



Department
of Energy &
Climate Change

Annex B: Strike price methodology

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Contents

Introduction	4
Overview of methodology for deriving a CfD strike price	4
Strike Prices in the period 2014/15 – 2016/17	5
Strike prices in 2017/18 and 2018/19	9
Comparison of support levels under the RO and CfDs	10
Treatment of different risk allocation between the RO and CfD in setting of strike prices	11

Introduction

1. This annex explains the methodological factors that determine the Contract for Difference (CfD) strike prices set out in the EMR Delivery Plan.
2. The Renewables Obligation (RO) is the existing financial support mechanism for large-scale renewable generation. Our aim in setting strike prices is to ensure a smooth transition¹ for investors from the RO to the CfD, and to minimise hiatus in investment. Our approach to strike prices in the period 2014/15 – 2016/17 is based on “RO minus X” (or RO-X). The RO signifies our intent to provide support aligned to that under the Renewables Obligation (RO), and the ‘minus X’ reflects the assumption that the required rate of return for a renewables project to proceed, the hurdle rate, is lower under the CfD than under the RO for most renewable technologies. The RO-X methodology is a guideline and not a rigid equivalence. There are clearly different assumptions that can be made about factors such as future wholesale prices, and there is no commitment on the Government’s part to maintain this equivalence in future.
3. In later years, CfD strike prices are based on the expectation of declining costs due to learning through deployment and the requirements that deployment remains within the LCF affordability constraint, while providing a level of renewable generation consistent with meeting the 2020 renewable energy target.

Overview of methodology for deriving a CfD strike price

4. There are a range of factors to consider in setting a strike price, covering:
 - technology specific factors such as capital and operating costs, financing costs as well as any build constraints;
 - market conditions such as wholesale prices and the discount which generators face when signing a power purchase agreement (PPA); and
 - policy considerations such as the specific contract design, choices about technology mix and meeting the ambition for renewable electricity.
5. These factors mean that a strike price for a particular technology is different to the ‘levelised cost’ – the average cost over the lifetime of the plant per MWh generated². Relative to this figure a strike price could be higher or lower for a number of different reasons, all of which are taken into account in the setting of these strike prices:

¹Details on RO transitional arrangements were set out <https://www.gov.uk/government/consultations/transition-from-the-renewables-obligation-to-contracts-for-difference> to which DECC will issue a Government Response in due course

² ‘Electricity Generation Costs December 2013’ DECC (2013)
<https://www.gov.uk/government/publications/electricity-generation-costs>

- **Costs not included in DECC’s standard levelised costs:** CfD top-up payments will be paid on the basis of generation after taking account of the generator’s share of transmission losses, known as the Transmission Loss Multiplier so the strike prices need to be increased to account for this.
 - **PPAs:** The revenue received by the generator is a combination of the wholesale price and the CfD top-up, which is the difference between the strike price and the reference price. If the generator cannot achieve the reference price because it sells its power through a PPA at a discount to the market price, the strike price must be increased to compensate for this³. PPA discounts reflect route to market costs including the costs of trading and imbalance costs⁴.
 - **Contract length:** The levelised cost is defined over the operating life of a project. If the CfD contract length is shorter than the operating life and wholesale prices and capacity market revenue post-contract are lower than the levelised cost then, all other things being equal, the strike price must be increased above the levelised cost to compensate for this.
 - **Other policy:** Levy Exemption Certificates (LECs) provide around £5/MWh of support. The modelling assumes CfD plants (like those supported under the RO) will receive LEC revenue and the strike price is reduced to account for this.
6. The key assumptions used for setting of strike prices, including for levelised costs, fossil fuel prices, effective tax rates, PPA discounts and maximum build assumptions are listed in the Government’s levelised cost report⁵ and the report from the System Operator (National Grid)⁶. Annex H (Changes to Modelling Assumptions) to the EMR Delivery Plan⁷ describes the changes made to assumptions since the analysis carried out for the draft Delivery Plan published in July 2013.

Strike Prices in the period 2014/15 – 2016/17

7. Strike prices for 2014/15 – 2016/17 are set so that, given our current assumptions set out in paragraph 4, they are at broadly equivalent levels to the RO in order to enable a smooth transition between the instruments and avoid all investors preferring one or the other. We refer to this approach as “Renewables Obligation minus X” or RO-X.
8. The ‘minus X’ reflects the assumption that the required rate of return for a renewables project to proceed, the hurdle rate, is lower under the CfD than under the RO for most

³ PPA discounts on wholesale revenue and support payments have also been included in the modelling of the revenues of RO supported plants.

⁴ Here ‘imbalance costs’ refers to the overall costs of managing a generator’s contractual position between the reference market and delivery. For intermittent generators, this means the costs associated with managing the difference between generators’ forecast output 24 hours ahead of delivery and actual generation.

⁵ See footnote 2.

⁶ See Annex D, <https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan>

⁷ See Annex H, <https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan>

renewable technologies⁸. It also reflects PPA discount assumptions to reflect the reduced risks in CfD PPAs.

9. Calculating strike prices on the basis of RO-X involves the following steps:
 - I. Calculate, for each technology in each year, an RO range of the net present value (NPV) of lifetime costs of plants commissioning in that year based on plant capital, operating, fuel and financing cost estimates⁹. Variation in the supply curve is derived from low, central and high capital costs¹⁰, with other costs held constant;
 - II. Combine these costs with revenue assumptions¹¹ to determine the discounted NPV of the marginal investment under the RO¹²;
 - III. Calculate a range of costs under CfDs, based on the same cost assumptions, except for different financing costs under CfDs. Combine this with revenue assumptions under the new EMR arrangements and vary the strike price in £1 increments until the NPV of the same marginal investment under CfDs is as close as possible to that under the RO; and finally,
 - IV. Round strike prices to the nearest £5. ROC bands have been set in 0.1 ROC increments, with 0.1 ROC indicating a difference in support of around £5/MWh. All strike prices are therefore rounded to the nearest £5/MWh (2012 prices), to be consistent with this convention. The actual strike price paid to generators will then be updated in line with CPI inflation.
10. There are also a number of other considerations in the RO-X calculation for specific technologies:
 - Technologies that are grouped together in a single category under the RO are given a common strike price e.g. the different ACT technologies
 - Technologies that were limited by the offshore wind band in the Renewables Obligation Banding Review (ROBR¹³) get the same, or lower strike price as offshore¹⁴
 - The biomass conversion contract length is constrained to an end date in line with the RO (2027)

⁹ The costs included are pre-development, regulatory/licensing, capital, fixed operational costs, variable operational costs and fuel costs. Financing costs are included by discounting all costs/revenues at the appropriate technology and time specific hurdle rate.

¹⁰ See footnote 2.

¹¹ The revenues included are wholesale (assuming investors have 5 year foresight of wholesale prices), RO/CfD support payments, LECs, capacity market revenues and heat revenues where appropriate and adjusting for assumed PPA discounts.

¹² For technologies with no modelled economic build under the RO, the strike price is set so that the (negative) NPV of the cheapest plant is the same under CfDs as under the RO.

¹³ Government response to the consultation on proposals for the levels of banded support under the Renewables Obligation for the period 2013-17 and the Renewables Obligation Order 2012', DECC (2012)
<https://www.gov.uk/government/consultations/supporting-large-scale-renewable-electricity-generation>

¹⁴ In some cases the RO-X strike price for technologies that were linked to offshore wind in the ROBR will be lower than the offshore wind RO-X strike price. This is due to the technology specific hurdle rates that have been assumed.

- The landfill gas strike price is set at the expected level of the wholesale price, but also accounting for reductions in volatility of wholesale market revenues associated with CfDs, thereby offering a minimal support level. This is in line with the RO band of zero that open landfill gas sites receive under the RO. Strike prices have been set at the same level for open and closed landfill sites because the difference between the costs of the two types of landfill is marginal. A CfD is offered to give developers greater certainty about their revenue streams. A CfD is offered to landfill gas to capture the greenhouse gas reduction benefit of landfill gas resulting from its capture and combustion of methane.

11. Strike prices for all technologies are flat or degressing over time.

Box 1. Worked example: RO-X strike price components for a generic onshore wind generator commissioning in 2015/16

The following worked example demonstrates the components required to convert the level of support for a generic onshore wind farm commissioning in 2015/16 from 0.9 ROCs to a CfD strike price of £95/MWh. This calculation uses the assumptions described in paragraph 6; in reality different generators will face different costs and receive different revenues. It should be noted that the actual method used for calculating RO-X strike prices was as outlined in the text. This example is to illustrate the contribution of the different components.

Stage 1: Calculate the levelised revenue for a generator under the RO

Item	Amount (£/MWh)	Descriptor
Wholesale Revenue (post PPA discount)	£51	Amount that generator can expect to receive over the lifetime of their plant, i.e. PV^i (24 years wholesale revenue ⁱⁱ) / PV (24 years of generation)
ROC Revenue (post PPA discount)	£38	Amount that generator can expect to receive over the lifetime of their plant, i.e. PV (20 years of ROC revenue) / PV (24 years of generation)
Other revenues (LEC post PPA discount and Capacity Market Revenue)	£5	Amount that the generator can expect to receive over the lifetime of their plant from LECs, and after RO support ends from the Capacity Mechanism, i.e. PV (4 years of CM revenue and 24 years of LEC post PPA discount revenue) / PV (24 years of generation)
Lifetime Levelised Revenue (Under RO)	£94	£/MWh amount that the generator can expect to receive over the lifetime of their plant (using RO hurdle rate)

Stage 2: Adjust the RO levelised revenue for the key differences as a result of the CfD to get to the lifetime levelised revenue for the CfD

Hurdle Rate Impact	-£7	Reduced costs of financing for investors means that less revenue is required for the generator so support can be reduced
Lifetime levelised revenue required for the CfD	=£87	

Stage 3: Identify how much of the levelised revenue required needs to come from the strike price after accounting for other revenue streams if CfD contract lasted full lifetime (24 years)

Other revenues (LEC and CM Revenue)	-£6	Generators are assumed to be still entitled to LEC payments and so the strike price can be reduced by an equivalent amount. In addition Capacity Mechanism revenues are received after the end of the CfD contract.
Wholesale PPA Discount	+£6	Generators would not be able to achieve the levelised revenue if the strike price was set at this level due to a PPA discount on the wholesale price, making it less than the RO equivalent. Therefore the strike price must increase to ensure the same level of support.
Strike Price assuming support is spread over the life of the plant (24 years)	=£87	

Stage 4: Adjust the strike price for the shorter contract length

Contract Length Impact	+£8	Levelised revenue covers the whole lifetime of the plant. However, strike prices are based on support for only 15 years of operation, and therefore strike prices must be set at a higher level to compensate generators for this.
Strike Price	£95	

Stage 5: RO-X strike price for onshore wind in 2015/16 is £95.

ⁱPV = Present value. This gives the formula for levelised revenues, i.e. discounted revenues divided by discounted lifetime generation.

ⁱⁱWholesale price projections taken from National Grid's scenario 1, with 5 years' foresight applied. See footnote 5.

Strike prices in 2017/18 and 2018/19

12. In the years 2017/18 and 2018/19 strike prices are defined by factors including the affordability constraint presented by the LCF, as well as expectations of future technology costs.
13. There is significant uncertainty about how costs of certain technologies will evolve over time, due to learning from international or UK deployment. In general, estimates of the cost of different electricity generating technologies in the future are driven by expectations and assumptions of technology specific learning rates and deployment. The data sources referenced in reports from DECC (2013)¹⁵ and the System Operator (2013)¹⁶ set out more detailed information about learning and deployment scenarios used. In general, IEA projections are the main source of global deployment for all technologies¹⁷. Notable exceptions are ACT, marine and offshore wind.
14. For ACT technologies learning rates are driven by scenarios of technical potential for UK deployment as set out in Arup (2011)¹⁸.
15. Marine (tidal stream and wave) learning rates are derived endogenously within modelling, based on information set out in Ernst & Young (2010)¹⁹.
16. A further exception is offshore wind where costs follow the cost reduction profiles described in Annex H²⁰.
17. A further factor is the requirement to stay within the agreed LCF profile of expenditure. Strike prices need to be consistent with levels of deployment within this constraint.

¹⁵ See footnote 2.

¹⁶ See footnote 6.

¹⁷ IEA18 projections are the main source for global deployment and learning rates for most technologies

¹⁸ Parsons Brinckerhoff, Solar PV Costs Update, May 2012,

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43083/5381-solar-pv-cost-update.pdf

¹⁹ See

http://webarchive.nationalarchives.gov.uk/20121205174605/http://decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/explained/wave_tidal/798-cost-of-and-financial-support-for-wave-tidal-strea.pdf. Under this approach, a learning rate of 13.2% is used for wave, 13.0% tidal stream shallow and 12.5% for tidal stream deep, e.g. every doubling of cumulative wave deployment is associated with a reduction in costs of 13.2%.

²⁰ See footnote 7.

Comparison of support levels under the RO and CfDs

18. It is important that comparison of support levels between the RO and CfDs is carried out over a consistent time period because of the difference in the length of support.
19. The RO and CfDs can be compared by looking at the average support cost (per MWh) to society over the lifetime of the plant²¹. This is calculated by taking the present value of support payments and dividing by the present value of generation. The discount rate used is the social discount rate of 3.5%. Table 1 shows the difference in support costs for the RO and CfDs²² for key renewable technologies.

Table 1. Comparison of levelised support costs for key renewable technologies commissioning in 2015/16 under the RO or CfDs using the social discount rate

(2012 £/MWh)	Under the RO	Under CfDs	CfD saving
Onshore wind	37	21	16
Offshore wind	84	65	19
Biomass conversion*	44	40	4

*support for biomass conversions ceases in 2027 under both the RO and CfDs.

20. From the consumer perspective, three key factors drive the difference between the RO and CfD support in Table 1:
- Change in hurdle rate under CfDs;
 - The shorter contract length for CfDs; and
 - Wholesale electricity prices are increasing over time resulting in a declining profile of CfD top-up payments, compared to fixed RPI-linked payments under the RO.
21. To illustrate the uncertainty of support costs to future electricity wholesale prices we have also estimated the level of support under CfDs for a high fossil fuel prices/high wholesale price scenario and for a low fossil fuel prices/low wholesale price scenario. This results in a range of levelised support costs under CfDs (in 2012 £/MWh for projects commissioning in 2015/16) of £8/MWh to £35/MWh for onshore wind, £53/MWh to £80/MWh for offshore wind and £23/MWh to £59/MWh for biomass conversion.

²¹ This comparison refers only to RO and CfD support costs from the consumer perspective. If instead the levelised revenues (see footnote 11 for details of revenues considered) of a project under the RO and CfDs are compared using the investor hurdle rate, the difference between the two support mechanisms is significantly smaller, and defined by the reduced hurdle rate under CfDs, and any differences in PPA discounts. As an example, the difference for onshore wind commissioning in 2015/16 is £7/MWh. The comparison of support payments from a consumer perspective cannot be used to directly compare strike prices with support under the RO from the perspective of an investor.

²² To calculate the CfD support payments, the wholesale price projections from National Grid's scenario 1 were used.

22. To illustrate the assumed investor perspective, Figure 1 shows modelled investor expectations of revenues under the RO and CfDs for onshore wind commissioning in 2015/16. This is illustrative of the lower level of support under CfDs – although CfD support payments in early years are higher than under the RO, they do not increase over time. By contrast, RO payments increase each year as a result of RPI rather than CPI indexing, and are for 20 years compared to 15 years of CfD payments.

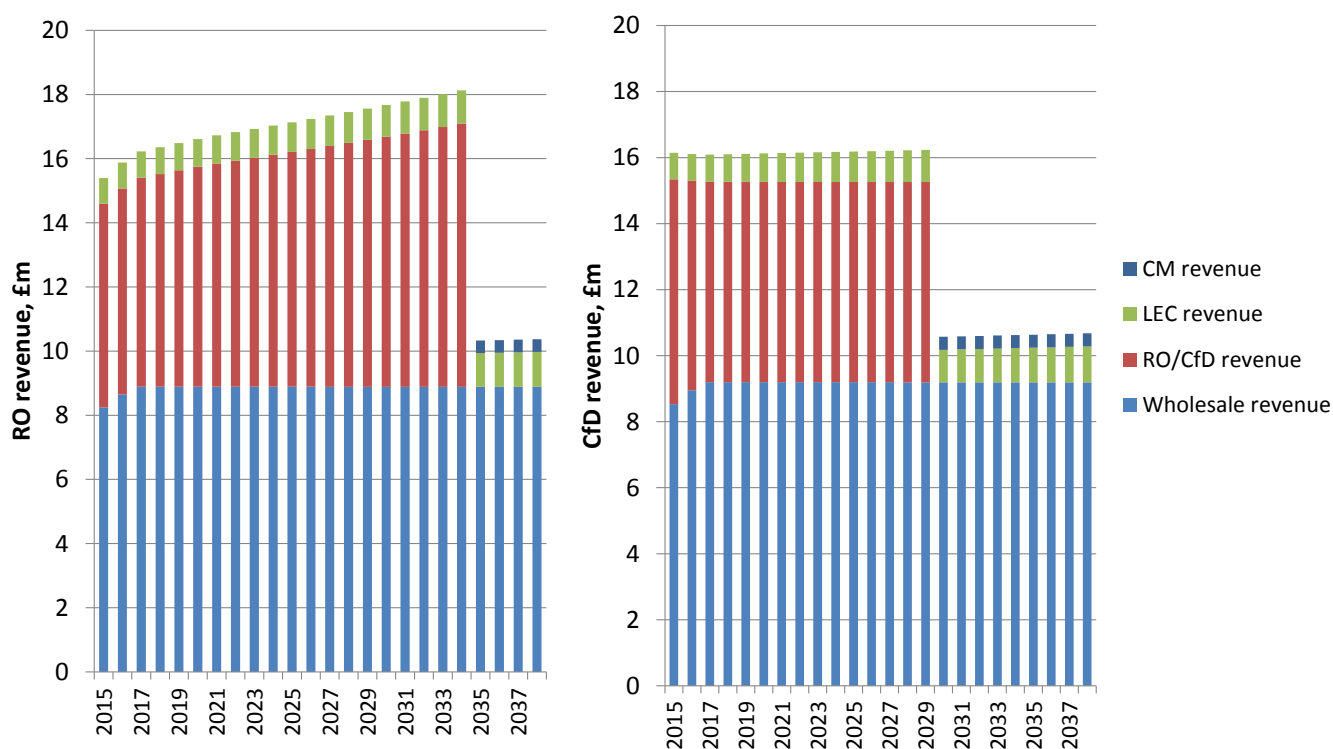


Figure 1. Modelled investor expectations of revenues for a generic onshore wind plant commissioning in 2015/16 under the RO (left) and CfDs (right) in CPI real terms.

Treatment of different risk allocation between the RO and CfD in setting of strike prices

23. DECC commissioned NERA Economic Consulting to review the existing evidence on the costs of capital assumptions under EMR. This involved NERA considering evidence from responses from the Draft Delivery Plan Consultation, Analyst Reports and Interviews with the finance industry. In addition, NERA quantified factors that these sources of evidence identified as changing the cost of capital under CfDs relative to the Renewables Obligation.

24. NERA assessed 4 factors that would change the cost of capital under CfDs relative to the Renewables Obligation:

- 'Wholesale Market Risk' – a lowering of revenue risk under CfDs due to reduced exposure to wholesale market prices relative to the RO;

- 'Allocation Risk' – a higher risk for developers of inability to take forward projects under constrained allocation and therefore losing pre-development costs. This increased risk is due to Government being more exposed to wholesale prices under the CfDs relative to the RO;
- 'Construction Delay' Risk – increased risk for projects with long construction times falling outside the CfD 'long stop date' and into a period of constrained allocation; and
- 'Novelty Premium' - initial premium due to uncertainties about how the mechanism and its institutions and the will work in practice.

25. This is reflected in the hurdle rate reduction assumptions (please see Annex H²³ for more details on assumptions used in the EMR Delivery Plan)

²³ See footnote 7.

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