing Note: The Economics of Wood Pellet based Power Generation in the United Kingdom

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IMPORTANT NOTICE

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Key Points

A switch from wood pellet biomass power generation to additional generation from renewable technologies, such as offshore wind, has the potential to create between £1.93 Bn and £2.49 Bn of additional economic value and additional UK employment.

- The UK provides a number of incentives for biomass power generation. These were initially put in place when biomass power generation appeared to offer a competitive cost versus renewable alternatives and when the UK was seeking to comply with the EU Renewable Energy Directive. These drivers are no longer present because of the fall in the cost of other renewable technologies and because of the UK exit from the EU.

- Although the UK has commitments to biomass power generators, at least the ongoing variable cost of wood pellet seems avoidable, i.e. could be saved through a change in policy.

- Applying the UK Government 'Green Book' methodology for economic appraisal of policies, a decision to continue burning wood pellet for power generation destroys significant economic value, particularly when compared against an alternative of generating an equivalent level of additional power from offshore wind or similar technologies. Alternative renewable technologies would also create more employment in the UK than the largely overseas biomass supply chain.

- Conversely, an expansion of offshore wind generating capacity that achieves the same lifetime electricity generation creates significant economic value. [The comparison to offshore wind is illustrative and not intended to represent a proposed optimal alternative. Given the similarities between the economics of offshore wind, onshore wind and solar PV, it is expected that an expansion of some combination of offshore wind, onshore wind and solar would likewise create significant economic value, potentially more than the offshore wind alone case].

- Although the analysis underpinning this briefing note is simplified and only considers a limited number of options, the results suggest that a detailed re-assessment of biomass support and the UK energy mix is warranted and that a switch away from biomass for power generation could make available a significant incremental level of funding to accelerate offshore wind and other renewable energy deployment. This could allow the Government to make additional financial commitments, and support additional employment, in the low-carbon energy sector without putting it under any additional financial strain.

Introduction

The UK Government has historically encouraged both the conversion of coal-fired power stations to burn biomass and the development of dedicated biomass burning power stations. These options were considered to be low-cost measures to reduce power sector greenhouse gas (GHG) emissions and enabled the UK to comply with the EU Renewable Energy Directive targets. Accordingly, both coal-to-biomass conversions and dedicated biomass plants have been included in the list of eligible technologies for the Renewables Obligation (RO) and for the current approach to supporting low-carbon power projects through Contracts for Difference (CfD), although only to 2027 for coal-to-biomass conversions.

Since these decisions were made, the world has changed. Non-biomass renewable power generation alternatives have become substantially cheaper in cost and the UK is no longer part of the EU.

The UK Government has committed itself to long running regulatory incentives and contracts for biomass power generation and previous UK Government behaviour suggests that if policy is changed the UK Government will protect investors who have responded to previous policy and regulations. Despite this, a significant proportion of the costs for future biomass power generation could be avoided, in particular the cost of wood pellets, for which there is an international market and which could presumably be sold or diverted from the UK power sector. A valid question is therefore whether choosing to continue burning wood pellets for power generation in the UK makes economic sense.

This briefing note applies the 'Green Book' methodology for the economic analysis of UK be Government policy to the burning of wood pellets for power generation by comparing this against other generation options, specifically natural gas and additional offshore wind. There are a range of alternative technologies that could contribute to the UK power generation mix; the alternatives to biomass generation used in the analysis are not intended to represent proposed optimal alternatives. However, comparing their economics against biomass provides insights into whether a full re-assessment of the UK power sector generation mix may be appropriate.

The assumptions used in the analysis are intended to be conservative. This is particularly true of the carbon intensity of wood pellet supply where the assumption used is the Drax estimate of carbon intensity despite the wide range of views on actual carbon intensity. Drax is the largest UK power station burning wood-pellet. The carbon intensity assumption affects the economics through the valuation of changes on overall CO_2 emissions between scenarios.

Methodology

Two 'low-carbon' power generation alternatives are assessed against the alternative of higher gas-fired power generation from existing combined-cycle power plant that currently operate at relatively low load factors on the power system in the UK. The alternatives considered are wood pellet biomass, the current policy, and increased offshore wind. Neither of these is suggested as an optimal policy for the UK; they are both used as benchmarks to illustrate the comparative economics of wood pellet biomass for power generation.

Wood pellet generation is considered over the period 2022 to 31st March 2027, a period starting at a future date to allow time for policy changes and renegotiation of biomass supply contracts through to the planned end date for wood pellet generation to qualify for the current incentive

arrangements. The volume of wood pellet based power generation is the estimated combined output of the Drax biomass units and Lynemouth power station, which converted to biomass in 2018. The offshore wind capacity is sized to produce the same level of generation across the project life as the biomass generation does in the period assessed. The actual volume of offshore wind and other technologies that could be deployed in an alternative strategy to biomass generation is something that would need to be worked out as part of a detailed system optimisation. We do not suggest that biomass generation can be immediately replaced with offshore wind (or other renewables) given project development and consent timelines and other considerations. The analysis is deliberately considering a switch of current subsidies to future renewables with an unavoidable gas use in the nearest term but materially lower CO_2 emissions overall.

We note that there are significantly divergent views on the actual CO_2 emissions resulting from power generation from wood pellets. For the purposes of this analysis, we have assumed that the carbon intensity of power generation from wood pellets is as claimed by Drax, a major user of wood pellets for power generation. This is a conservative assumption, both because of the different views on the actual carbon intensity of wood pellets and because the appropriate carbon intensity to assume for a Green Book compliant methodology would be that of the marginal wood pellet supply rather than the calculated carbon intensity of supply to a specific consumer with an explicit interest in a low carbon intensity.

The comparison uses the latest traded carbon values stipulated by HM Government for economic appraisal and is undertaken for gas price sensitivities based on the Intercontinental Exchange forward curve for NBP gas (as at 29th January 2021) and at the UK Government Department of Business, Energy and Industrial Strategy (BEIS) forward gas price assumptions. Both wood pellet power generation and additional offshore wind generation are valued on the basis of the gas-fired generation that they displace by operating.

Other key assumptions are:

- The wood pellet fired power plant continue to be available capacity on the power system, removing a need to consider capacity adequacy as a result of closure timings. This does not indicate that these power plant should continue to operate even if wood pellet is uneconomic versus gas-fired generation; that decision is not considered as part of this analysis.

- Except when curtailed due to an excess of renewable generation, the output of both wood pellet and offshore wind power plant would displace gas-fired generation from the power system.

- The cost of additional offshore wind generation is based on the clearing price for the CFD Allocation Round 3 offshore wind auction, indexed to nominal prices. This cost is maintained as constant in real terms. The clearing price accepted by offshore wind developers will cover all the costs that offshore wind project owners are liable for, including network costs, which are charged to generators in the UK through a cost-reflective zonal transmission charging methodology. Using the CFD strike price rather than a breakdown of individual cost components is a conservative approach because the strike price will embed a commercial rate of return on the investment; the discount rate required within a UK Government appraisal would be lower, implying a lower overall cost.

  There are system costs linked to an expansion of offshore wind generation that the generator is not liable for, specifically system balancing costs where a surplus of output in one part of the

transmission system means that renewable generation has to be reduced and compensated for by thermal power generation connected elsewhere. Under the power market rules applied in both Great Britain and Northern Ireland, generators affected by these balancing arrangements are compensated by the system operator. In the analysis, the incremental balancing costs arising from an assumed expansion of offshore wind generation have been estimated using the detailed data published by Aurora Energy Research from a study that they carried out for the National Infrastructure Commission of the system costs of different levels of renewable penetration.

The analysis does not involve detailed modelling of the power systems. There will therefore be some elements that are not captured, for instance a change in the efficiency of gas-fired power plant as their dispatch pattern alters, which may be an additional cost for higher wind scenarios due to more changes in load for gas-fired power plant. However, other simplifications will disadvantage offshore wind; an example is the use of an annual average gas price in the offshore wind evaluation, which will miss the positive correlation between seasonal gas prices and wind output (meaning that a windfarm may actually offset gas with a higher volume weighted average price).

- The analysis assumes that there is no change in the traded carbon values required for UK Government economic appraisal as a result of the switch to a UK Emissions Trading Scheme (from participation in the European Union Emissions Trading Scheme) or as a result of a change in biomass policy itself. Given that the current UK Government methodology for setting carbon values for the 'traded' sector (i.e. activities that participate within the carbon trading system) is intended to set values that result in the UK meeting carbon targets, both could theoretically have an effect. However, we note that the UK Emissions Trading Scheme (UK ETS) seems set to have a surplus of allowances in the initial years due to the UK cutting traded sector emissions to below the implicit emissions caps for the UK in the EU Emissions Trading Scheme, which have been used as a basis for defining the UK ETS caps (with an additional 5% reduction). This could lead to lower values being set for the traded sector, which would mean that assuming the current values is beneficial to the economics of wood pellet power generation when compared to gas-fired generation. The impact for offshore wind is more complex because the generation from additional projects would happen over the medium- to long-term when carbon prices are expected to rise significantly as carbon caps bite.

- Avoided costs from a reduction in wood pellet consumption by UK power plant are valued at an estimated long-term average spot price of wood pellets. In reality, the reduction in contract payments or incentives would differ from this value. However, the analysis assumes that the UK Government will compensate investors who have responded to UK Government policies such that their returns from investment are not affected by policy reversals, and this will partially offset the contract payment reductions. As an example, the strike price set in CfDs can be thought of as comprising three elements: 1) the fixed costs of running the power plant; 2) a return to investors on their historic capital investment; and 3) a cost for wood pellets. For the purpose of this analysis, we assume that the power plants continue to be available, so the fixed costs of operating the power plant will still have to be met (this may be conservative but a more detailed assessment would be required to identify available fixed cost savings). We are also assuming the UK Government protects investors; therefore, the investment return is still paid.

Regarding the cost of wood pellets themselves, there will be long-term wood pellet supply contracts in place that will need to be terminated and/or re-negotiated. It was stated in the Drax EU State Aid application that long-term contracts tend to be at a price premium to the expected spot value of wood pellets. It is to be expected that there will be clauses in the contracts intended to protect the wood pellet supplier against contract termination and therefore compensation will be payable under the wood pellet contracts as well, which may be comparable to the difference between the long-term contract price and spot market prices. The value recoverable from avoiding future consumption of wood pellets would therefore seem to be the spot value. This may again be conservative; presumably wood pellet suppliers could divert wood pellet supplies into long term contracts elsewhere (both Enviva and Drax note in a variety of publications the growth in demand for wood pellets in Asia).

Drax has stated an aspiration to reduce the costs of wood pellets to a level equivalent to a cost of £50/MWh for power generation by 2027. This appears to be based on a self-supply strategy that can beat the market price for wood pellets. We have not used this cost of wood pellets in the analysis for two reasons; firstly, the cost reduction may not happen, and, secondly, the Green Book methodology requires the opportunity cost of resources to be used in economic appraisal and the market price for wood pellets is the best measure of this.

Compensation to investors would obviously be a legal and political question. Some contracts will include clauses specifying how changes in law will be dealt with and how compensation would be calculated where appropriate; for instance, the 'Operations Cessation Event' clauses in the CfDs. In other cases, such as for power plants benefitting from the Renewables Obligation, appropriate compensation would be a Government decision. Assuming that the avoided costs are solely a spot market value of the wood pellets not consumed is thus a conservative assumption to make regarding the outcome of this process.

- There is no assumed learning benefit from ongoing wood pellet burn for power generation. This is a well understood process using existing technology. Carbon capture and sequestration (CCS) is unproven in the UK power sector; however, it is not obvious that there is any link between ongoing unabated large-scale burn of biomass for power generation and the development of CCS.

The key assumptions are summarised in the table on the following page:

Assumption	Source	Value
Biomass cost	*Argus / Drax*	*trending up to 170 USD/t and then flat nominal*
Gas price	*BEIS / The Intercontinental Exchange*	*BEIS 51.45 p/therm trending up at 4% nominal pa / ICE at 40 p/therm flat nominal*
Carbon price	*HM Treasury carbon valuation*	*22 £/t trending up to 73 £/t by 2027 (nominal) (and continuing to rise thereafter)*
Biomass output	*Aurora Energy Research*	*17.6 TWh per annum*
Offshore wind capacity factor	*BEIS Electricity Generation Cost Report*	*48% for Allocation Round 3 technology*
CCGT efficiency	*Digest of UK Energy Statistics (DUKES)*	*48.8% average CCGT efficiency*
CCGT carbon intensity	*Ricardo AEA estimate for LNG fed CCGT*	*0.45 tonnes per MWh lifecycle emissions*
Biomass carbon intensity	*Drax*	*0.124 tonnes per MWh*
Wind curtailment	*Aurora Energy Research - study for the National Infrastructure Commission*	*marginal impact variable over time*
Wind balancing costs	*Aurora Energy Research - study for the National Infrastructure Commission*	*marginal impact variable over time*
Biomass consumption per MWh	*European Commission - Drax State Aid Approval*	*approx 0.55 tonnes per MWh*
Offshore wind cost per MWh	*BEIS - CFD Allocation Round 3 results*	*£40 per MWh in 2012 terms*
Battery cost and build	*Aurora Energy Research - study for the National Infrastructure Commission*	*around 870 £/kw*
Discount rate	*HM Treasury*	*3.5% real*

Key Results

The continued burn of imported wood pellets for power generation in the UK has a negative economic value of -£0.92 Bn (BEIS gas price assumptions) or -£1.84 Bn (ICE forward gas price curve) over the 2021 to 2027 period, including CO_2 emissions reductions valued at the traded carbon values stipulated for the economic appraisal of UK Government policies. In other words, even when taking account of the value of CO_2 emission reductions calculated according to CO_2 intensity figures potentially beneficial to the case for biomass, burning imported wood pellets for power generation destroys substantial economic value.

Conversely, an expansion of offshore wind generating capacity that achieves the same lifetime electricity generation creates either £1.5 Bn or £95 Mn in economic value depending on the gas price scenario. The value of avoided gas burn and the value of the CO_2 emissions avoided more than covers the costs of offshore wind. Given the similarities between the economics of offshore wind, onshore wind and solar PV, it is expected that an expansion of some combination of offshore wind, onshore wind and solar would likewise create significant economic value, potentially more than the offshore wind alone case.

The cessation of wood pellet burn for power generation in the UK, with an equivalent amount of generation being sourced from additional offshore wind (or potentially other similar or even lower cost renewable technologies), is therefore estimated to create either £2.49 Bn or £1.93 Bn in economic value, depending on assumed gas prices and on the basis of conservative assumptions.

The below table summarises the economic value of the low carbon options assessed:

Economic value (GBP)	BEIS gas price	ICE gas price
Biomass burn (1)	*-0.92 Billion*	*-1.84 Billion*
Additional offshore wind (2)	*1.5 Billion*	*0.095 Billion*
Switch from biomass to wind (2-1)	*2.49 Billion*	*1.93 Billion*

As previously explained, this is a simplified analysis. However, the results indicate that a more detailed cost-benefit assessment of continuing to pay out biomass subsidies is warranted.

Additional impacts

According to Drax, more than 80% of the wood pellet supply chain cost is outside of the UK. In fact, this 80% is to get pellets to the exporting port; the remaining 20% comprises both the ocean freight and transport at the UK end. Subsidising biomass imports is therefore primarily creating employment in exporting regions, such as the southern USA. A significantly higher proportion of money spent on offshore wind, or other renewables, is spent in the UK.

A study by the International Renewable Energy Association estimates that there are 2.1 million man-days of employment involved in the lifecycle of a 500 MW offshore windfarm. Our offshore wind scenario involves 1550 MW of additional offshore wind capacity, which would accordingly require 6.51 million man-days of effort. Assuming just 50% of this occurs in the UK, that is 3.25 million man-days of employment.

Given the assumption that the biomass fired power plant will continue to be available in all scenarios, employment impacts at the biomass power plant will be minimal. Should cost savings be identified this could be offset by a reduction in compensation which would create funds for additional investment elsewhere.

The biomass to power generation activity will largely cease in 2027 under current arrangements. For the biomass scenario to offer an equivalent level of aggregate UK employment over this period to the employment benefits from the offshore wind scenario would require there to be nearly 3,400 people employed full time transporting biomass from the ports to Drax and Lynemouth. This does not seem credible.

In addition to significant economic benefits, a switch of support from wood pellet power generation to additional offshore wind would therefore also appear to create considerable potential employment gains.