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Contracts for Difference: the Instrument of Choice for the Energy Transition

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Introduction

Contracts for Difference ("CfDs") are increasingly seen as the method of choice for incentivising investment in low-carbon projects and new technologies. Previously known mainly as a financial hedging instrument, CfDs have become more widely known as a source of success for the accelerated development of offshore wind in the UK. They also play a central role in European attempts to reform electricity markets to accommodate increasing levels of renewable generation in several countries. Both the UK's ongoing Review of Electricity Market Arrangements ("REMA") and the EU's Electricity Market Reform identify CfDs as a key instrument for decarbonising electricity generation.

The UK, the EU, several EU Member States and, increasingly, other countries around the world have recently announced (or reaffirmed) their intention to prioritise CfDs to support investment in renewable energy projects. Following the successful experience with CfDs in renewables, it has been recognised that the CfD concept may be suitable for applications beyond electricity generation. Work is underway to develop and scale up CfD-based business models for clean hydrogen and carbon capture and storage ("CCS"), and there is scope for a wider use of CfDs for low-carbon solutions as the energy transition progresses.

But what are CfDs and why are they becoming increasingly important for clean energy projects?

This paper explains the concept of CfDs and compares this instrument with other support mechanisms for clean energy deployment. It highlights the reasons why CfDs have been favoured over other support schemes and addresses some of the key perceived challenges that could affect their uptake beyond the power sector. It then discusses the market experience with CfDs to date and provides an outlook on the future role of CfDs in accelerating the energy transition.

1. What are CfDs?

CfDs have many uses in financial and energy markets. In this paper we discuss CfDs as risk management tools for clean energy projects. In this context, CfDs mainly serve as instruments to provide price support for emerging technologies and to encourage desired behaviours, such as investment by private actors in more sustainable production methods. By providing stability and predictability of future revenue streams, CfDs encourage investment in new projects that might otherwise take many years to develop or not come to market at all if they were solely dependent on volatile market prices.

There is no single definition of a CfD, and distinctions are sometimes made between its different forms.

In this paper we focus on two-way (or two-sided) CfDs, which are fast becoming the most common form of CfD for clean energy projects. The European Commission has explained this concept as follows:

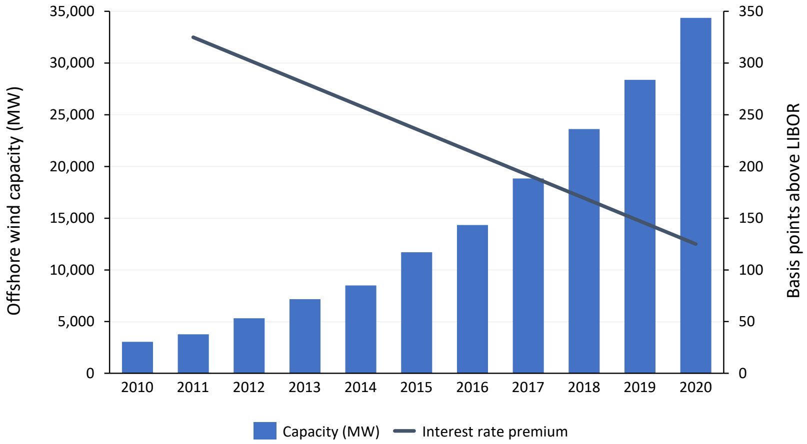
> *"A **two-way contract for difference** is a **contract signed between an electricity generator and a public entity**, typically the State, which sets a strike price, usually by a competitive tender. The generator sells the electricity in the market but then settles with the public entity **the difference between the market price and the strike price**. It thus allows the generator to receive a stable revenue for the electricity it produces, while at the same time it provides a revenue limitation for generators when market prices are high. **In a two-way CfD, if the market price is below the strike price, the generator receives the difference; if the market price is above the strike price, the generator pays back the difference."**[1]*

The defining feature of CfDs is the difference between the market price and the strike price agreed in advance with the CfD counterparty.

[1] European Commission, "Questions and Answers of the revision of the EU's internal electricity market design," 2023, https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_1593 (emphasis added).

CfDs enable new renewable generation projects to avoid the volatility of wholesale electricity markets and to achieve a stable long-term revenue profile over the term of the contract. A stable and predictable long-term revenue profile can be desirable for a number of reasons. In the case of renewable energy projects in particular, this stable revenue profile makes it easier for these projects to be developed using a project finance structure, i.e. to be financed using a leveraged debt structure created specifically for the project. In this type of structure, lenders rely solely on the project's cash flows for repayment (meaning the debt is 'non-recourse'). This approach is commonly used for infrastructure projects and is attractive to institutional investors with a long-term investment profile. The long-term nature of these investments allows lenders to offer lower interest rate premiums and longer debt tenures, thereby reducing the cost of capital for projects and creating a virtuous circle that reduces the cost of energy over time as more projects are developed, as shown in the chart below for offshore wind projects.

Figure 1: Financing premium cost reduction for offshore wind projects (2010-2020)



Source: FTI Consulting based on data from WindEurope (2020)

To illustrate the practical importance of CfDs in enabling offshore wind project financing, on average between 33% and 50% of new capacity in Europe has been financed through this mechanism over the past 15 years, in several countries bordering the North Sea.[2] Stabilising the revenue profile of renewable power projects through the use of CfDs and making these projects acceptable to be financed with non-recourse debt is also important as these projects have a different risk profile than fossil-fuelled power projects, with relatively high upfront costs that can leave the project exposed during its operational cycle if wholesale power prices are lower than expected.[3]

Looking to the future, with some estimates suggesting that more than 380 GW of new offshore wind capacity could be added over the next 10 years[4], this would require a call for an average of more than $40 billion of debt finance per year to achieve this goal.[5] Without the use of revenue stabilisation mechanisms such as CfDs, it may not be possible to mobilise this level of debt finance. As more investment is directed towards the deployment of new clean energy projects, the role of CfDs as an enabler underpinning the availability of project finance in this area will only increase.

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[2] PFI, "Offshore wind debt 15 years on", 2021, https://www.pfie.com/story/3151364/offshore-wind-debt-15-years-on-cqwp8mbjh8

[3] Beiter, P., Guillet, J., Jansen, M. et al, "The enduring role of contracts for difference in risk management and market creation for renewables", Nature Energy, 2024.

[4] GWCEC, "Global Offshore Wind Report", 2003, https://gwec.net/gwecs-global-offshore-wind-report-2023/

[5] Assuming an average cost of USD 3 million per MW for Capital Expenditure (Capex) and 40% of debt finance.

2. CfDs in comparison with other support mechanisms

2.1 The role of government support in facilitating clean energy projects

Most support mechanisms have been introduced to incentivise the development of new renewable generation. These support schemes generally aim to provide price protection to developers, either through a fixed minimum price or through a top-up to prevailing market prices. The aim is to encourage the deployment of a desirable technology that is still too expensive to compete on its own with prevailing market alternatives. This was certainly the case with the first renewable power plants (solar and wind), which were more expensive per unit of electricity produced than than power plants that produced electricity using fossil fuels (coal, gas and oil).

In principle, the aim of using incentive mechanisms for new technologies - either direct subsidies or price stabilisation mechanisms - is to accelerate the deployment of these technologies and make them competitive over time. The support mechanisms may become redundant once the new technologies are able to compete on their own merits in the open market. As more of a desired technology is deployed its costs will go down through economies of scale and learning curve effects, driving competitiveness against legacy technologies. This logic underpins the desire to use lessons learnt from support schemes in the power sector into other relevant decarbonisation technologies, such as clean hydrogen and CCS.

A key question for governments that want to incentivise the deployment of clean energy technologies is how to fund the support schemes that will provide price support or price stabilisation. In general, there are three alternatives available to fund these schemes: (1) through general taxation and the use of the government budget, (2) through levies (fees) charged directly to consumers (consumers of electricity in the power sector, for example), and (3) through a specific fund set up specifically for this purpose.

Funding the support schemes through general taxation and the government national budget might be undesirable because it is very difficult for governments to ring-fence the required budget to support the deployment of a technology against all other competing asks for government expenses and investment. It can be also challenging for governments to keep consistency on investment from one budget planning exercise to the next, and from one government term to the next.

The most common way of funding the support schemes is through specific fees to consumers of the product that needs an increased supply (e.g. electricity consumers) or levies on consumers of the products that governments want to phase out (e.g. natural gas). However, there are trade-offs to consider when enacting direct taxation on consumers, such as how to calibrate the tax burden between households and industry, for example, or how to avoid overburdening consumers of one product (e.g. electricity) while keeping customers of another product (such as natural gas) insulated from the full cost of decarbonisation measures.[6] These choices have wider potential economic impacts, for example in the areas of industrial investment and job creation.

In an attempt to avoid the pitfalls of relying on the national budget and to protect consumers from higher taxes, some countries are creating specific funds for energy transition efforts. These funds, such as Germany's Climate and Transformation Fund (*Klima- und Transformationsfonds*)[7], serve to fund the support schemes that will provide specific budgets for clean energy support mechanisms. To ensure that these funds have the required reserves, they can be funded from a variety of sources, such as income from national emissions trading of CO_2 credits or income from government-auctioned leases (e.g. from offshore wind leases).

[6] Karimu, A., Bali Swain, R. , "Implication of electricity taxes and levies on sustainable development goals in the European Union", Science Direct, 2023, https://www.sciencedirect.com/science/article/pii/S0301421523001386
[7] Die Bundesregierung, "170 billion euros for energy supply and climate protection", 2022, https://www.bundesregierung.de/breg-de/themen/deutsche-einheit/klima-und-transformationsfonds-2065714

2.2 Different types of support mechanisms: alternatives to CfDs

There are several types of support mechanisms that have been implemented over time to support the deployment of renewable power generation, from Feed-in-Tariffs (“FiTs”) to Feed-in-Premiums (“FiPs”). In the table below we compare the key mechanisms and alternatives to CfDs and highlight their key characteristics:

Table 1: Key characteristics of government support schemes - alternatives to CfDs

Mechanism	Also Known As	Stable Minimum Price	Price Ceiling	Price Allocation	Contracted Volume
Feed-in-Tariff (“FiT”)	---	Yes	Same as minimum price	Administrative process	Variable
Power Purchase Agreement (“PPA”)	---	Yes	Same as minimum price	Auction (government) bilateral negotiation (corporate)	Fixed
Contract for Difference (“CfD”)	- Two-way CfD - Two-sided CfD - Two-sided FiP - Two-sided Sliding Premium	Yes	Same as minimum price	Administrative process/ auction	Variable
Feed-in-Premium (“FiP”)	- One-way CfD - One-sided CfD - One-sided FiP - One-sided Sliding Premium	Yes	No	Auction	Variable

Source: Authors

Feed-in Tariffs (“FiTs”)

FiTs started being used in the power sector during the late 1970s in the US to incentivise the development of renewable power generation technologies. They have gradually become a common way to support the growth of renewable energy installations in many countries.

FiTs guarantee a fixed rate for the electricity generated from renewable sources, usually a price that is typically higher than prevailing market prices and are paid to renewable energy producers for a specific duration (typically from 15 to 25 years). A generator receives a fixed price for each megawatt-hour (“MWh”) of electricity produced and the fixed-rate tariff is typically set through an administrative process.

The key advantage of FiTs is that they are simple mechanisms. The government sets the rules for producers to qualify for the scheme and then commits to paying the tariffs when production starts. The tariff is calculated based on the estimated cost of production for a given technology. Due to their simplicity, FiTs are also more accessible to smaller producers.

By providing revenue certainty to developers, FiTs serve to lower the overall project risk. This encourages more developers to come to the market and makes more finance available at a lower cost, even though the volume of production is still a risk. FiTs also have a special place in incentivising the adoption of a specific technology when there is no market mechanism, either because the technology is so new that no market exists for it (early adoption), or because there is a centralised system of resource allocation in place, for example, where there is a single entity that is vertically integrated and responsible for managing the power production, transmission and distribution in a given country.

The disadvantages of the FiT mechanism are directly related to its simplicity. Governments have limited ability to anticipate technological developments and cost reductions over time as more projects deploy a given technology. Although cost reductions indicate the success of technology deployment, costs can change significantly over time. This means that governments may end up paying a tariff that is too high and giving developers a windfall profit that distorts the market.

Another limitation of FiTs is that it is challenging for governments to forecast and limit the number of projects that might qualify and the total production capacity that will be developed. This can result in market cannibalization, for example, if too much solar power is generated during the middle of the day. This, in turn, can lead to a huge budget overrun by governments that fail to properly calibrate the adoption of FiTs and end up having to spend way more on this support scheme than originally expected. Countries that have attempted to rectify this situation retrospectively (e.g. Spain) have generated numerous legal disputes illustrating the risks of regulatory change in relation to government support schemes.[8]

Power Purchase Agreements ("PPAs")

A PPA is a contract between a power producer and a buyer. The agreement stipulates that the buyer (often utilities or corporations) will purchase energy from the producer at a fixed price for a specified period of time (usually 5 to 10 years, but longer-term PPAs can exceed 10 years). Although PPAs are not exclusive to renewable energy projects, they have become a well-known tool for buyers to procure renewable energy to meet their sustainability goals.

The PPA defines the terms of the agreement, such as the amount of power to be supplied, the negotiated price, how the power supply is measured (accounting rules) and the nature of penalties for non-compliance. PPAs can be tailored to the specific needs of the buyer and seller, and the contracted electricity can be physically delivered, if there is a direct connection between the parties, or it can be a virtual delivery, if there is no direct connection and the delivery is made through a third-party network.

PPAs can provide revenue predictability and risk mitigation to enable projects to secure development finance, particularly debt finance. They have also become a popular tool for large offtakers to mitigate their risk and lock in the price of electricity for a longer period than the wholesale market is prepared to offer. Due to their bilateral nature, PPAs can offer flexible contractual terms to the parties. Because of their perceived benefits, PPAs have become an important tool for companies seeking to source 100% of their electricity from renewable sources (the RE100 initiative).

A disadvantage of PPAs is that they can be complex to negotiate, precisely because of their bespoke nature. Structuring a PPA can require in-depth knowledge of energy markets and a long negotiation period, which increases the relative cost of setting up these contracts. In addition, if PPAs are overly prescriptive in terms of power supply (especially baseload PPAs), they can also lead to financial distress if the seller has to compensate for unforeseen events (such as lower than forecast wind or solar irradiation) with purchases from the wholesale power market or pay financial penalties to the buyer.

Feed-in-Premiums ("FiPs")

FiPs, also known as one-way (or one-sided) CfDs, have been used in a growing number of jurisdictions since the mid-2010s as a mechanism to incentivise the development of renewable generation and to overcome some of the distortions of the previously dominant FiTs.

FiPs compensate generators for low electricity prices up to agreed strike prices and leave the market upside to be captured by the producers in case the wholesale electricity prices are above the strike price. This guarantee of a minimum price for renewable projects provides the necessary de-risking of project revenues to make projects bankable (i.e. to incentivise investors, especially debt lenders, to provide the required financing for new projects).

By their nature, FiPs also protect consumers from overcompensating generators when electricity prices are above the agreed strike price. It is important to distinguish between FiPs that pay a sliding premium (i.e. the difference between the prevailing wholesale electricity price and the strike price as long as the strike price is above the market price) and incentive mechanisms that provide a fixed premium paid on top of market prices. Confusingly, some fixed premium mechanisms are sometimes referred to as FiPs. Examples include Production Tax Credits ("PTCs") in the US and various types of Guarantees of Origin ("GoOs") or Renewable Energy Certificates ("RECs"), which are paid as an agreed premium to renewable energy producers to certify that the electricity they produce is indeed from renewable sources. In this paper, we only consider FiPs as the more widely used sliding FiP mechanism.

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[8] See Maynard S., Ason. A., "Sovereign Risk in International Renewable Energy Investments: Key Lessons from Oil & Gas Disputes", Euromoney's Expert Guide – Rising Stars 2018, International Arbitration, UK, 2018.

FiPs share several advantages of CfDs, such as better public budget use, by limiting the amount that needs to be “topped up” to generators to the agreed strike price, and lower operational complexity being a straightforward mechanism to implement and understand the mechanics. But FiPs fail in comparison to CfDs on the consumer fairness metric, especially at times when electricity prices surge to very high levels.

The way that most wholesale electricity markets work is by setting the price at the short-run marginal unit of production – or the last power plant that needs to start production to fully meet the demand at a given time. These are usually coal or gas-fired power plants, in which the production costs are higher than for renewables. When fossil fuels – especially natural gas – prices are abnormally high, as happened throughout 2022, the marginal price of electricity in power markets might also increase in a similar steep way to keep supply and demand balanced.

Abnormally high electricity prices could bring unexpected windfall profits to renewable power producers (and these windfall profits might be perceived as unfair by consumers). To get around the perceived unfairness, governments are pressed to create new windfall profit taxes to cap the abnormal profits of renewable generators. But these new taxes, adopted in part because of how the FiTs and FiPs mechanisms work, also end up creating market distortions and increasing the risk to developers. This is precisely what happened across Europe in 2022, when the curtailment of gas imports from Russia led to a sharp rise in gas prices and, by extension, electricity prices. In some markets, prices rose by four or five times (and in some cases more) from their recent long-term trends. Unexpected windfall profits for energy companies, including low-carbon utilities, prompted a backlash from governments across the continent, with new windfall profits taxes introduced in the UK and several EU countries.[9]

2.3 Advantages and limitations of CfDs compared to other support mechanisms

CfDs have been used to provide the necessary support for the deployment of new clean technologies and to overcome some of the limitations of other support mechanisms such as FiTs, PPAs and FiPs.

In our view, the three main advantages of CfDs over other support mechanisms are:

1) better public budget use,
2) lower operational complexity, and
3) inherent consumer fairness.

The better use of public money comes from the fact that government budgets to be allocated to CfDs can be better targeted to incentivise the desired development of clean technologies, without the risk of budget overruns that have occurred on several occasions with FiT schemes. And by providing a stable revenue profile for projects, CfDs enable private finance to play a greater role in the required investment in new technologies. Much of the success of CfDs`(in the UK and elsewhere - is due to the fact that the stable revenue profile, combined with falling technology costs and increasing construction expertise, has reduced risk perceptions and consequently allowed greater competition for investment in new projects, reducing the risk premium demanded by lenders.

Two key considerations for the implementation of CfDs are how the scheme will be funded and how the contract system will be managed. As mentioned above, the funding of a CfD scheme can either be socialised through general taxation or shared only with electricity consumers through a levy on electricity tariffs. The second consideration in the implementation and operationalisation of a CfD support scheme is the choice that policymakers have to make between having a specific, typically public, entity either pay the support scheme when prices are low or collect payments from generators when prices are high, or assigning this responsibility to a government department. Either way, the operationalisation of CfD schemes is generally less complex than support schemes such as FiTs and PPAs, as the number of CfD contracts is more limited and tends to be allocated to larger projects. The allocation of contracts is also a simpler process, whether through direct allocation or competitive auctions.

[9] Reuters, “Windfall tax mechanisms on energy companies across Europe”, 2022, https://www.reuters.com/business/energy/windfall-tax-mechanisms-energy-companies-across-europe-2022-12-08/

As noted above, another key advantage of CfDs is customer fairness. Because CfD strike prices are locked from the outset, and because in periods of high price governments capture the difference between the wholesale market price and the strike price paid back by generators, consumers are protected from having to provide excessive support and governments avoid the pitfall of the unfairness perception that befalls the support schemes in times of high electricity prices that generate profit windfalls as can happen with FiT and FiP schemes.

Limitations of CfD schemes

CfD support schemes are not without limitations. The key ones worth mentioning are:

1) the potential for market distortion,
2) excessive focus on cost reduction, and
3) lower adaptation flexibility.

The potential for market distortion is not necessarily inherent to CfDs, but as the number of CfDs allocated in a given market grows they start crowding out other potential route-to-market options such as corporate PPAs, for example, that are important to develop a power market that is driven more by private instruments rather than government-sponsored support schemes. CfDs are also in general location-agnostic, especially if allocated through competitive auctions, and can exacerbate issues with overproduction of renewable electricity in certain regions, and drive down the power price in these regions – a problem known as a low capture price – and at an extreme overgeneration can drive prices into negative territory and force generators to stop (or curtail) their production to keep the supply and demand of electricity in the grid balanced. To avoid this issue, the design principles of CfDs and how they can be used most effectively to incentivise markets are actively being discussed both as part of the UK's REMA and as part of the EU Electricity Market Design reform process.[10]

The second issue with CfDs is that, because of their inception as a pure financial instrument, their functioning is based on settling differences between some chosen reference price index (usually a weighted average of market prices) and the strike price agreed in the contract. Given the CfD benefits to reduce project risks by providing a long-term stable revenue profile to projects, governments have used CfDs to force cost reductions of new renewable projects over time, by limiting the maximum strike price in successive cohorts of contracts, and thus limiting any support that is required and at the same time increasing the value accrued to consumers.

The issue with this focus on cost reduction by bringing down the strike prices, which at times can become excessive, is that it forces developers to look for ways to deliver the projects within the allocated budget. This could limit potential investments developers could make in local supply chain capabilities, could limit community benefits, and it could limit innovative technologies that could be developed. And, in the absence of other restrictions, it could stimulate the import of standard components from abroad instead of creating a manufacturing capacity in-country as most governments would like to do to create sustainable "green jobs."

This leads to a third limitation of support mechanisms in general, in which CfDs suffer as they become more prevalent: the difficulty in adapting the mechanism as the context changes. Approving the contract terms and conditions and deciding the budgets that will be assigned to CfD allocations take time, and so does agreeing the allocation mechanism, especially in the context of an auction. Given the time lags involved, CfDs are rather inflexible when the industry cost context changes in a short space of time, as happened throughout 2022 and 2023. The discussion on whether and how the support mechanism should be adapted to take account of the additional factors that governments want to be addressed, like supply chain development, for example, becomes a protracted debate that could limit societal benefits by the time any new contracts and allocation mechanisms are in place.

Finally, CfDs work around a given reference price index. In electricity markets the reference price is some form of weighted average of wholesale power prices calculated over a period of time, from a monthly average to a half-hour depending on the market and on the type of contract offered. This

[10] Compass Lexecon, "Unlocking the power of contracts for difference (CfDs) to accelerate the energy transition", 2023, https://www.compasslexecon.com/cases/unlocking-the-power-of-contracts-for-difference-cfds-to-accelerate-the-energy-transition/

reference works well for CfDs that are meant to stimulate the development of new renewable power generation projects but could lead to challenges when CfDs are used as the support mechanism of choice for new clean energy solutions that lack a transparent and widely adopted reference price, such as with hydrogen. The best example of this challenge is the fact that the first CfDs offered in the UK under the Hydrogen Production Business Model ("HPBM") use a weighted average of sales contracts (achieved sales price) that uses natural gas prices as a floor to calculate the reference price.[11] The business model has created an incentive for price discovery over time as hydrogen production and offtake agreements begin to be agreed.[12] This illustrates that CfDs alone can be a good contracting mechanism, but the choice of reference price index is a design choice that is still controversial in the electricity market and is certainly not straightforward in the case of other clean energy technologies.

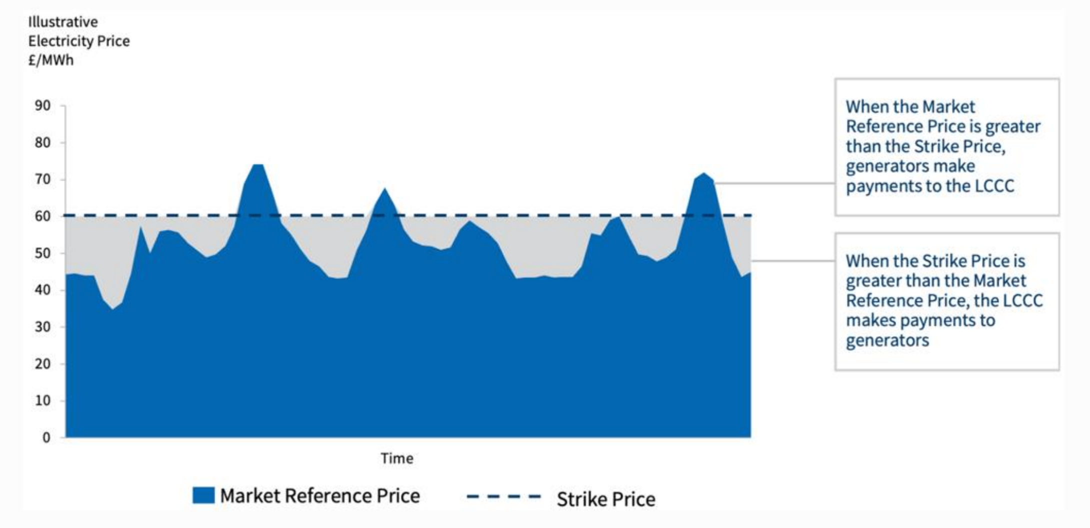
3. The use of CfDs to date

3.1 The UK experience as a primary reference point

CfDs were first developed[13] and introduced in the UK as part of the 2013 Electricity Market Reform. Having replaced the Renewables Obligation, CfDs have become the government's main mechanism for supporting low-carbon generation. They have been instrumental in accelerating the deployment of renewable generation and the pace of decarbonisation in the country over the past decade.[14]

UK CfDs are private law agreements between generators and the government-owned counterparty, the Low Carbon Contracts Company ("LCCC"), which is also responsible for settling the contracts. If the market price for electricity generated by a CfD generator is below the strike price specified in the contract, the LCCC makes payments to the generator to make up the difference. However, if the market price is above the strike price, the generator pays the LCCC the difference. This is illustrated by the chart below.

Figure 2: CfD mechanism in the UK



Source: FTI Consulting

[11] DESNZ, "Hydrogen Production Business Model", 2023, https://www.gov.uk/government/publications/hydrogen-production-business-model

[12] RenewableUK, "Demystifying the Hydrogen Business Model for Electrolysis", 2023, https://www.renewableuk.com/news/656766/Demystifying-the-Hydrogen-Business-Model-for-Electrolysis.htm

[13] Department for Energy & Climate Change, "Planning our electric future", 2011, https://assets.publishing.service.gov.uk/media/5a78b0dce5274a2acd1890be/2176-emr-white-paper.pdf

[14] In 2022, the UK's total greenhouse gas emissions were almost half those of 1990, and CO_2 emissions from electricity generation in 2022 were more than 70% lower than in 1990. DESNZ, "2022 UK greenhouse gas emissions, provisional figures", 2023, https://assets.publishing.service.gov.uk/media/6424b8b83d885d000fdade9b/2022_Provisional_emissions_statistics_report.pdf

The payments, and repayments, paid and received by the LCCC for the CfD scheme are passed on to consumers' electricity bills.[15]

CfDs are awarded for 15 years through auctions to allow competition between technologies and help keep prices low. The government sets a budget in advance, then sealed bids of strike prices submitted by developers are accepted sequentially from the lowest to the highest until the budget is exceeded. In April 2023, the government launched a consultation process on the introduction of criteria other than cost for assessment as part of its allocation process for CfDs. The purpose of introducing non-price factors ("NPFs") is to incentivise projects and developers to deliver broader value to society and the environment across the wider supply chain, rather than simply rewarding the lowest cost projects. In response to the call for evidence, the government has identified the NPFs that are potentially appropriate for valuation under the CfD auction process, including innovation, sustainability, and capacity building.[16] The UK government intends to introduce these NPFs from Allocation Round ("AR") 7, which is scheduled for 2025, onwards.

To date, there have been five competitive auctions for CfD capacity. The results of the first round (AR1) were announced in February 2015, and the results of the fifth round (AR5) were announced in September 2023. The auctions were preceded by investment contracts awarded to renewable projects (offshore wind and biomass) in 2014. CfDs are also being used to support nuclear generation in the UK[17], with the main terms of the CfD for Hinkley Point C (which is expected to deliver 3.2 GW of clean electricity generation capacity from 2025) agreed back in 2013.

To date, most of the capacity (including 95-96% of the capacity awarded in AR2 and AR3) was offshore wind.[18] Strikingly, in 2023, AR5 received no bids from the offshore wind sector.[19] While some considered the auction a failure, given the pressing need to accelerate the development of offshore wind capacity was not fulfilled, AR5 still managed to tender contracts to almost 2 GW of solar PV projects and to almost 1.5 GW of onshore wind projects. The lack of bidders in the offshore wind sector provided much needed information about the mismatch between expected cost reductions assumptions by the UK government and the reality of an industry that was navigating a changed context with increased interest rates and higher supply chain costs. The results served to illustrate the shortcomings of the CfD allocation process and triggered a review of the process and of the budget required to accelerate new offshore wind projects in the changed cost context.

The sixth allocation round (AR6) opened on 27 March 2024. The range of eligible technologies is represented by the chart below, with Pot 1 for the "established technologies," Pot 2 for the "emerging technologies" and Pot 3 reserved for offshore wind projects.

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[15] The CfD allowance added a total of around £75 to typical domestic electricity bills over the period April 2019 to December 2023. House of Commons, "Contracts for Difference Research Briefing," 2023, https://researchbriefings.files.parliament.uk/documents/CBP-9871/CBP-9871.pdf.

[16] DESNZ, "Introducing a CfD Sustainable Industry Reward", 2024 https://www.gov.uk/government/consultations/introducing-a-contracts-for-difference-cfd-sustainable-industry-reward

[17] FTI Consulting, "New Regulatory Frameworks Are Supporting Nuclear Plant Financing", 2023, https://www.fticonsulting.com/insights/fti-journal/new-regulatory-frameworks-supporting-nuclear-plant-financing (discussing the UK approaches to de-risking and making nuclear investments possible).

[18] The auctions for offshore wind contracts were examined in a paper by the OIES that conducted empirical analysis of the auction outcomes (from 2014 and 2017) and provided insights into the overall efficiency, benefits, and potential pitfalls of the scheme. See Welisch, M., Poudineh, R., "Auctions for allocation of offshore wind contracts in the UK", OIES, 2019, https://www.oxfordenergy.org/publications/auctios-allocation-offshore-wind-contracts-difference-uk/.

[19] Offshore Wind Biz, "Offshore Wind Developers Take a Pass on UK's Fifth CfD Round as Maximum Bid Price was Too Low", 2023,https://www.offshorewind.biz/2023/09/08/offshore-wind-developers-take-a-pass-on-uks-fifth-cfd-round-as-maximum-bid-price-was-too-low/

Figure 3: Eligible technologies for AR6 in the UK

Pot 1
- Onshore Wind (>5MW)
- Solar PV (>5MW)
- Energy from Waste with CHP
- Hydro (>5MW and <50MW)
- Landfill Gas
- Remote Island Wind (>5MW)
- Sewage Gas

Pot 2
- Advanced Conversion Technology
- Anaerobic Digestion (>5MW)
- Dedicated Biomass with CHP
- Floating Offshore Wind
- Geothermal
- Tidal stream
- Wave

Pot 3
- Offshore Wind

Source: Department for Energy Security and Net Zero ("DESNZ")

After the results from AR5 in the offshore wind sector, the UK government decided to increase the budget available for the AR6 process to more than £1 billion (an almost five-fold increase from the AR5 budget, and the largest budget of any CfD round yet). However, despite this impressive increase in budget some concerns remain about the underlying methodology used to calculate how much of the budget can be used to support new offshore wind capacity. This illustrates the challenge of adapting a CfD allocation process to a changing context, a fact that needs to be recognised and addressed if this support mechanism is to be used more widely across a wider range of clean energy technologies.

3.2 CfDs in EU Member States

Outside the UK, CfDs have been used to support clean energy projects mainly within the EU. A recent study found that CfDs have so far been used in nine EU Member States: **France, Spain, Denmark, Greece, Hungary, Ireland, Italy, Poland**, and **Portugal**.[20]

In October 2023, the European Commission approved a CfD scheme notified by **Lithuania.**[21] The measure (first presented as a draft law in 2020[22]) should support the roll-out of renewable offshore wind in the country with CfDs awarded through a competitive bidding process for 15 years. Following the approval by the European Commission, Lithuania's National Energy Regulatory Council ("NERC") opened an offshore wind tender in January 2024 (the country's second, but the first applying the CfD scheme), which is currently looking for a developer of a 700 MW offshore wind farm in the Baltic Sea**.**[23]

In March 2024, a large-scale (**€**3 billion) CfD scheme proposed by **Romania** was cleared by the European Commission.[24] The scheme is applicable to two types of technologies, solar photovoltaic and onshore wind installations, subject to several requirements. These include that the installed capacity of eligible projects must entirely comprise new electricity generation capacity and utilise only onshore wind or solar technology. The CfDs will be issued by the Romanian Electricity and Gas Market Operator ("OPCOM") for 15 years. The first two rounds of auctions, each with separate tenders for eligible onshore wind and solar power generation technologies, aim at a total capacity of 5 GW.[25] The first tender was initially planned for the autumn of 2023 but got delayed because of the

[20] Florence School of Regulation, "Contracts-for-Difference to support renewable energy technologies: Considerations for design and implementation", 2024, https://fsr.eui.eu/publications/?handle=1814/76700#:~:text=A%20key%20design%20question%20for,private%20capital%20for%20renewable%20energy

[21] European Commission, "Commission approves €193 million Lithuanian scheme to support offshore wind farms to foster the transition to a net-zero economy", 2023, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3843

[22] Offshore Wind Biz, "Lithuania Opts for CfD Offshore Wind Auction Scheme," 2020, https://www.offshorewind.biz/2020/09/03/lithuania-opts-for-cfd-offshore-wind-auction-scheme/

[23] Montel News, "Lithuania launches 2nd offshore wind auction for 0.7 GW", 2024, https://montelnews.com/news/1535190/lithuania-launches-2nd-offshore-wind-auction-for-07-gw

[24] European Commission, "Commission approves €3 billion Romanian State aid scheme to support onshore wind and solar photovoltaic installations to foster the transition to a net-zero economy", 2024, https://ec.europa.eu/commission/presscorner/detail/en/ip_24_1329

[25] Schönherr, "Romania launches new renewables CfD support scheme targeting 5 GW of onshore wind and solar capacities", 2023, https://www.schoenherr.eu/content/romania-launches-new-renewables-cfd-support-scheme-targeting-5-gw-of-onshore-wind-and-solar-capacities/

prolonged clearance process. The second tender is scheduled for 2025. According to press reports, the plan is to award CfDs to 10 GW of wind and solar capacity by 2030.[26]

A CfD scheme is under development in **Belgium**, where a "two-sided CfD system is [being] installed to replace the existing one-sided CfD system."[27] The new CfD scheme will be applied to the upcoming tender for offshore wind projects in the Princess Elisabeth Zone in the English Channel. The bids will be evaluated based on two award criteria: (i) the offered strike price, which will have a relative weight of 90% in the tender evaluation, and (ii) the "business model innovation", to which the remaining 10% weight will be attributed. Business model innovation essentially refers to the realisation of an increase in citizen participation above the minimum of 1% of the project's capex[28] and, as such, serves as an example of a non-price criterion (which reflects the trend, noted above for the UK, to incorporate NPFs into the CfD allocation process).

According to the reports, CfDs are currently considered for clean energy projects in other EU countries (for example, in **Estonia**[29] and **Slovenia**[30]).

3.3 CfDs in other jurisdictions

Outside the EU, CfDs have been used sparingly to support clean energy projects.

For example, in **Albania**, the first auction for CfDs for power purchases from wind farms, was held in 2013. Three bidders have been awarded a total of 222.5 MW in capacity for projects between 10 MW and 75 MW.[31] In neighbouring **Serbia**, the first auction for CfDs took place in 2023, with the total of 400 MW capacity awarded to four wind power projects. The auction for solar projects was under-subscribed (with only 11.6 MW awarded out of 50 MW available). The price ceilings were €105/MWh for wind and €90/MWh for solar but, due to the low turnout, the lowest solar bid landed higher than the one for wind power (€88.65/MWh against €64.48/MWh). The winners of the auctions were offered to sign 15-year CfDs.[32] The second renewable energy auction in Serbia is scheduled for 2024.[33]

In December 2023, **Norway** received clearance from the EFTA Surveillance Authority ("ESA") monitoring compliance with European Economic Area ("EEA") rules for up to kr23 billion (€2.04 billion) in state aid in the form of CfD for the Southern North Sea II offshore wind farm project. The auction opened on 18 March 2024. Five applicants have been approved for the auction, where the qualified players compete for state support by submitting increasingly lower bids until one bidder remains. The winning bid will determine the strike price that forms the basis of the CfD (with a term of 15 years).[34]

Outside Europe, CfDs have been applied, for example, **Australia**. At a state level, CfDs have been utilised for years within the Victorian Government's Victorian Renewable Energy Target ("VRET"), in the context of development of renewable energy projects with the Victorian Government. Currently, CfDs

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[26] Renewables Now, "Romania to soon launch CfD auction for 2 GW of wind and solar", 2023, https://renewablesnow.com/news/romania-to-soon-launch-cfd-auction-for-2-gw-of-wind-and-solar-830464/

[27] Allen & Overy, "The tender principles for the development of the Belgian offshore Princess Elisabeth Zone", 2023 https://www.allenovery.com/en-gb/global/news-and-insights/publications/the-tender-principles-for-the-development-of-the-belgian-offshore-princess-elisabeth-zone

[28] Clifford Chance, "Belgian offshore wind – upcoming tendering of the Princess Elisabeth Zone", 2023, https://www.cliffordchance.com/briefings/2023/07/belgian-offshore-wind---upcoming-tendering-of-the-princess-elisa.html

[29] European Commission, "Draft update of Estonia's National Energy and Climate Plan for 2030", 2023, https://commission.europa.eu/system/files/2023-08/Estonia_Draft_Updated_NECP_2021-2030_en_1.pdf

[30] Montel Energetika, "Slovenia should turn to CFDs to boost renewables – minister", 2024 https://www.energetika.net/eu/novice/trading/slovenia-should-turn-to-cfds-to-boost-renewables-%E2%80%93-m

[31] European Bank, "Albania announces results of first onshore wind auction", 2023, https://www.ebrd.com/news/2023/albania-announces-results-of-first-onshore-wind-auction.html

[32] Balkan Green Energy News, "Serbia awards CfDs for 400 MW in wind power capacity, 11.6 MW for solar in first auctions", 2023, https://balkangreenenergynews.com/serbia-awards-cfds-for-400-mw-in-wind-power-capacity-11-6-mw-for-solar-in-first-auctions/

[33] PV Magazine, "Serbia to auction at least 400 MW of wind, solar", 2024, https://www.pv-magazine.com/2024/02/29/serbia-to-auction-at-least-400-mw-of-wind-solar/

[34] Norwegian Government, "Five applicants qualified for the offshore wind auction for Sørlige Nordsjø II", 2024, https://www.regjeringen.no/en/aktuelt/five-applicants-qualified-for-the-offshore-wind-auction-for-sorlige-nordsjo-ii/id3025843/

are becoming relevant to a national roll-out in Australia, which is expected to underwrite projects that will bring a total of 32 GW of clean energy capacity to the market. According to press reports, the Commonwealth plans to establish a CfD mechanism whereby bidders will offer a strike price and payments will flow in two directions based on the difference between this strike price and the spot price on the National Electricity Market ("NEM"), which covers Australia's major interconnected states.[35]

4. Future use of CfDs

4.1 New CfD schemes: wider geographic and technological reach

New CfD schemes are currently either planned or under development in several jurisdictions. This applies both to countries that have already used CfDs and those that are only considering them as new support schemes. An example of the former category is France, which has a robust market experience with renewable CfDs (since 2016) and where CfDs are now reportedly proposed for nuclear energy.[36] As noted above, work on CfD schemes is underway in other European countries, and increasingly in other parts of the world. One example is New Zealand, where CfDs feature prominently in consultation documents submitted as part of the process of developing a regulatory framework for offshore renewable energy[37] and are seen as a compelling option for the local market, which has significant offshore potential but very few customers who could sign PPAs to provide a similar level of commercial de-risking for projects.[38]

Recent work on CfDs outside Europe will change the role (and common perception) of CfDs as a Europe-centric support scheme. In a parallel development, discussed below, CfDs are no longer exclusively focused on renewable and nuclear power generation, but are increasingly applicable to low-carbon solutions.

For any new CfD scheme, a detailed legal, regulatory and contractual framework needs to be put in place (and, at least in the EU/EEA context, cleared for state aid.) The whole process spanning from legislative proposals to the actual contracts, typically takes several years and involves multiple stakeholders, including through public consultations of the scheme. When considering CfDs as a revenue support mechanism for clean energy projects, governments need to address a number of questions about how to finance, structure and manage the schemes. Experience with CfDs to date provides useful precedents, including on the CfD allocation process and optimal contract terms. There is also a growing body of research focusing specifically on the design of CfDs.[39]

New CfDs will be introduced into a pre-existing regulatory landscape and measured against the industry's previous local experience, good or bad,[40] with other support schemes. Particularly for new markets and applications, the success of CfDs will largely depend on how quickly investors can become familiar and comfortable with the relevant legal and contractual framework.

In the long term, one of the key considerations for a successful CfD scheme will be how to manage the instrument in a changing market environment. CfDs need to provide legal certainty to the market, but as such need to be continually refined to fully reflect prevailing market conditions and the state of

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[35] Energy Storage News, "Biggest energy policy change': 32GW CfDs could put Australia on track for 2030 climate targets", 2024, https://www.energy-storage.news/biggest-energy-policy-change-32gw-cfds-could-put-australia-on-track-for-2030-climate-targets/

[36] Montel News, "France should consider CfD for nuclear output: experts", 2024, https://montelnews.com/news/8ca0ab94-f596-4652-9e83-6797d9c6ff97/france-should-consider-cfd-for-nuclear-output-experts

[37] Ministry of Business, Innovation and Employment, "Developing a Regulatory Framework for Offshore Renewable Energy: Second Discussion Document", 2023, https://www.mbie.govt.nz/dmsdocument/26913-developing-a-regulatory-framework-for-offshore-renewable-energy-pdf

[38] BusinessNZ Energy Council, "Can New Zealand Afford Offshore Wind Energy? We can't afford to ignore it", 2023, https://bec.org.nz/category/resources/

[39] See, for example, ENTSO-E, "Position Paper on Sustainable Contracts for Difference Design", 2024, https://www.entsoe.eu/2024/02/20/position-paper-on-sustainable-contracts-for-difference-design/

[40] See Del Río, P., Mir-Artigues, P., "A Cautionary Tail: Spain's Solar PV Investment Bubble, International Institute for Sustainable Development", 2014, https://www.iisd.org/gsi/sites/default/files/rens_ct_spain.pdf

development of the relevant technologies. The challenge will therefore be how to maintain CfDs within the pre-defined timeframe and, if necessary, how to modify them in a way that does not infringe on the rights of their beneficiaries. The availability and status of CfDs may be subject to change, which needs to be factored into the investment risk.

Eventually, CfDs in their current form will be phased out, as is usual with support schemes for any new technology, most likely when the fundamentals of clean energy projects improve to the point where they can be fully market driven, including through long-term market procurement mechanisms such as PPAs. The need to define the relationship between CfDs and PPAs in jurisdictions that apply both instruments is becoming a pressing issue (and reflects the increasing use of both mechanisms).

4.2 The growing role of CfDs for low-carbon solutions

Following the successful experience with CfDs, it has been recognised that the CfD concept may be suitable for applications beyond power generation. Work is already in progress in the UK, the EU and in other regions on CfD-based business models for clean hydrogen and CCS, initially to be applied to one of these technologies but potentially evolving into multi-technology schemes.

Hydrogen

The business case for clean hydrogen relies on government policy to drive decarbonisation. There are several relevant forms of government support, including FiTs and PTCs. The CfD concept is one of the options for government support for hydrogen projects, but not a straightforward one. As noted in a recent paper summarizing the main conclusions of OIES hydrogen research to date: “The [CfD] scheme works well in the electricity industry where there is a clearly defined market price. Lack of an established market for clean hydrogen adds an additional complexity, but the UK government has been developing innovative solutions to achieve a similar result.”[41]

UK Hydrogen Production Business Model (“HPBM”)

In the UK (where the government’s ambition is to deliver 5 GW of low-carbon hydrogen production capacity by 2030[42]), the consultation on the design of a low-carbon hydrogen business model started in 2021 and resulted in the development of the HPBM.[43]

The HPBM is designed to incentivise the production and use of low-carbon hydrogen by providing producers with revenue support to overcome the operating cost gap between low-carbon hydrogen and fossil fuels. Modelled after the CfD for renewable power, the HPBM is implemented through the Low Carbon Hydrogen Agreement (“LCHA”), a private law contract signed between a hydrogen producer and the LCCC. Following the renewable CfD precedent, the LCHA runs for a term of 15 years.

Revenue support under the HPBM is only provided for hydrogen volumes which: (i) comply with the Low Carbon Hydrogen Standard (“LCHS”), (ii) are sold to Qualifying Offtakers (volumes sold for export, blended into the natural gas grid, or sold to a Risk-Taking Intermediary are not qualifying) and (iii) are not sold and subsequently claimed under the Renewable Transport Fuel Obligation (“RTFO”) scheme. These conditions should ensure that only low-carbon hydrogen is supported, and that the value of this decarbonisation accrues to the UK and not to traders taking speculative positions in the emerging hydrogen market. It also ensures that volumes of hydrogen claimed under the RTFO are not supported under the HPBM in order to avoid overcompensation and market distortions.

The LCHA effectively guarantees that even if producers cannot sell their hydrogen at a price high enough to recoup their cost of production and make an agreed return on investment then the counterparty will top them up to that level. The difference amount is calculated as the difference between

[41] See Lambert M., “Clean Hydrogen Roadmap: Is greater realism leading to more credible paths forward?”, OIES, 2023, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2023/09/Clean-Hydrogen-Roadmap-ET25.pdf

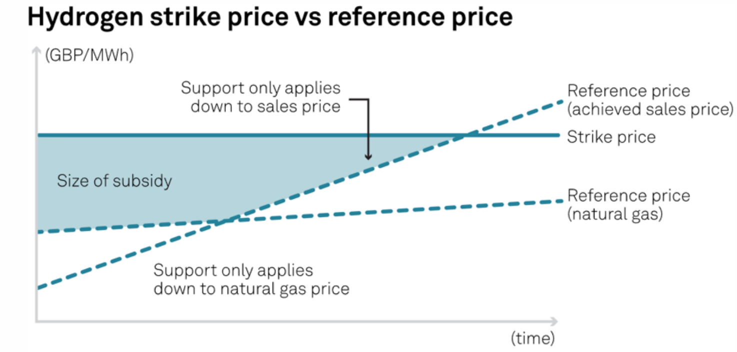
[42] UK Government, “Energy white paper: Powering our net zero future”, 2020, https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future

[43] UK Government, “Hydrogen production business model”, 2022, https://www.gov.uk/government/publications/hydrogen-production-business-model

the strike price (which is agreed by DESNZ at pre-contractual negotiations) and the reference price (which represents the market value of the hydrogen sold). The strike price is indexed to protect producers from cost changes beyond their control – for electrolytic producers, the strike price is indexed to Consumer Price Index ("CPI"), for CCS-enabled projects, the natural gas costs in the strike price are indexed to a natural gas benchmark and the non-gas costs to CPI.

The payment mechanism under the LCHA is illustrated by the figure below.

Figure 4: Payment mechanism in the LCHA



Source: DESNZ

The LCHA will not allow the producer to fully recoup its costs where hydrogen is sold below the prevailing natural gas price, i.e. at a discount relative to the closest fossil fuel alternative. If producers do sell below the prevailing natural gas price, then any revenue support payable will be paid up from that prevailing natural gas price.

The work on implementing the HPBM is in progress. In December 2023, the UK government awarded 11 green hydrogen projects with a total capacity of 125 MW CfDs at a strike price of £241/MWh, as a result of the first Hydrogen Allocation Round (HAR1).[44] The second Hydrogen Allocation Round (HAR2) was launched shortly afterwards, for contracts of up to 875 MW. Both allocation rounds are expected to help meet the government's target of up to 1 GW of electrolytic hydrogen production projects in operation or under construction by 2025.[45]

CfDs for hydrogen projects in the EU

In the EU, the discussion on CfDs for hydrogen projects has gained prominence in the context of the H2Global scheme introduced in Germany. Not a CfD as such, but an instrument using CfD-like logic, H2 Global is designed to help bridge the gap between supply and demand prices for clean hydrogen.[46]

A notable recent development in the EU is that the CfD concept is increasingly understood as an instrument relevant to both production and incentivizing demand for clean hydrogen. For example, France will allocate €4 billion for the deployment of 1 GW of electrolysis capacity through CfDs by 2026. According to government materials, CfDs should set a price for a kilogram of low-carbon hydrogen that is guaranteed to be competitive with grey hydrogen and will be awarded through "a transparent, non-discriminatory auction reflecting European best practice." [47] The auctions will aim at the award of public support for a period of 15 years for the construction and operation of hydrogen production units based on water electrolysis. According to the latest updates, the tender process will be open to applicants

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[44] DESNZ, "Notice: HAR1 successful projects", 2023 https://www.gov.uk/government/publications/hydrogen-production-business-model-net-zero-hydrogen-fund-shortlisted-projects/hydrogen-production-business-model-net-zero-hydrogen-fund-har1-successful-projects

[45] DESNZ, "Second Hydrogen Allocation Round (HAR2) Application Guidance Document", 2022, https://assets.publishing.service.gov.uk/media/657b07c30467eb001355f853/hydrogen-allocation-round-2-application-guidance.pdf

[46] H2Global, "The H2 Global Instrument", 2024, https://www.h2-global.de/project/h2g-mechanism

[47] Ministry of Economics and Finance, "Investing in decarbonization infrastructure in France", 2023, https://www.economie.gouv.fr/files/files/2023/DP_Paris_deep_decarbonisation_EN.pdf

established in the EU and EEA that intend to “build and operate a unit to produce renewable or low-carbon hydrogen by electrolysis of water on French territory.”[48] The procedure is expected to consist of three phases: (i) the selection of candidates to participate in the competitive dialogue; (ii) the competitive dialogue (for a maximum of five participants); and (iii) the selection of the winning projects. In the final phase, 70% of selection criteria will be weighted on price, with the remaining 30% based on non-price elements (to be determined through a consultation process).[49] The planned scheme is understood to target major industry players and projects with a capacity greater than 30 MW identified for fuel refining, synthetic fuel production and direct industrial use without blending in France. The first auction for 150 MW is expected to be launched in 2024 (with a second auction for 250 MW in 2025 and the third and final one under the scheme for 600 MW in 2026).[50]

At EU level, CfDs have been considered as one of the possible design options for the European Hydrogen Bank.[51] The pilot auction for the European Hydrogen Bank that opened in November 2023 (and attracted 132 bids from projects located in 17 European countries) was for a fixed premium subsidy for up to 10 years and only upon certified and verified renewable hydrogen production.[52] Nevertheless, CfDs can be considered for a competitive bidding process at the EU level at a later stage, especially when a reference clean hydrogen price is determined.[53] According to the reports, CfDs are also considered by the European Commission for a EU-wide scheme to support the purchase of green hydrogen for offtakers. This mechanism would ensure that green hydrogen is no more expensive to a buyer than grey hydrogen produced from unabated fossil fuels, or possibly, depending on the framework, no more expensive than the equivalent amount of natural gas, and so the mechanism would be "slightly different from standard CfDs", which are normally applied to production rather than consumption.[54]

CfDs for hydrogen projects in Asia

CfDs are emerging as a mechanism to unlock the hydrogen economy in Asia, with CfD schemes in preparation in Japan and South Korea.[55] The legislative process appears to be more advanced in Japan, where the government plans to use CfDs for both domestically produced and imported low-carbon hydrogen. The government will set a reference price for hydrogen and the beneficiaries of the scheme will receive a top-up payment if the market price falls below the reference price. Conversely, they will need to pay back the difference if the market price exceeds the reference price. According to the reports, the reference price will to be based on the highest of three options: (1) the price of raw materials and fuels that will be displaced by low-carbon hydrogen arriving in Japan (such as liquified natural gas or coal); (2) this price plus a measure of “environmental value”, and (3) the actual sales price of grey

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[48] BMH Avocats, “France’s new green hydrogen support mechanism: an opportunity for European players?”, 2024 https://bmhavocats.com/2024/02/15/energie-frances-new-green-hydrogen-support-mechanism-an-opportunity-for-european-players/

[49] Hydrogen Insight, “France to launch 4bn contracts-for-difference programme to support clean hydrogen production”, 2023, https://www.hydrogeninsight.com/policy/france-to-launch-4bn-contracts-for-difference-programme-to-support-clean-hydrogen-production-reports/2-1-1508431

[50] Hydrogen Insight, “France unveils plan for 6.5GW of ‘low-carbon electrolytic hydrogen’ by 2030 in draft update of national H2 strategy”, 2023, https://www.hydrogeninsight.com/policy/nearly-9bn-france-unveils-plan-for-6-5gw-of-low-carbon-electrolytic-hydrogen-by-2030-in-draft-update-of-national-h2-strategy/2-1-1573875

[51] Konrad Adenauer Stiftung, Design Options for a European Hydrogen Bank, 2023, https://www.kas.de/en/single-title/-/content/gestaltungsoptionen-fuer-eine-europaeische-wasserstoffbank

[52] European Commission, “European Hydrogen Bank pilot auction: 132 bids received from 17 European countries”, 2024, https://climate.ec.europa.eu/news-your-voice/news/european-hydrogen-bank-pilot-auction-132-bids-received-17-european-countries-2024-02-19_en

[53] Deloitte, “Actualizing the green hydrogen economy”, 2023, https://www2.deloitte.com/content/dam/Deloitte/de/Documents/sustainability/Deloitte_Actualizing-green-hydrogen-economy.pdf

[54] Hydrogen Insight, “European Commission is considering Contracts for Difference for green hydrogen offtakers”, 2023, https://www.hydrogeninsight.com/policy/exclusive-european-commission-is-considering-contracts-for-difference-for-green-hydrogen-offtakers/2-1-1561729

[55] S&P Global, “Clear guidelines, formation of CfD schemes likely to unlock Asian hydrogen market in 2024”, 2023, https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/122923-clear-guidelines-formation-of-cfd-schemes-likely-to-unlock-asian-hydrogen-market-in-2024

hydrogen (or its derivatives) in existing markets.[56] The scheme should increase the likelihood of offtakers committing to purchase volumes, thereby providing financial certainty to investors. According to industry insights, several projects are currently awaiting the introduction of the scheme, with the first CfDs expected to be awarded in 2024.

CfDs for hydrogen projects in other regions

The discussion on using CfDs to support hydrogen projects is currently starting in other parts of the world. For example, in Canada, CfDs have been considered for the Canada Growth Fund as a potential investment tool, which, according to government materials, "can help manage perceived uncertainty around, for example, the evolution of a carbon price or of the price of a product, such as hydrogen.".[57] Interestingly, in the US (where CfDs are not permitted as financial instruments due to regulatory issues), "pay-for-difference contracts" that provide support to projects based on the price they can achieve in the market have featured as one of the options for a demand-side support mechanisms for H2Hubs.[58]

There is certainly scope for considering CfDs to incentivize hydrogen economy in other jurisdictions.

CCS

CCS is a key mitigation technology for the global energy system to reach its net zero target but several characteristics and risks make financing CCS projects challenging. In response to those challenges, governments have adopted different approaches as they attempt to establish a sustainable CCS market through contributing capital and sharing costs and risks (that range from "minimal" to "full" government control options, as discussed in a recent paper on CCS business models published by the OIES[59]).

In the UK, CCS plays a key role in the Net Zero Strategy and there has been significant government involvement in the development of the CCS market. CfD-based business models for CCS projects in the UK are still under development but it is worth highlighting that work on them started earlier than on those for low-carbon hydrogen.

The first consultation on the Dispatchable Power Agreement ("DPA"), the planned contractual framework for power generation with CCS, took place in 2019, with the indicative Heads of Terms ("HoTs") published in 2020.[60] In a nutshell, the DPA is a private law contract between a carbon-emitting power generator and the LCCC, based on the standard terms and conditions of the CfD for the AR4 and adapted to enable natural gas-fired CCS power plants to play a mid-merit role in meeting electricity demand, displacing unabated thermal power plants. Departing from the usual 15-year contract term for renewable CfDs, generators have flexibility to choose an appropriate term length for the DPA that is between 10 and 15 years (regardless of whether developing a new build, repowered or retrofit project).[61]

The Industrial Carbon and Capture Contract ("ICC Contract"), which is another relevant contractual framework for CCS projects, has been drafted to offer consistency with the AR4 CfD and the DPA. Many provisions of the earlier CfD contracts have been included in the HoTs (published in 2021[62]), subject to minor alterations (e.g. references to 'generator' have been changed to 'emitter'), with other areas

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[56] Hydrogen Insight, "Japan to offer CfD-style subsidfies for domestic and imported hydrogen next year – with strict conditions", 2023, https://www.hydrogeninsight.com/policy/japan-to-offer-cfd-style-subsidies-for-domestic-and-imported-hydrogen-next-year-with-strict-conditions/2-1-1568229

[57] Department of Finance, "Canada Growth Fund", 2022, https://www.budget.canada.ca/fes-eea/2022/doc/gf-fc-en.pdf

[58] Department of Energy, Office of Clean Energy Demonstrations, "Bipartisan infrastructure law: additional clean hydrogen programs", https://oced-exchange.energy.gov/Default.aspx#FoaId8e15135b-a033-47ca-9c7a-ebf2e5771a41

[59] Fattouh B., Muslemani H., Jewad R., "Capture Carbon, Capture Value: An Overview of CCS Business Models", OIES, 2024, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2024/02/CM08-Capture-Carbon-Capture-Value_Final.pdf

[60] DESNZ, "Dispatchable Power Agreement: Heads of Terms", 2020, https://assets.publishing.service.gov.uk/media/5fe08422d3bf7f3a32aae08f/ccus-business-models-annex-d-dpa-heads-of-terms.pdf

[61] DESNZ, "Dispatchable Power Agreement: Business Model Summary", 2022, https://assets.publishing.service.gov.uk/media/6373993e8fa8f559604a0b8b/ccus-dispatchable-power-agreement-business-model-summary.pdf

[62] DESNZ, "Industrial Capture and Storage Contract: Heads of Terms', 2021, https://assets.publishing.service.gov.uk/media/615c63c88fa8f52982a86011/icc-indicative-heads-terms-october-2021-annex-b.pdf

requiring substantial amendments to cater for the bespoke elements of the ICC business model. In essence, the ICC Contract is a private law contract between the emitter and the LCCC, which is for a 10-year term with the option for a five-year extension (subject to certain conditions). Like for the DPA, several updates on the proposed contract design for the ICC Contract have been published to date.[63]

Another example for the application of the CfD concept to CCS projects is the Danish scheme to support the roll-out of CCS technologies, which was approved by the European Commission in 2023.[64] Under the scheme, the aid will be awarded through a competitive tendering procedure and open to companies active in any industrial sectors (including the waste and energy sectors) that could demonstrate a project able to capture and store a minimum quantity of 0.4 million tonnes per annum from 2026. The aid will cover the difference between the estimated total costs of capturing and storing a tonne of CO_2 over the lifetime of the contract and the return expected by the beneficiary. The first contract was awarded in 2023, covering up to 20 years of project operation. Future contracts are expected to be for 15 years.[65]

Multi-technology schemes

The examples of support schemes discussed above focus on a single technology and apply to either hydrogen or CCS. This approach can be explained through the difference in business models for the relevant technologies but, at a later stage, it is feasible that CfD schemes for low-carbon solutions, like is common for renewable CfD schemes, will be applicable to two or more technologies (potentially grouped into different categories or "pots" in the allocation process).

An example of a multi-technology approach is the Dutch SDE++ scheme, which applies to five technology categories: renewable electricity, renewable heat, renewable gas, low-carbon heat, and low-carbon production. For all but CCS technologies, the SDE++ scheme is a put-option based on energy prices. Awarded projects obtain a strike price for renewable energy for a period of 12 or 15 years. Only for CCS, the SDE++ benchmarks an emission reduction strike price (€ per tonne of CO_2 reduced) instead of an energy strike price. CCS installations receive the difference between emission allowance revenues and the strike price as long as the revenues per ton captured are lower than the strike price. The CCS Porthos project (aiming to permanently store the emissions captured in the Port of Rotterdam offshore), which was awarded SDE++ funding in 2021, took Final Investment Decision in October 2023. This recent development should accelerate the process of gaining practical experience with the SDE+ contracts. To date, feedback from industry and academia was reportedly mixed, including concerns that two different award mechanisms within one support scheme may have led to unequal funding distribution across different projects.[66]

In the most recent and widely publicised development, in March 2024, the German government launched the first bidding round of its estimated €50 billion scheme for so-called "Climate Protection Contracts" *(Klimaschutzverträge)*, which work as Carbon Contracts for Difference ("CCfDs").

The German CCfDs will offer payments for 15 years to industrial players (such as steel and chemicals producers) to switch to using green hydrogen, CCS, or other low-emissions methods of production. The scheme will also indirectly incentivise investment in the production of a green hydrogen infrastructure, such as hydrogen production plants and pipelines.[67]

Under the scheme, winning bidders, selected on their promise to save the most carbon at the lowest price, would be guaranteed a strike price for using the lower-carbon option, in the form of a top-up

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[63] See DESNZ, "Industrial Carbon Capture Business Models Update", 2023, https://assets.publishing.service.gov.uk/media/652eb3b56b6fbf000db75852/ccus-iccc-business-models-update-october-2023.pdf

[64] European Commission, "State aid: Commission approves €1.1 billion Danish scheme to support roll-out of carbon capture and storage technologies", 2023, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_128

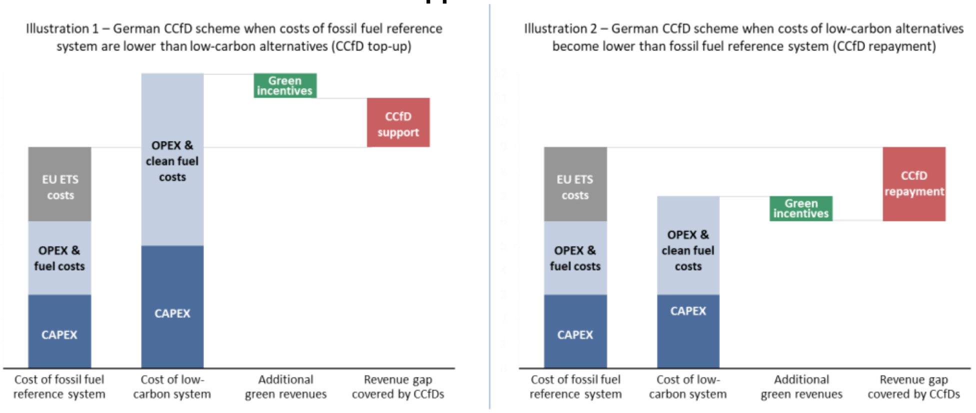
[65] Clean Air Task Force, "Designing Contracts for Difference", 2024, https://www.catf.us/resource/designing-carbon-contracts-for-difference/

[66] For a discussion, see Climate Strategies, "Carbon Contracts for Differences (CCfDs) in a European Context", 2022, https://henrike-hahn.eu/files/upload/aktuelles/dateien/Study_CCfD_Henrike-Hahn_6.2022.pdf

[67] Hydrogen Insight, "Germany opens first €4bn bidding round for Carbon Contracts for Difference", 2024, https://www.hydrogeninsight.com/industrial/hydrogen-in-industry-germany-opens-first-4bn-bidding-round-for-carbon-contracts-for-difference/2-1-1612591

payment from the government based on the prevailing cost of the higher-carbon option, including any existing price on carbon under the EU Emissions Trading System ("ETS"). In essence, this top-up subsidy would make the low-carbon option the same price to the end user as the high-carbon option. However, if the greener option becomes cheaper, the situation is reversed. If the cost of manufacturing using low-carbon alternatives becomes cheaper than the existing fossil fuel-based alternative at a given point in time, the symmetric nature of CCfDs would ensure repayment of the difference, as shown in the figure below. This crossing point is expected to occur as EU ETS credits become more expensive over time and the cost of clean technologies (such as hydrogen) decreases as the market grows.

Figure 5: Illustration of the German CCfD support scheme



Source: Authors

The German CCfDs include an early termination option after three years in the event that low-carbon production becomes cheaper than the alternative. The early termination feature is important as governments experiment with CfD-type instruments in different markets. One of the biggest challenges in creating a functioning market for clean hydrogen is exactly how to incentivise demand, given that early movers[68] may be wary of committing to long-term contracts, knowing that the cost of low-carbon products (e.g. low-carbon hydrogen) will fall over time. The early termination feature attempts to address this delicate balance by offering long-term support contracts that are in place when prices are too high but can be terminated when the competitive market starts to drive prices down. The UK HPBM model attempts to address the same challenge in a slightly different way by providing incentives in the CfDs for hydrogen producers to work with their offtakers (and customers) to bring prices down over time.

4.3 The interplay between CfDs and CCfDs

In policy discussions, CfDs increasingly tend to overlap with CCfDs in the context of low-carbon solutions.

CfDs and CCfDs have the same underlying logic (and function in a similar way as a price hedge), but they prioritise different objectives. Specifically, CfDs have been used to provide stable, long-term revenue support for the development of new clean energy technologies. CCfDs, on the other hand, aim to bridge the costs of implementing desired decarbonisation initiatives, mainly in the heavy industry sector. For new clean technologies such as low-carbon hydrogen, they both aim to create a competitive market where one does not exist in a meaningful way currently, but while production CfDs aim to boost supply, CCfDs (and potential similar instruments) aim to bridge the cost gap to increase demand and overcome the reluctance of first adopters.

The interplay between CfDs and CCfDs will be tested by market evidence. At present the policy choice between CfDs and CCfDs largely depends on whether governments wish to incentivise market development and risk allocation through the supply side (CfDs) or the demand side (CCfDs). However, this basic distinction between supply- and demand-side instruments is no longer so clear-cut since, as

[68] See Craen S., "Financing a world scale hydrogen export project", OIES, 2023, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2023/01/Financing-a-world-scale-hydrogen-export-project-ET-21.pdf

noted in the hydrogen example above, CfDs can potentially be used to stimulate demand for hydrogen and CCfDs (at least indirectly) to stimulate investment in the production of hydrogen infrastructure. Ultimately, as with most clean energy options, both instruments will be needed to accelerate the energy transition, and the advantages and disadvantages of CfDs and CCfDs will become clear and will be adjusted over time as more countries adopt these alternatives.

5. Conclusions

The diversity of support schemes is currently increasing, as more jurisdictions have started or upgraded their energy transition-related support measures. The UK, the EU, several EU Member States, and other countries have recently announced (or reasserted) their intention to prioritize CfDs for supporting investment in renewable and low-carbon projects.

In the power sector, the CfD mechanism has emerged as the preferred arrangement to provide the required revenue support and stimulate the construction of new renewable power generating facilities. CfDs help to overcome limitations and distortions caused by the previous generation of support schemes, such as FiTs and FiPs, providing better value for money for governments and enabling projects to be de-risked and funded by the private sector. CfDs also offer lower implementation and operational complexity than PPAs, even though the novel use of CfDs to provide revenue support for hydrogen production might show that this fact is dependent on the existence of a market for the product to provide a reference price than on the CfD mechanism itself. CfDs also help governments to address the fiscal fairness issue that bedevils other technology support schemes by providing a cap on the amount of support to be provided and by collecting differences in times of high prices.

However, CfDs should not be seen as a silver bullet for decarbonization as they have their own limitations. For example, they can generate market distortions and crowd out other market-driven initiatives such as corporate PPAs. And, if used to drive down the price of production too fast (such as with power generation), the focus on cost reduction can cause unwanted consequences in the local supply chain and even reduce the number of local jobs required instead of increasing them. Also because of the high expectations that CfDs address a myriad of desired outcomes, they have been burdened by ongoing discussions on how to add more dimensions to the allocation or the functioning of the mechanism, which, at its heart, is a price hedge. New designs of CfD contracts are being debated to address the perceived shortcomings of CfDs and how they can be used to effectively support the evolution of, for example, electricity markets. Another example and direction of reform is the discussion on the use of "non-price factors" alongside purely financial metrics in the allocation of CfDs.

The general expectation is that over time required revenue support mechanisms will be phased out in favour of pure market mechanisms However, given the pressing need to accelerate investment in energy transition solutions, in the short-term the opposite will be true, with the demand for more (and more effective) revenue support having to be offered not only to renewable power projects but to other clean energy solutions such as hydrogen and CCS. Over the past decade, the growing demand for support schemes for clean energy has created a favourable environment for the introduction of CfDs. Applying the CfD approach to low-carbon solutions and other emerging uses will bring new challenges (e.g. in terms of the design of new CfDs and their interaction with other support schemes), but will also offer the benefit of building on the experience and lessons learned from the use of CfDs to date.

In a historical context, as a new-generation approach to facilitating low-carbon generation, increasingly replacing other support schemes, CfDs have become a widely used instrument at a remarkable pace. Over time, the use of CfDs for clean energy projects has only increased, and there is no evidence that the instrument has been withdrawn in any country. There is also a growing understanding of the need to introduce new schemes and reform existing CfDs to respond to changing market circumstances. Recent work on CfDs outside Europe will change the role of CfDs as a Europe-centric support scheme. In parallel, CfDs for renewables will increasingly coexist with those for other clean energy projects. Overall, momentum for CfDs is building and the recent acceleration of work on CfD schemes suggests that there is scope for CfDs to be introduced in more jurisdictions and for a wider range of clean energy technologies. As an increasingly important support scheme to facilitate the global energy transition, CfDs will become an integral part of future energy markets in the coming years.