Contracts for Difference, Bid/Offer Incentives and Efficiency in the Balancing Mechanism

Market Analysis*

8 May 2024

Abstract: The bidding behavior of CfD supported renewable generators in the Balancing Mechanism is under review by Ofgem for potential breaches of the TCLC. Ofgem believes that these generators' bids should include avoided CfD repayments when day-ahead market prices are high, passing on these benefits to consumers. Ofgem now proposes to codify this with changes to its TCLC Guidance. However, the distortions to bidding incentives created by these CfDs are by now well understood, and these incentives lead to economic inefficiencies which can increase costs for consumers. Adopting Ofgem's suggested approach to CfD payments and bid prices would likely exacerbate these distortions to incentives, leading to deviations from merit order dispatch and misaligned prices in the BM. In contrast, the NGESO and Elexon have recognized the potentially high costs of these distortions and are proposing changes to BM cash flows for these generators to rectify this.

1 Introduction

The Contracts for Difference (CfD) scheme is the UK government's main mechanism for supporting low carbon electricity generation. CfDs are 15-year contracts between low-carbon electricity generators and the Low Carbon Contracts Company (LCCC). Contracts are awarded in competitive auctions. Since 2014 there have been 6 auctions, or allocation rounds, which have seen a range of different renewable technologies competing directly against each other for a contract. Generators with CfDs receive revenue from selling their electricity into the wholesale market, and by making offers and bids in the Balancing Mechanism (BM). When the market reference price is below the contract strike price,

*Market Analysis Ltd., 34 Great Clarendon Street, Oxford OX2 6AT, UK. Email: davidharbord@market-analysis.co.uk

generators receive a top-up payment for the additional amount from the LCCC. Conversely, if the reference price is above the strike price, the generator must pay back the difference.[1] The LCCC finances these payments via a levy on electricity suppliers, set quarterly.

CfDs already auctioned by the government will, by 2030, cover some 30GW of renewable energy generating capacity in the UK, mostly offshore wind. The government plans to conduct auctions on a twice-yearly basis to contract additional capacity as part of its goal to reach 80% wind and solar energy by 2035.

The BM is the primary mechanism the Electricity System Operator (ESO) has to balance electricity supply and demand close to real time. BM participants submit offers to sell energy (by increasing generation or decreasing consumption) to the system and bids to buy energy (by decreasing generation or increasing consumption). The ESO balances the system by accepting bids or offers as required. The parties are then paid for the volumes of energy in accepted bids and offers the prices they tendered into the BM.

On a continuous basis, the ESO compares the sum of generators' Final Physical Notifications (FPNs) with the Transmission System Demand Forecast (TSDF). If there is an imbalance, the ESO must accept bids to reduce generation/increase demand or offers to increase generation/reduce demand to make up the difference. When there is a transmission constraint, reducing generation in response to the ESO accepting a bid (being "constrained down") has no effect on contractual payments from suppliers or imbalance settlement payments. Consequently, the incremental impact on a generator of reducing its output will be limited to costs avoided (positive or negative) from reducing generation.[2]

Generators operating in the BM are bound by the Transmission Constraint Licence Condition, or TCLC, the purpose of which is to ensure that, in constrained situations that give rise to market power, there continues to be efficient economic dispatch by the ESO of generation plant. The TCLC therefore prohibits bids that give rise to "excessive gain", with the objective of protecting against the exploitation of market power by generators operating in the presence of transmission constraints which would be inconsistent with efficient dispatch. As Ofgem (2023) explains,

> "The TCLC exists to protect against this market power. By prohibiting licensees from obtaining an excessive benefit in transmission

[1] For Intermittent CfDs (generators using solar PV, wind or tidal assets), the Reference Price is set hourly: it is the weighted average of the settlement prices for the two day-ahead auctions, run by the N2EX and EPEX power exchanges, for the relevant hour. Department for Energy Security and Net Zero (2023). Contracts for Difference for Low Carbon Electricity Generation: Call for Evidence on introducing Non-Price Factors into the Contracts for Difference Scheme.

[2] The ESO only rebalanced 5% of the electricity market prior to 2012 when the market was dominated by large, flexible generators. Currently, balancing services regularly make up over 50% of national demand in large part due to the increase in network constraints. Rebalancing payments from the ESO are predicted to rise from £0.5-1 billion in 2022 to £2-2.5 billion per year in the 2030s. POSTnote 694, By Brian Tam, Alan Walker, 2 May 2023.

constraint periods, it helps to keep down balancing costs – and, ultimately, consumers' bills."

Ofgem publishes guidance to licensees and other interested parties on it's interpretation and approach to the enforcement of the TCLC. The current version of the guidance was published in 2017, and Ofgem is currently consulting on a revised version of this guidance to come into effect in 2024.

For generation plants without CfDs (or similar support mechanisms) bids in the BM are intended to reflect the costs avoided or incurred from reducing generation below their FPNs. For a nuclear plant, for example, reducing generation at short notice is costly, whereas for gas-fired plants there is a cost savings associated with burning less gas.[3] For renewable generators with CfDs the situation is more complex. This is because the CfDs currently in place make payments based on MWhs physically generated. Therefore, unlike supplier contracts, when a generator reduces generation in response to an accepted BM bid, the generator loses CfD revenue when the market reference price is below the strike price and avoids CfD repayments when the market reference price is above the strike price. The incremental impact on a CfD generator of reducing generation will thus be a net loss of revenue equal to lost CfD payments in the first case, minus avoided costs of generation and, in the second case, avoided CfD payments plus avoided costs of generation.

While Ofgem's 2017 guidance on the TCLC did not directly address the issue of CfD payments as a relevant factor in determining, or evaluating, a generator's bidding behavior, the current consultation proposes to make this explicit:[4]

> 2.22 While avoided costs were referred to in the 2017 Guidance, we have sought to make even more explicit in the updated guidance that generators should ensure that their bid prices are reflective not only of the costs of being bid down, but also the benefits. This includes any benefits associated with avoided subsidy repayments under the Contracts for Difference (CfD) scheme. As the guidance makes clear, a licensee which failed to submit bid prices in transmission constraint periods which reflected its avoided costs such as those relating to avoided subsidy repayments under the CfD scheme would be likely to obtain an excessive benefit, in breach of the TCLC.

Further,

> 2.33 ... Under existing market arrangements there may also be costs or benefits to some generators of being bid down associated with subsidy payments received or foregone under either the Contracts for Difference (CfD) or Renewables Obligation (RO) schemes, which we will similarly take into account when assessing the benefit that a licensee obtains or seeks to obtain through its bid prices:

[3] See Ofgem's notice of 13 October 2023 regarding EP SHB Limited.

[4] Ofgem, Update to the Transmission Constraint Licence Condition guidance Publication date: 7 December 2023.

> Payments to/from CfD generators are based on metered output, i.e. output after any bid or offer has been accepted by the ESO. This means that in periods where the relevant wholesale reference price is below a generator's strike price, the licensee may incur a further cost when it has a bid accepted attached to the subsidy payment that is lost as a result of the unit's reduced output. In contrast, in periods where the relevant wholesale reference price is above a generator's strike price, the licensee may incur a further benefit where it has a bid accepted as a result of the repayment it no longer has to make to the Low Carbon Contract Company.

Ofgem's motivation for this change in its guidance appears to be, at least in part, a period of high wholesale electricity market prices from September 2021, which meant that for most of this period CfD strike prices have been below market reference prices. CfD generators whose bid prices did not reflect this "further benefit" (i.e. avoided payments to the LCCC), may therefore, in Ofgem's view, be receiving an "excessive benefit", and potentially in breach of the TCLC.

In our view, Ofgem's approach to CfD payments and bid prices will likely exacerbate the already well-understood distortions to incentives created by these CfDs for generators' bid and offer behavior in the BM. These CfD-created incentives potentially result in considerable economic inefficiency by distorting merit order dispatch (i.e. productive inefficiency) and misaligned prices in the BM (i.e. allocative inefficiency), thus increasing the costs of constraint management for consumers. The remainder of this note expands on this point.

2 Bidding Incentives in the BM

It is widely recognized that the CfDs currently held by renewable generators distort offer and bid incentives in ways that are detrimental to economic efficiency and consumer welfare. This has been explained in Newbery (2023), Höckner *et al* (2020), Schlecht *et al* (2023), Elexon (2023a)(2023b) and as part of the REMA process (House of Commons (2023) and UK Parliament Post Note 694 (2023)). The reason is, as explained above, that CfD payments are based on actual, metered output, so CfD generators lose or avoid CfD payments when their output falls below their FPNs. These contracts are therefore unlike traditional CfDs which were purely financial contracts and payments did not depend on actual generation.

Current CfDs distort pricing incentives and competition in a number of ways, including generators' location decisions (see Annex 1 and Newbery (2003) for more details). With regard to constraint management by the ESO:

1. When the market reference price is below the strike price ($P < S$), the generator is incentivized to bid very low (i.e. negative) prices in the BM to compensate for lost CfD payments when constrained down, whereas non CfD generators can profitably bid at the avoidable cost of having their output constrained down.

2. When the market reference price is above the strike price ($P > S$), a CfD generator is incentivized to set bid prices well above avoidable costs to be constrained off ahead of cheaper non CfD plant, to avoid making CfD repayments while still receiving its contractual revenues.

These distortions to bidding incentives result in inefficient dispatch of generating and distort prices in the BM, resulting in losses that must ultimately be borne by consumers.

This inefficiency and the resulting consumer loss is illustrated by the 6th of January 2021 bidding behavior by Beatrice wind farm. Day ahead prices reached £1000/MWh on that day. The Beatrice wind farm has a CFD strike of £162/MWh, so with a day ahead hourly price of £1000/MWh it became more profitable for the wind farm to offer a bid to reduce volume at less than £838/MWh. In this instance the Beatrice bid was £781/MWh, giving an additional profit of £57/MWh (£838-£781), resulting in a total revenue of £219/MWh (£162+£57). According to Bloomberg "*After allowing SSE to turn off Beatrice, National Grid paid EDF to fire up its West Burton B gas plant. On Jan. 8 the same gas plant earned 4,000 pounds a megawatt-hour for two units.*"[5]

As is well understood, in the presence of a transmission constraint the ESO should create a "merit order" of bids and choose to constrain the output of the lower-cost plants first. It does this by accepting the lowest costs bids first and continues in order of descending bids, until the constraint is satisfied. To achieve efficient dispatch (i.e. productive efficiency) the bids made by generators should reflect only the underlying economically relevant avoidable or incurred costs of reducing their generation. CfD payments, lost or avoided, are not economically relevant costs or benefits to be factored into the calculation of bid prices.[6]

CfD generators are incentivized to include lost or avoided CfD payments (S-P) in their bid prices, whereas the only relevant costs are the actual economic costs incurred or avoided when plants reduce their output behind a constraint. These costs are typically either zero or negative for solar and wind plants whereas for gas-fired plants there will frequently be a cost saving from being constrained off in terms of gas not consumed. Hence their bid prices will typically be positive to reflect this (and any other avoidable costs saved). Ofgem itself makes a similar point in its notice of 13 October 2023 regarding EP SHB Limited in para 2.9 where it states that "*a gas-fired generator benefits by – among other things - no longer having to burn as much gas, reducing its fuel costs.*"

Efficient economic dispatch therefore requires that gas plants are generally constrained off before intermittent renewable plants, something which does not always occur when CfD generators include avoided CfD payments in bid prices, as illustrated by the January 2021 bidding behavior of Beatrice wind farm. The

[5] Bloomberg, "How the U.K. Power System Can Be Mismatched to Climate Goals" 11 January 2021.

[6] CfD payments or repayments are purely financial transfers between generators and the LCCC, designed to reduce risk for renewable generators, and bear no relation to the actual economic (i.e. physical) costs of reducing or increasing generation.

distortions to bidding behavior of wind plants from 2020 to the present is further illustrated by the figure.

Ofgem's suggested bidding behavior for CfD supported generators (to be codified in proposed amendments to its guidance), would mandate that these generators include in their bids lost or avoided CfD payments, potentially leading to considerable economic inefficiency and distortions to BM prices, particularly in periods when their bid prices would be positive and above those of gas-fired plants.[7]

The current market arrangements, and the proposed changes to Ofgem's Guidance, thus lead to distortions in competition and economic inefficiencies which can result in consumers paying too much for the management of transmission constraints. Another cost of these distortions is the environmental cost which occurs when environmentally preferable renewable plant is constrained down before gas-fired plants.

Ofgem appears to be concerned, however, that by not distorting their bid prices in the manner it suggests when the market reference price exceeds the strike price, CfD supported generators are denying consumers a benefit which they would have otherwise received in the counterfactual situation in which they are not constrained off and make CfD repayments to the LCCC. This is not generally the case whenever there is competition between generators to be constrained off. The inefficiency and consumer costs entailed by bidding according to the proposed guidance can be illustrated with some extremely simple, stylized examples.

Example 1.

Assume a windfarm with a CfD has costs of being constrained down of $15/MWh$ ($C_{off} = 15$) while a gas-fired plant benefits from saved gas costs of $C = 25/MWh$. We assume that each generator has capacity k and that the ESO needs to constrain production behind a constraint by an amount $q < k$. Given the costs, any period in which the wind plant is constrained down in favour of the gas-fired plant results in a pure productive efficiency loss of $40q$.

Assume that in the relevant period the CfD strike price less the market reference price is equal to $(S - P) = -100$, the case which appears to be of greatest concern to Ofgem.

Scenario 1: Both plants bid their actual avoided or incurred costs of being constrained down, so $B_W = -15/MWh$ and $B_G = 25/MWh$. The gas-fired plant will be constrained down, and the BM receives revenue of $25q$. The LCCC receives CfD repayments of $100k$. The incremental consumer benefit/cost $= 25q$ less the costs the BM incurs buying additional energy on the other side of the constraint (which are constant throughout).[8]

[7] This distortion in incentives is now clearly recognised by Elexon (in "Initial Written Assessment: P462 'The removal of subsidies from Bid Prices in the Balancing Mechanism"' of 9 November 2023), See further below.

[8] We assume here that revenues received by the ESO in the BM and CfD repayments made

Scenario 2: The wind plant bids according to Ofgem's revised guidance, so $B_W = (100 - 15)/MWh = 85/MWh$ while $B_G = 25/MWh$. The wind plant is now constrained off, and the BM receives revenues of $85q$ and a CfD repayment of $100(k - q)$ is made to the LCCC. Incremental consumer benefit/cost = $85q$-$100q$ = $-15q$.That is, the bid price paid to the BM less the lost CfD repayment.

Hence the efficiency loss of $40q$ is borne by consumers.

Example 2.

We assume a single solar plant with a CfD and $C = C_{off} = 0$ and a windfarm with $C_{off} = 15/MWh$ with ROC support of $50/MWh$.[9] Each plant has a capacity of k and the ESO again needs to constrain production by $q < k$.

We now assume that $(S-P) = 100/MWh$ in the relevant period, so having bids accepted in the BM lead to a loss in support payments for these generators.

Scenario 1. Both plants bid actual costs, so $B_S = 0$ and $B_W = -15/MWh$.The solar plant will be constrained down for a BM cost of 0 and the LCCC avoids a CfD payment of $100q$. ROC benefits of $50k$ are unaffected. Hence the incremental consumer benefit = $100q$.

Scenario 2. Both plants bid following Ofgem's guidance, so $B_S = -100/MWh$, reflecting lost CfD payments, and $B_W = -65/MWh$, reflecting shut down costs and lost ROC payments. The wind farm is now constrained down for a BM cost of $65q$ and the LCCC makes a CfD payment of $100k$ while ROC benefits saved are $50q$. Hence the consumer benefit/cost is $-65q + 50q = -15q$.

The difference in costs between the 2 scenarios is $115q$, equivalent to deadweight efficiency loss of $15q$ plus $100q$ in LCCC payments not avoided.

Bidding according to the revised TCLC Guidance can result in distortions to merit order dispatch and increased consumer costs of managing constraints. Note that if renewable support mechanisms did not depend on actual metered output, bidding behavior would be identical in Scenarios 1 and 2 in both examples, so efficient dispatch would be restored and consumer costs reduced.

---

to the LCCC are ultimately passed on to consumers via reduced electricity prices. This appears to not have been the case, at least until October 2022, due to the way Ofgem's standard tariff price cap was calculated, and still may not be the case due to the government's Energy Price Guarantee (EPG).

[9] As of 2021/22, each ROC was notionally worth approx. £55, with offshore wind farms receiving 2 ROCs per MWh and onshore wind farms 0.9 ROCs per MWh. Source: https://www.naturalpower.com/mediaLibrary/other/english/4740.pdf

3 Contracts for Differences

As noted above, the issues created by CfDs and other renewable support schemes have been well recognized and widely discussed for a number of years. Newbery (2023) and Höckner et al (2020) address distortions to offer and bid incentives as well as distortions to constraint management created by these support schemes, particularly CfDs. Newbery writes:

> "Almost all existing price and quantity-based schemes create distortions because the subsidized strike price determining the revenue (on average above the market price) is only paid if the VRE generates. Hence it is the subsidized strike price, not the market price, that guides location and dispatch decisions. The contrast with hedging instruments used for conventional generation is most clearly seen with the British Contract-for Difference (CfD) with FiT (Energy Act 2013 at HoC, 2013).

Newbery (2023) addresses the issue of transmission constraints and proposes that a £0/MWh price cap be imposed on CfD generators' bids:

> "In the absence of LMPs, transmission constraints have to be addressed in the balancing market. Generators indicate how much they will accept to be constrained down and replaced by other generators that indicate how much they need to be paid to increase output. ... Normal practice is to pay their lost profit, best indicated in a last-price balancing auction. For an unsubsidized generator if the market price is p and it bids its avoidable cost c, it would be paid its foregone profit p - c to reduce output.
>
> The problem with subsidized generation is that their lost profit may be distorted by the subsidy. If they only receive a subsidy if dispatched, and if the subsidy is y above the spot price,p, they may be willing to make a negative bid of—(y–c), which can lead to an inefficient choice of units to constrain down .... An efficient support scheme will avoid this. One relatively simple solution is to prohibit VRE from negative bids while allowing conventional generation to make negative offers to avoid having to shut down and expensively re-start."[10]

As Newbery (2023) emphasizes, "*the first requirement is to ensure that VRE always bids its avoidable cost and hence ensures efficient dispatch*".

Höckner et al. (2020) recognize that this is a problem in the German electricity market when addressing the need to redispatch to resolve congestion constraints. Instead of calling for a redesign of the renewables support scheme, they argue for side payments to offset the distortion of treating the support price, not the market price, as the opportunity cost.

[10] Newbery is concerned here with negative bids aimed at recovering lost subsidies, but the logic of his argument applies equally to positive bids which exceed avoidable costs.

Elexon (2023a) have also clearly recognized the problem created by current renewable support systems and the resulting distortion to incentives, considering a proposal for reform of the BSC from the NGESO. They state:

> "Due to current market arrangements, generation units which hold support mechanisms through CfD or RO Certificates (ROCs), need to price recover an expected subsidy in their Bid Prices. This prevents them from pricing on equal terms with un-subsidised units and means that their Bid Price is not reflective of the consumer cost or savings of this transaction.
>
> The Proposer believes that this is a structural issue with the interaction between the Balancing Mechanism (BM) and support mechanism arrangements because all subsidies are currently based upon metered output recovery, whilst a BM Bid Acceptance will reduce output and thus lead to the subsidies being lost. This means transactions taken in Bid Price order are not in line with consumer cost order and could lead to less cost-effective actions being taken.
>
> The Proposer believes if not addressed, there could be continued consumer cost caused by the interaction between the BM and support mechanism arrangements."

Elexon (2023b) further explains the distortions to competition entailed by CfDs and Renewable Obligation Certificates (ROCs):

> "This regularly occurs in the BM with the most common interaction observed between units with CfDs whose Bid Price vary based upon a Day Ahead market reference price and units which are subsidised via ROCs. The lower the market price, the greater the support mechanism revenue that the CfD unit must recover. In order to do this, the CfD unit must continually reduce their bid price, as the Day Ahead market clears at a lower price to recover its support mechanism. This means a ROCs unit which has a high marginal consumer cost, but a lower support mechanism level becomes cheaper in the BM. This disincentivises both units from competing, as the CfD unit cannot reasonably increase their Bid Price to above the ROC unit, whilst the ROC unit is not incentivised to seek a lower marginal rate as there is less competition. Similarly, if Day Ahead Prices are very high, a CfD unit may have a negative support mechanism level (payment owed to the Low Carbon Contracts Company) meaning that the ROC unit cannot reasonably increase their bid price to above the CfD unit, whilst the CfD unit is not incentivised to seek a lower marginal rate."

Elexon suggests a solution to this essentially equivalent to that of Höckner et al. (2020) in Germany:

> "The proposed Solution is to amend the BSC to make a Balancing Mechanism Unit (BMU) whole for any lost support mechanism value, by changing the formula for the BM Unit Cashflow. Currently the support mechanism is included implicitly within the Bid Price which not only effects the merit order stack but is also driving negative pricing."

The purpose of Elexon's proposal is "*to allow all units to compete based on marginal (or avoidable) costs without the distortion of subsidies, thereby creating a more efficient BM.*"

In our notation (see Annex 1), Elexon is proposing to adjust CfD subsidized generators' BM cash flows by including a term $q(S-P)$, where q is the amount of output lost from being constrained down. Hence a bid price $b = (C - C_{off})$ will now make subsidized generators indifferent between producing or being constrained off, as is required by efficiency. When the market reference price exceeds the strike price the generator will be required to make, rather than receive, an additional payment in relation to its bid.

Elexon estimates that this change could result in £16 billion of consumer savings by 2030,[11] and believes that this reform will:

- result in savings to end consumers from the removal of costs identified through CfD to BM interactions Further savings would be expected by improving the transparency of marginal prices and enabling greater competition between ROC units, CfD units and merchant units;
- facilitate fairer competition by allowing subsidised and unsubsidised units to compete against each other based on consumer cost. The units will be able to set their Bid Price without the distortion of the subsidies, creating a level playing field between subsidised and unsubsidised units; and
- reduce price volatility allowing generators to reduce their imbalance risk premium in their pricing strategy, which should in turn lead to reduced prices, thus improving market efficiency.

Finally, the incentives problem created by CfDs have also been recognized in the REMA process, and reforms to the structure of future CfDs have been proposed (see House of Commons (2023) and UK Parliament Post (2023)). Reforms under consideration include:.

• CfDs with wholesale price exposure. CfDs could be moderately exposed to the market conditions by implementing a 'strike price range'. This would give generators a guaranteed maximum and minimum price per MWh output, exposing them to market conditions within that range.

• Separating revenue from generation. CfD revenue may also be based on predicted generation in a particular location. This so-called 'Deemed CfD' and

[11] In what Elexon calls the "best case scenario" this number is reduced to £518 million by 2030.

similar reforms may alleviate system constraints by decoupling payments from real-time generation.[12]

• Revenue cap and floor. A cap and floor support mechanism guarantees minimum revenue (the 'floor') while limiting excessive profits through a revenue maximum (the 'cap').

The Government issued a Call for Evidence closing in May 2023 on the potential reforms to CfDs. It has previously recognized other incentives issues with the CfDs, namely those which lead CfD generators to bid negative prices into intraday and balancing markets, because it is the subsidized strike price, not the market price, which guides their bidding and dispatch decisions (see Annex 1). Beginning with the contracts for allocation rounds AR2 and AR3, when the CfD reference price is below zero for six or more consecutive hours, no difference payments are made for any generation during the period. For subsequent rounds, the government proposed that no payment be made during any hour when the day ahead price is negative. In *Contracts for Difference for Low Carbon Electricity Generation: Consultation on proposed amendments to the scheme* (March 2020), it proposed "*extending the existing negative pricing rule so that difference payments are not paid to CfD generators when day-ahead prices are negative,*" as such payments "*...encourage CfD generators to keep generating during these periods of low demand and also facilitates negative bidding into the balancing mechanism, increasing costs for consumers.*"[13]

Of course, adopting purely financial CfD contracts for which difference payments are based on predicted, rather than actual, generation would resolve this issue as well as others we have discussed here.

4 Conclusion

Renewable support mechanisms such as CfDs create distortions to bid and offer incentives for renewable generators which lead to economic inefficiency and higher costs. Mandating that CfD generators factor lost or avoided support payments into their bids in the BM via the TCLC will likely exacerbate these distortions to incentives, potentially resulting in considerable economic inefficiency from distorted merit order dispatch and misaligned prices in the BM. These costs are ultimately borne by consumers. In our view, Ofgem should consider whether the putative benefits to consumers from its suggested bidding behavior compensate for the potential consumer harm created by distorted bidding incentives in the BM.

[12] This is similar to Newbery's (2023) proposal of a 'yardstick CfD' which pays regardless of whether the generator is producing or not.

[13] Negative day-ahead price periods peaked in 2020, fell off sharply in 2021-22, but have increased dramatically again in 2023. Source: https://www.linkedin.com/pulse/negative-prices-gb-when-green-power-makes-britain-see-euan-killengray

References

[1] Höckner, J., S. Voswinkel, and C. Weber (2020) "Market distortions in flexibility markets caused by renewable subsidies - The case for side payments." *Energy Policy* 137: 111135, 1–13.

[2] Newbery, David (2023) "Efficient Renewable Electricity Support: Designing an Incentive-compatible Support Scheme," *The Energy Journal*, Vol. 44, No. 3, 2023.

[3] Schlecht, Ingmar; Maurer, Christoph; Hirth, Lion (2023) "Financial Contracts for Differences," ZBW - Leibniz Information Centre for Economics, Kiel, Hamburg. (https://www.econstor.eu/bitstream/10419/268370/1/Financial_CfD.pdf)

[4] UK Parliament POSTnote 694 By Brian Tam and Alan Walker, 2 May 2023, *Electricity Market Reform*.

[5] House of Commons Library Research Briefing, 12 September 2023, by Nicole Watson and Paul Bolton, *Contracts for Difference*.

[6] Elexon (2023a) "P462 'The removal of subsidies from Bid Prices in the Balancing Mechanism - Initial Written Assessment."

[7] Elexon (2023b) "P462 'The removal of subsidies from Bid Prices in the Balancing Mechanism - BSC Modification Proposal Form."

Annex 1 CfDs and Bid/Offer Incentives in the BM

Contracts for Differences between electricity generators and suppliers traditionally have been purely financial contracts, unrelated to the actual production or consumption of energy. Based on a strike price S and a quantity Q, they paid the generator $(S-P)Q$ in any relevant period, where P is the reference market price. In contrast, the current CfDs to support renewables in the UK base payments and repayments on actual (metered) generation. The latter distort offer and bidding incentives in the BM, to the detriment to efficiency, as we explain here.

Under a **purely financial contract,** a generator's profits when producing (p) versus not producing (np) are given by,

$$\begin{aligned} \pi_p &= (S-P)Q + (P-C)Q = (S-C)Q \\ \pi_{np} &= (S-P)Q \end{aligned}$$

where C = avoidable or marginal costs. That is, the generator receives (or pays) its CfD revenues whether producing or not. Thus producing is preferred to not producing if and only if,

$$\begin{aligned} (S-C)Q &> (S-P)Q \qquad \text{or} \\ P &> C \end{aligned}$$

Hence a generator's incentive with a purely financial contract, if a price taker, is to offer generation at avoidable cost. In the absence of market power, generators with and without CfDs will be dispatched efficiently, based on the merit order of avoidable cost.

Under **the current CfDs**, a generator has to produce to receive its CfD payment but not its market revenues, so its profits from producing versus not producing are,

$$\begin{aligned} \pi_p &= (S-P)Q + (P-C)Q = (S-C)Q \\ \pi_{np} &= PQ - PQ = 0 \end{aligned}$$

as the generator is required to buy Q from the ESO at the market price P. Hence the generator prefers to produce when $(S-C)Q > 0$, or if $S > C$. Assuming $S > C$, the generator wants to produce at all times, hence its incentives are to offer a price of 0 or below. Efficient dispatch and market prices are thus compromised.

as the generator is required to buy Q from the ESO. Hence producing is more profitable if $S > C$ as above and generators incentives are to offer 0 or negative prices.

Constrained off Payments and Bids

Under a **purely financial CfD,** a generator's profits from producing versus being constrained off are given by

$$\begin{aligned} \pi_{on} &= (S-P)Q + (P-C)Q = (S-C)Q \\ \pi_{off} &= (S-P)Q + (P-C_{off})Q - bQ \end{aligned}$$

where b is the bid price in the BM. Thus at a bid price of $b = C - C_{off}$ the generator is indifferent between producing or being constrained off. The generator is incentivized to set a bid price equal to the costs avoided when constrained off less the costs of reducing production. Again, absent market power, generators with and without CfDs will be dispatched efficiently following the merit order of avoidable and incurred costs.

If a generator has to produce to receive its CfD payment but not its contracted market revenues, on the other hand:

$$\begin{aligned} \pi_{on} &= (S-P)Q + (P-C)Q = (S-C)Q \\ \pi_{off} &= (P-C_{off})Q - bQ \end{aligned}$$

Hence a bid price $b = (C - C_{off}) - (S - P)$ makes the generator indifferent between producing or being constrained off. Thus generators with CfDs are incentivized to include lost CfD payments in bid prices, leading to inefficient dispatch and misaligned prices.

Newbery (2023) provides a detailed discussion of the distortions to economic efficiency created by renewable support schemes, including CfDs, with a focus on the resulting distortions to location decisions. He proposes a 'yardstick CfD' which pays regardless of whether the generator is producing or not that will ensure efficient dispatch and constraint management.