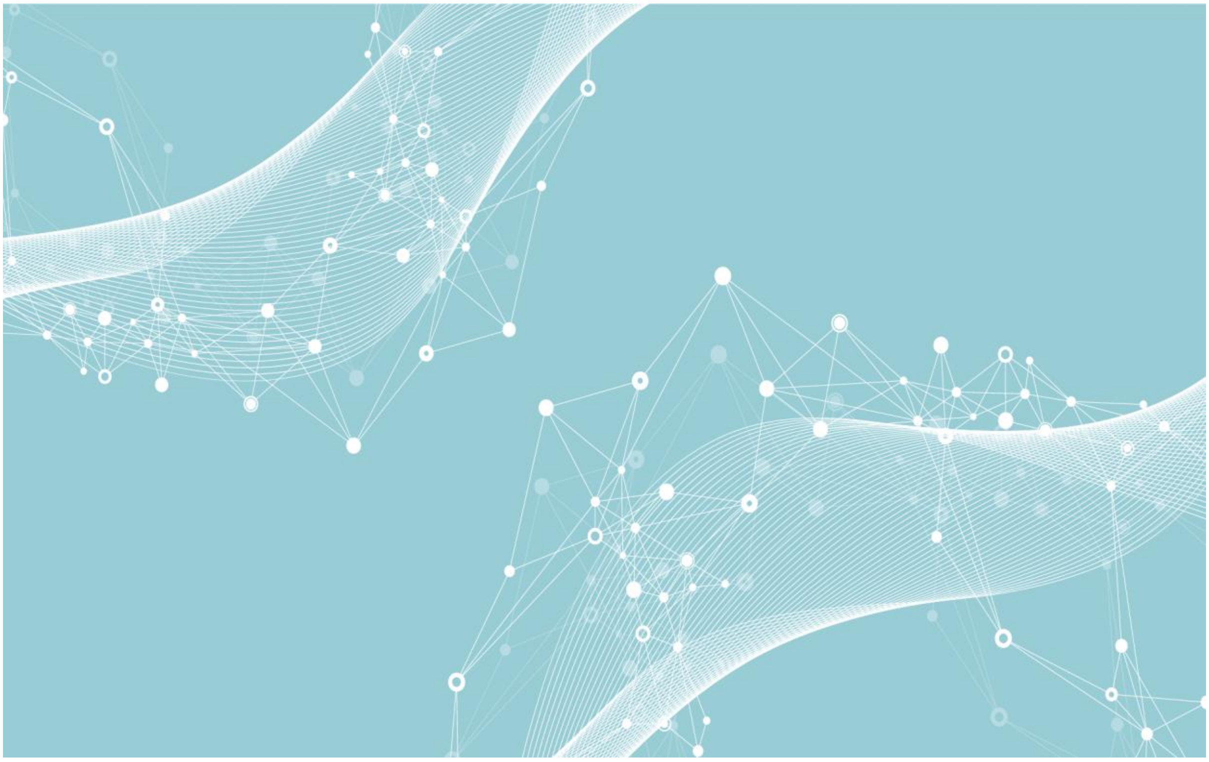


Options for a competitive bidding mechanism under the Innovation Fund - general assessment and two specific options

Assistance in the analysis and set-up of a competitive bidding mechanism for Contracts for Difference (CfD), Carbon Contracts for Difference (CCfD) or other comparable schemes under the Innovation Fund

European Commission CLIMA/2022/OP/0003

Authors: Winkler, Jenny; Held, Anne; Anatolitis, Vasilios (Fraunhofer ISI)

Lotz, Bastian; Gephart, Malte; Krause, Emma (Guidehouse)

Location: Karlsruhe, Berlin, London

Date: November 2022

Content

1 Background

The Innovation Fund (IF), as a successor of the NER300 programme, is one of the world's largest funding programmes for the demonstration of innovative low-carbon technologies. The Fund aims to demonstrate and commercialise industrial solutions to decarbonise Europe and support its transition to climate neutrality. Financing of the IF is provided by revenues from auctioning CO_2 emission allowances from the EU Emission Trading System (ETS) and remaining funds from the predecessor programme. Until now, the IF has used a selection procedure based on award criteria defined in its legal basis and call-specific scoring and ranking mechanisms.

The proposal of the ETS Directive put forward as part of the Fit-for-55 package in 2021[1] foresees the introduction of competitive bidding mechanisms (i.e. auctions) to award funding. The objectives of the competitive bidding mechanism are fourfold:

(1) Cost efficient way of distributing financial support. Auctions have been a major success story in the power sector in many Member States[2], bringing down the funding needs for renewable power by magnitudes.

(2) Price discovery and market formation. As long as there is sufficient competition, auctions reveal the "real" price of the private sector of engaging in a certain green activity. This creates valuable data points for the public sector but also helps to create markets where there are none yet, by providing a vetted price point.

(3) De-risking projects and leveraging private capital into them.

(4) Reducing administrative burden.

With the RePowerEU Plan to reduce dependence on Russian fossil fuels, the EC explicitly states hydrogen uptake in industrial processes as a central measure to reduce fossil fuel consumption in hard-to-abate industrial sectors[3]. Derived from that, **the first pilot auctions under the Innovation Fund will target green hydrogen production** and **transition to hydrogen-based production processes in new industrial sectors**. As green hydrogen can be used as an energy carrier in many sectors and appliances across the energy system, a cross-sectoral perspective is still ensured. In the industrial uptake case, both green and low carbon hydrogen could be targeted.

Consequently, a competitive bidding mechanism aiming at green hydrogen production and hydrogen uptake in industry is currently being developed by the Commission services, supported by a project team including Fraunhofer ISI, Guidehouse, ICF and BBH and the key options for this mechanism will be discussed with stakeholders at the workshop on 21 November 2022.

Hydrogen can be supported either on the production side (electrolysers) or on the demand side for the use in basic industries, for example in steel, glass or the chemical sector. Moreover, a combination of both demand side and supply side approaches is also possible.

---

[1] For more information see https://ec.europa.eu/info/sites/default/files/revision-eu-ets_with-annex_en_0.pdf. The proposal has been discussed by the Environment Council several times, showing general support for increasing effectiveness of the IF but yet unclear positioning with regard to its expansion, see https://data.consilium.europa.eu/doc/document/ST-6668-2022-INIT/en/pdf.

[2] Competitive auctions are recommended type of support under Climate, Energy and Environmental State Aid Guidelines.

[3] European Comission (2022): REPowerEU Plan. COM/2022/230 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN&qid=1653033742483

The support for hydrogen supply or demand would be paid out as "operational support" once project start to deliver (in contrast to IF grants that are paid based on project milestones as of grant award up until 10 years as of start of operation) and thus reduce future OPEX or revenue risks of successful bidders.

This paper provides an overview of possible auction configurations for hydrogen and discusses their advantages and drawbacks, taking into account policy objectives, feasibility and the specific framework conditions.

This paper first discusses **overarching issues** which are relevant for *all* auction configurations. Then, an **overview of the identified suitable auction configurations** for hydrogen is provided and discussed. Finally, further design-options are explored for **two, currently preferred, options**. The report closes with a set of 11 questions, where stakeholders have the possibility to contribute their views.

An overview of all auction design elements is provided in the Annex.

1.1 Overarching issues

This section addresses issues, which are relevant for more than one option of supporting hydrogen through auctions.

1.1.1 Supply and demand side approaches and how to direct hydrogen to where it is most needed

At least in the short- to medium-term, green or low-carbon hydrogen will be a scarce energy carrier. Therefore, its use should ideally be restricted to hard-to-abate sectors where no other more efficient and competitive options exist for reaching climate neutrality. This implies that green or low-carbon hydrogen should mainly be directed at basic industries and long haul-transport. A demand side approach can focus on those sectors where hydrogen is most needed. In a supply side approach, selling the green hydrogen could be restricted to these sectors[4]. This could however imply increased support expenditures (if a higher willingness to pay exists in other sectors).

If support is auctioned for supply-side projects this might increase the level of competition due to smaller project sizes and a wider geographical spread, compared to demand-side projects. This argument is however less relevant as long as the availability of transport infrastructure is limited and mostly integrated projects are expected to bid.

Targeting the demand side implies that not only investments in electrolysers but also other necessary adaptations to the production process such as new furnaces can be included in the support. However, the support remains concentrated on fewer sites even once hydrogen infrastructure is in place.

1.1.2 Availability of infrastructure

Currently, the available transport infrastructure for hydrogen is very limited. This is expected to play a major role for the expected outcome of the auctions. Thus, in the first years of the IF hydrogen auctions, mostly integrated projects (i.e. electrolyser on site or close to the site) are expected to be successful in the auction. Thus, bidders factoring transport costs into their bid face economic disadvantages compared to integrated projects (unless transport costs are covered separately).

[4] This can be done as part of prequalification criteria or technical requirements for participating in the auction and receiving the support. See Table 17Table 17 for an explanation of prequalification criteria.

Consequently and this regardless of auction configuration, pilot auctions are expected to favour integrated projects, similar to those addressed in the explicit joint auction focussing on industry clusters (see section 2.6).

This will change as infrastructure expands. Sufficient hydrogen transport infrastructure is also a prerequisite for having a functioning hydrogen market.

1.1.3 Enabling a level playing field - framework conditions and accumulation of support

A level playing field is crucial for enabling a sufficient degree of competition in auctions. As the IF competitive bidding scheme is an EU-wide scheme, projects from Member States (MS) with diverse framework conditions will compete in one auction. When designing the auction, it is therefore necessary to address the diversity of MS framework conditions to a certain degree to enable sufficient competition. However, levelling out all differences is neither useful nor feasible. Some differences reflect inherent regional competitive advantages - e.g. hydrogen production in countries with a high renewable energy potential are likely to be competitive, and this is desirable from a system-level perspective. Levelling out all regulatory differences with regards to taxes, permit requirements or lease rates is cumbersome and administratively not an option for the IF auction. This also applies for indirect support schemes on national and EU level such as low interest rate loans.

Direct support schemes for hydrogen on MS level, however, need to be considered when allocating support via the IF competitive bidding scheme. Unlike the current IF grant scheme, the new competitive bidding scheme can cover the full funding gap of the project. Therefore, the accumulation of support is not required for financing the project and should be avoided.

2 Main options for implementing a competitive bidding mechanism for hydrogen

In principle, there are many ways of auction configurations for supporting hydrogen under the IF taking into account the numerous design elements that have to be decided upon. Here, a two-step approach is applied. First, three core design elements making a crucial difference for the type of auction applied are identified and explained. In a second step, a comprehensive list of the additional design elements is presented in the Annex and some of these are discussed in the more detailed elaboration in Chapter 3. The basic design elements are the following:

1. The **recipient of the support** or **addressed sector** can either be the hydrogen producer addressing hydrogen supply or the hydrogen off-taker, typically industrial applications addressing hydrogen demand. Combined approaches are also possible.
2. The **reference market** that the financial support refers to needs to be defined. It can either be a market for hydrogen or for carbon allowances. The two main differences between both markets is that the market for CO_2 allowances is liquid, whilst no liquid market exists for hydrogen, hydrogen is mostly traded over the counter and prices are regionally differentiated. Another option discussed is to refer to the electricity market as the relevant reference, as electricity is the main input factor for producing green hydrogen.
3. The **remuneration form:** The planned competitive bidding mechanisms will award an operation-based support payment which can in theory be configured as a fixed premium, fixed tariff, a Contract for Difference (CfD) or Carbon-Contract for Difference (CCfD) payment.

Table 1 outlines seven possible configurations for designing a competitive bidding scheme for hydrogen, focusing on different combinations of the three basic design elements. Section 2.8 provides a description and discussion of these options in order to select the two most suitable approaches for a more in-depth discussion including additional design elements in Chapter 3.

Table 1: Overview of seven competitive bidding mechanisms according to the main design elements

		Addressed sector		
Reference market	**Remuneration options:**	**Supply**	**Demand**	**Combined**
Market for green[5] hydrogen	**CfD/sliding premium**	1) Hydrogen supply side auction	4) Hydrogen demand side auction	6) Joint hydrogen supply and demand auction for clusters 7) Double-sided auctions for H2 supply and offtake contracts
	Fixed premium			
	(Fixed tariff)[6]			
Market for CO_2 allowances	**CCfD**	2) CCfD auction for hydrogen supply	5) CCfD auction for demand side	Not applicable
	fixed premium			
	fixed tariff			
Electricity market (main input price)	**CfD/sliding premium**	3) Electricity as input auction	Not applicable	Not applicable
	fixed premium			
	fixed tariff			

In principle, the different reference markets can be combined with all different types of remuneration forms. However, some combinations are more suitable than others. Fixed tariffs for hydrogen imply that the Commission act as a trader on the respective reference market. As this is not a suitable role in the context of the Innovation Fund competitive bidding mechanism, fixed tariffs are only discussed in the context of double-sided auctions (where other options are not suitable).

For hydrogen supply, fixed premiums and CfD approaches are included in the discussion. As currently no liquid reference market exists for hydrogen, reducing the offtake market risk is a challenge that could be addressed by a CfD award. But also a fixed premiums are discussed as an alternative for the hydrogen market as a fixed premium implies stable support expenditures for the Commission.

The ETS carbon market and the electricity market are liquid markets - thus, in this context only CfD or CCfD aproaches are included in the assessment below.

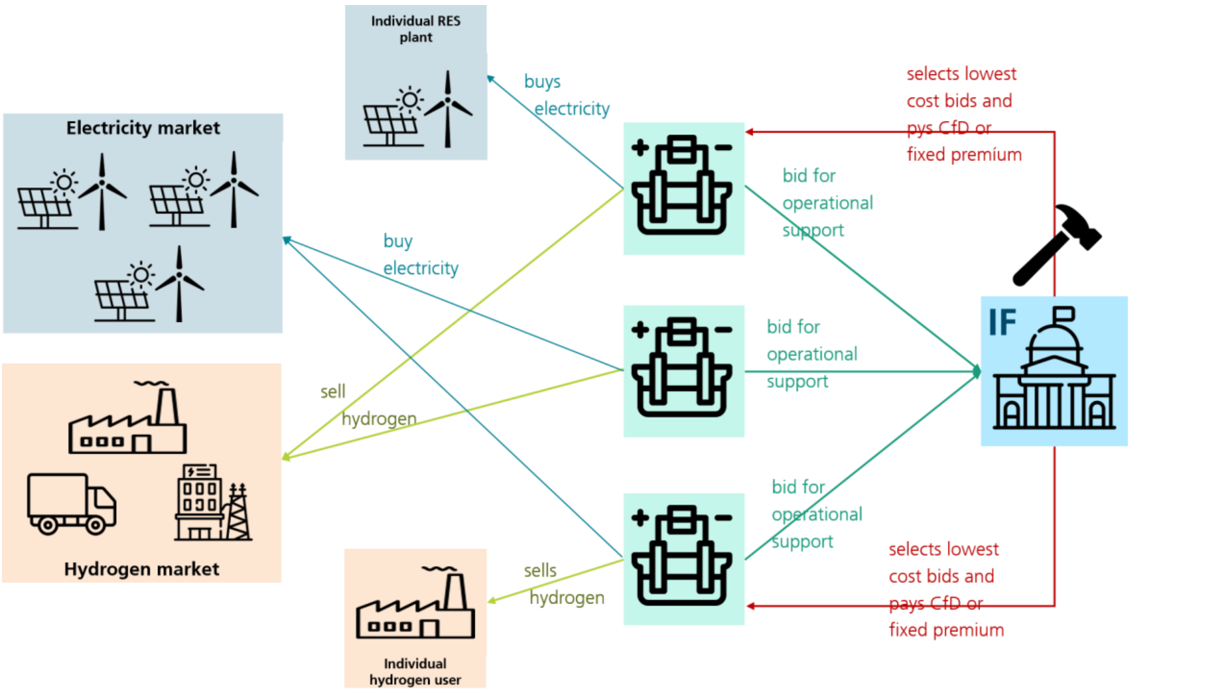
[5] Blue or grey hydrogen could also be considered as the reference market as an alternative for the market of green hydrogen.

[6] Discussed for double-sided auction only.

2.1 Supply-side auction using a Contract for Difference (CfD) or fixed premium

A supply-side auction addresses green hydrogen producers. Selected bidders receive operational support for each unit of hydrogen produced. They are responsible for negotiating off-take contracts and procuring the electricity needed for the production of hydrogen. The support payment aims at filling the gap between the production costs of green hydrogen and the willingness to pay of the hydrogen demand sectors. In addition, depending on the detailed design, the support scheme may cover price risks, either regarding the offtake price or the price of the input factor electricity.

Figure 1: Schematic depiction of a supply side auction for operational support based on CfD or fixed premium



Icons taken from https://www.flaticon.com/free-icon/electrolysis_4272195, https://cdn-icons-png.flaticon.com/128/1098/1098423.png, https://cdn-icons-png.flaticon.com/128/46/46290.png, https://cdn-icons-png.flaticon.com/128/4173/4173904.png,, https://cdn-icons-png.flaticon.com/128/2634/2634255.png, https://cdn-icons-png.flaticon.com/512/658/658120.png, https://www.flaticon.com/free-icon/lorry_605863, https://cdn-icons-png.flaticon.com/512/2979/2979654.png

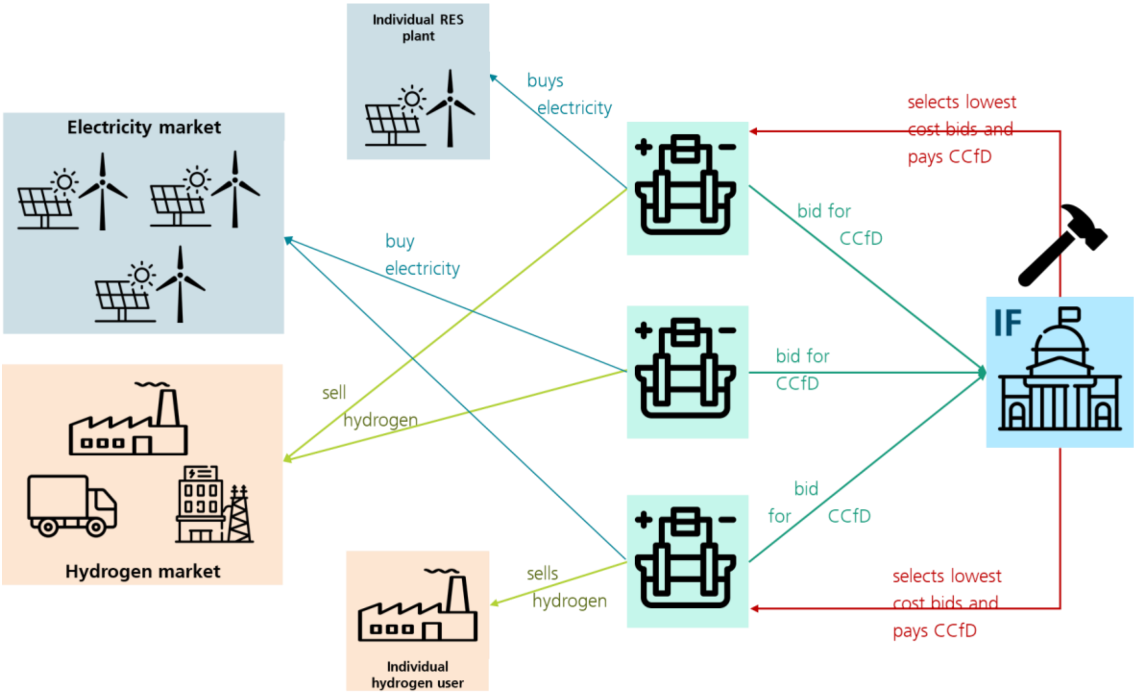
Table 2: Overview of main advantages and drawbacks of a supply-side auction based on a CfD or a fixed premium

Advantages	Drawbacks
• Clear focus on hydrogen capacity ramp-up and in line with electrolyzer capacity targets in the EU hydrogen strategy and domestic production target in the RePowerEU plan. • Relatively simple to implement, in particular if compared to a demand-side carbon-contract-for difference (CCfD)., as the instrument addresses very similar technologies (different types of electrolysers). • Potentially higher competition level compared to demand-side auction. • Electrolysers can in principle be built in all EU MS. • No inverse correlation between ETS revenues and support payments.	• Non-existing market for hydrogen implies risk for investors and poses questions on how to establish a reference price. • Possibly inefficient allocation to demand side sectors (e.g. use of hydrogen in passenger cars where direct electrification is preferable). Can be addressed via steering demand towards eligible sectors. • Specific approach for hydrogen, widening to other sectors requires adaptation, in particular regarding the reference price.

2.2 Supply-side auction using a Carbon Contract for Difference (CCfD)

As described in the previous option, there is currently still a cost gap between green and grey hydrogen which could be filled by a support scheme for hydrogen supply. In principle, it is also possible to support hydrogen generation based on a CCfD contract, i.e. by levelling the difference between the CO_2 abatement cost for a specific hydrogen supply facility and the carbon price. In order to make this possible, a calculation method for the amount of carbon abated per unit of hydrogen needs to be defined. This could for example be done on the basis of the ETS benchmarks.

Figure 2: Schematic depiction of a supply-side auction with a CCfD



Icons taken from https://www.flaticon.com/free-icon/electrolysis_4272195, https://cdn-icons-png.flaticon.com/128/1098/1098423.png, https://cdn-icons-png.flaticon.com/128/46/46290.png, https://cdn-icons-png.flaticon.com/128/4173/4173904.png,, https://cdn-icons-png.flaticon.com/128/2634/2634255.png, https://cdn-icons-png.flaticon.com/512/658/658120.png, https://www.flaticon.com/free-icon/lorry_605863, https://cdn-icons-png.flaticon.com/512/2979/2979654.png

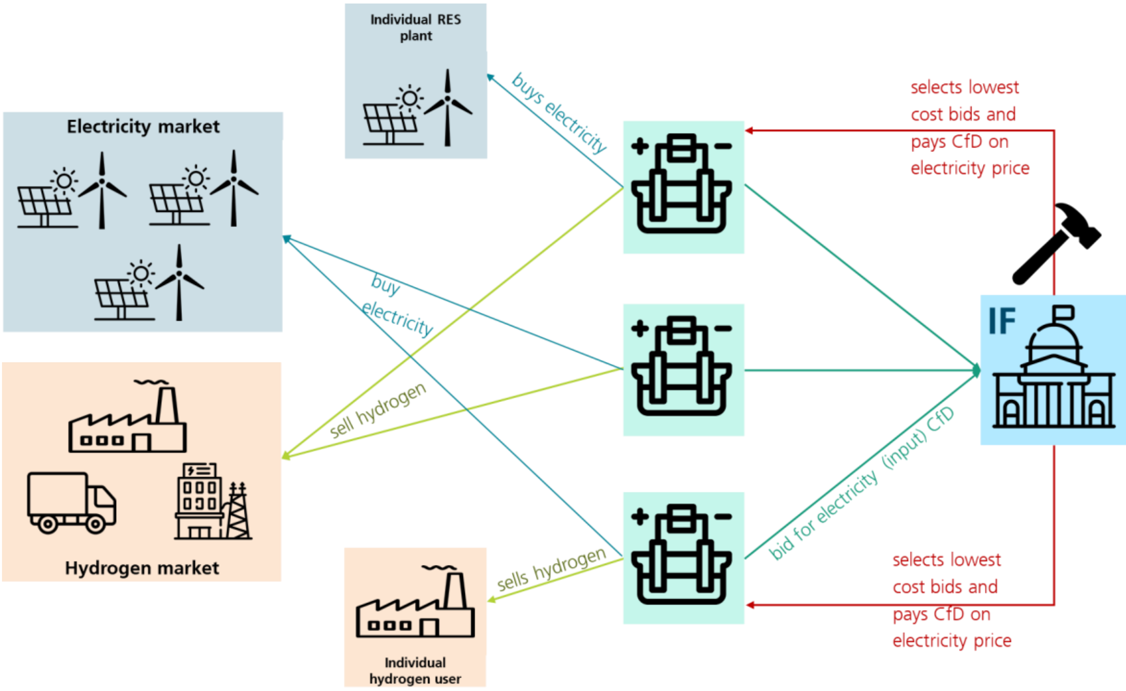
Table 3: Overview of main advantages and drawbacks of the option (focus on remuneration form CCfD)

Advantages	Drawbacks
• Direct link to emission reduction and to ETS. • Easier to open up to other sectors.	• Feasible but more complex than using a CfD, requires calculation methods for defining amount of carbon abated per unit of hydrogen. • Hedges against CO_2 price fluctuations while the CO_2 price risk may not be the main risk faced by hydrogen producers. Additional risk hedging can be introduced but increases complexity. • Inverse correlation between IF in-come and payment obligations through CO_2 Price

2.3 Supply-side auction for electricity using a CfD

Under this option, instead of a support payment for the produced hydrogen, the plant operator receives a premium payment for purchasing electricity. The electricity market price would serve as the reference price. Fluctuations in electricity costs are balanced out based on an EU-wide predefined index (i.e. average EU yearly day-ahead electricity prices). The support payment is adapted to the fluctuating electricity prices. The main objective of this option consists in reducing electricity price risks for hydrogen producers.

Figure 3: Schematic depiction of a supply-side auction for electricity using a CfD



Icons taken from https://www.flaticon.com/free-icon/electrolysis_4272195, https://cdn-icons-png.flaticon.com/128/1098/1098423.png, https://cdn-icons-png.flaticon.com/128/46/46290.png, https://cdn-icons-png.flaticon.com/128/4173/4173904.png,, https://cdn-icons-png.flaticon.com/128/2634/2634255.png, https://cdn-icons-png.flaticon.com/512/658/658120.png, https://www.flaticon.com/free-icon/lorry_605863, https://cdn-icons-png.flaticon.com/512/2979/2979654.png

Table 4: Overview of main advantages and drawbacks of a supply-side auction for electricity using a CfD

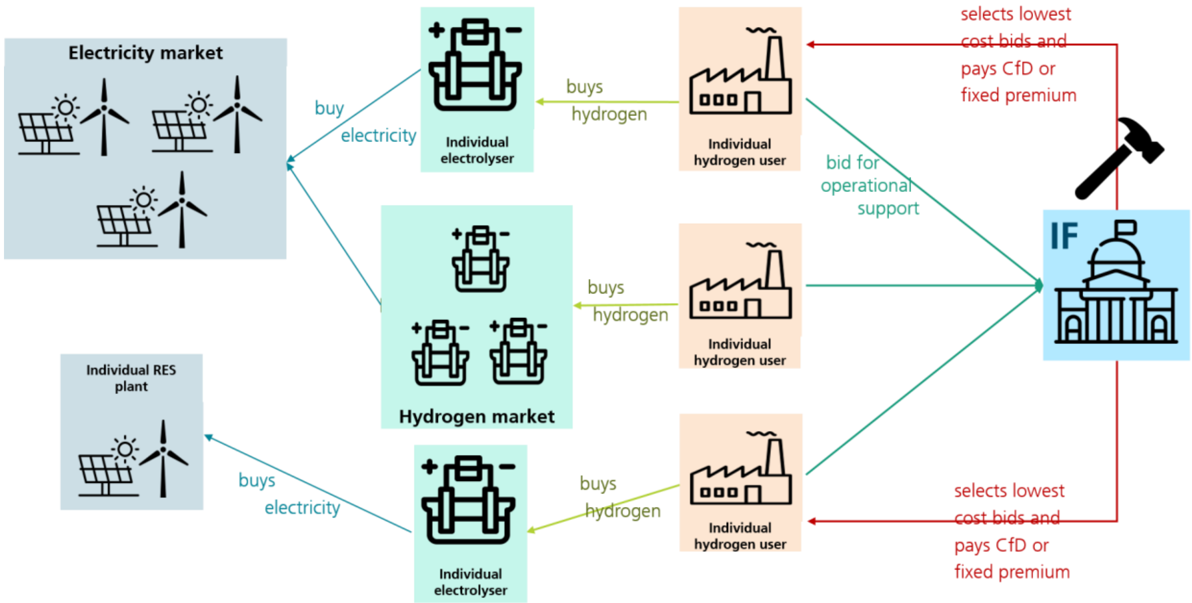
Advantages	Drawbacks
• Existing liquid electricity reference market. • Accounts for electricity price risk.	• Major differences between electricity price developments in MS not addressed so that main objective of reducing electricity price risks is not fully achieved (unless MS specific reference prices are implemented). • Potentially reduced demand for fixed price PPAs. • Potential legal problems due the fact that input and not output is supported. • Project-related budget caps limit risk reduction. • Fluctuating support payments as support giver takes on electricity price risks.

Due to the differences of electricity prices across the EU and the upcoming electricity market reform, this option comes with significant risks and uncertainties to implement at this moment. Electricity risk mitigation via indexing is discussed further as an option within supply-side auction in section 4.1.3.

2.4 Demand-side auction using a CfD or fixed premiums

The next option (shown in Figure 4) is supporting the demand of hydrogen based on a Contract for Difference (CfD) or fixed premium. The focus of such demand-side auctions for hydrogen is to cover the cost gap between the use of green or low-carbon hydrogen compared to a fossil-based energy carrier or feedstock. By aiming to bridge the cost gap between green or low-carbon hydrogen and fossil-based alternatives, an EU-wide demand-side auction for green hydrogen would create demand for green or low-carbon hydrogen, and thereby also incentivize the build out of production capacities (both domestically and via imports, if not excluded).

Figure 4: Schematic depiction of demand side auction for operational support based on CfD or fixed premium



Icons taken from https://www.flaticon.com/free-icon/electrolysis_4272195, https://cdn-icons-png.flaticon.com/128/1098/1098423.png, https://cdn-icons-png.flaticon.com/128/46/46290.png, https://cdn-icons-png.flaticon.com/128/4173/4173904.png,, https://cdn-icons-png.flaticon.com/128/2634/2634255.png, https://cdn-icons-png.flaticon.com/512/658/658120.png, https://www.flaticon.com/free-icon/lorry_605863, https://cdn-icons-png.flaticon.com/512/2979/2979654.png

Table 5: Overview of main advantages and drawbacks of the demand-side auction with a CfD or a fixed premium

Advantages	Drawbacks
• Directly contribute to spreading low-carbon (hydrogen-based) technologies in sectors where this is useful, incentivizing cost-efficiency. • CfD approach allows to factor in investment expenditure into the bid. • Clear path for technology expansion and thus for expanding electrolysis capacities. • No inverse correlation between ETS revenues and support payments.	• Limited risk reduction by CfD approach due to the lack of a liquid hydrogen market. • Sufficient level of competition within the sector is required to achieve satisfactory cost efficiency. • Potential legal problems due the fact that input and not output is supported.

2.5 Demand-side auction using a CCfD

The next option are demand-side CCfDs to support either selected sectors and technologies using hydrogen or a broader variety of technologies and sectors. The CCfD cover the gap between current ETS carbon prices and the necessary carbon price for making low carbon industrial technologies competitive.

Figure 5: Schematic depiction of demand-side auction with carbon contracts for difference

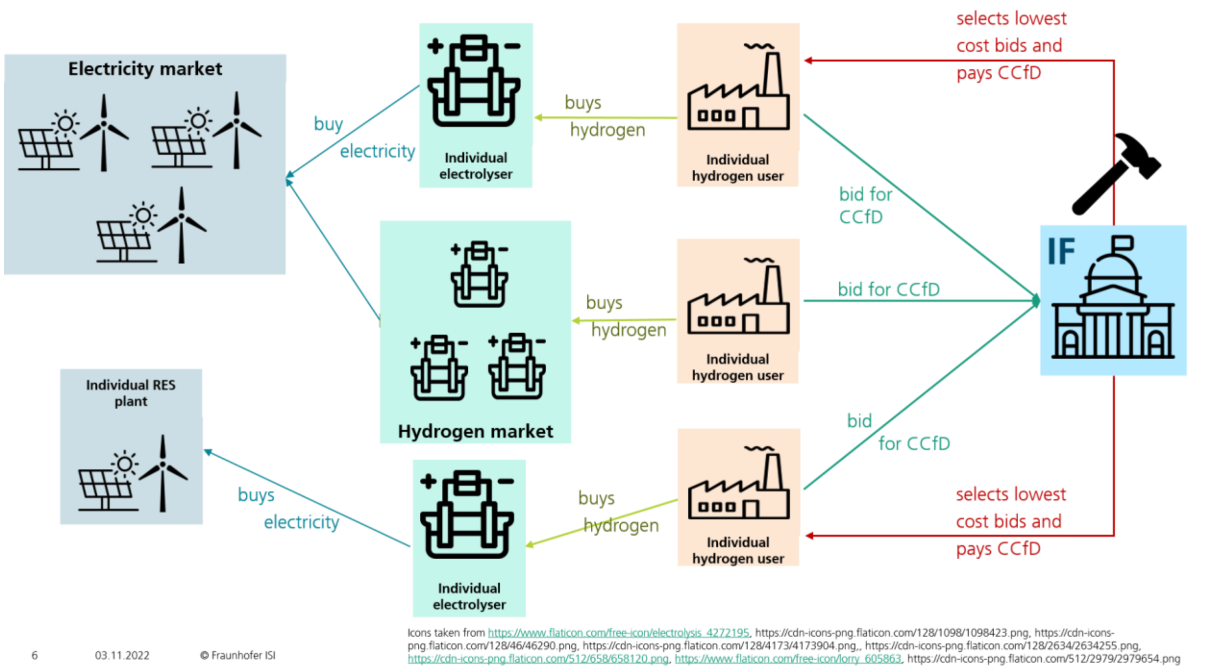


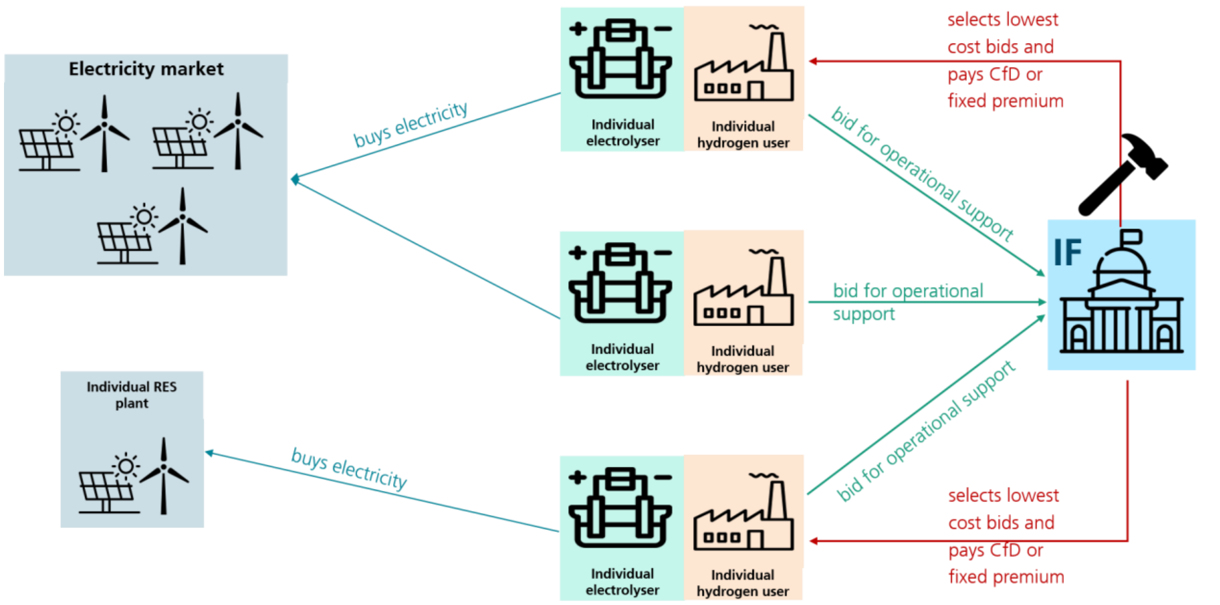
Table 6: Overview of main advantages and drawbacks of the demand-side auction using carbon contracts for difference (CCfDs)

Advantages	Drawbacks
• Targets sectors where green hydrogen will definitely be needed and is most probably the lowest cost option for emission reduction. • Investments in industry to use hydrogen (e.g. DRI) can be covered by the support. • Widening to other sectors relatively simple (even though providing a level playing field given different CO_2 abatement costs and project cost structures is still challenging).	• Less targeted to support ramp-up of hydrogen, in particular if not restricted to hydrogen technologies (e.g. if cement projects can participate). • Covering the difference between the ETS and the required carbon price might not take away sufficient risks, due to volatility in the (electricity or gas) market. Additional risk hedging instruments involve higher complexity. • Mainly locations with existing industrial sites are supported. This might lead to a more narrow geographical spread compared to a supply side auction once hydrogen transport infrastructure is in place.

2.6 Joint supply and demand-side auction for industry clusters using a CfD or a fixed premium (integrated projects)

Another option is to organize joint auctions for supply and demand industry clusters, where an electrolyser bids together with an off-taker, such as a steel plant. This option addresses the current lack of infrastructure to transport hydrogen by requiring a formal match of hydrogen producer and off-taker with a physical connection. In the current situation without a transport infrastructure, this option would imply very similar results to the supply-side auction using a CfD or fixed premium (see section 0) or the demand side auction using a CfD or fixed premium (see section 2.4). The option can be compared to the H2 IPCEI applications, just with the difference, that the price criterion would have a higher impact in the award procedure. This option practically formalises clusters, which are expected to be successful in a pure supply-side auction (or demand side auction) in the absence of transport infrastructure. As soon as hydrogen transport infrastructure is available, this approach presents major challenges, as it limits competition and neglects cost optimization potential from a system's perspective.

Figure 6: Schematic depiction of joined demand and supply side auction for industry clusters



Icons taken from https://www.flaticon.com/free-icon/electrolysis_4272195, https://cdn-icons-png.flaticon.com/128/1098/1098423.png, https://cdn-icons-png.flaticon.com/128/46/46290.png, https://cdn-icons-png.flaticon.com/128/4173/4173904.png,, https://cdn-icons-png.flaticon.com/128/2634/2634255.png, https://cdn-icons-png.flaticon.com/512/658/658120.png, https://www.flaticon.com/free-icon/lorry_605863, https://cdn-icons-png.flaticon.com/512/2979/2979654.png

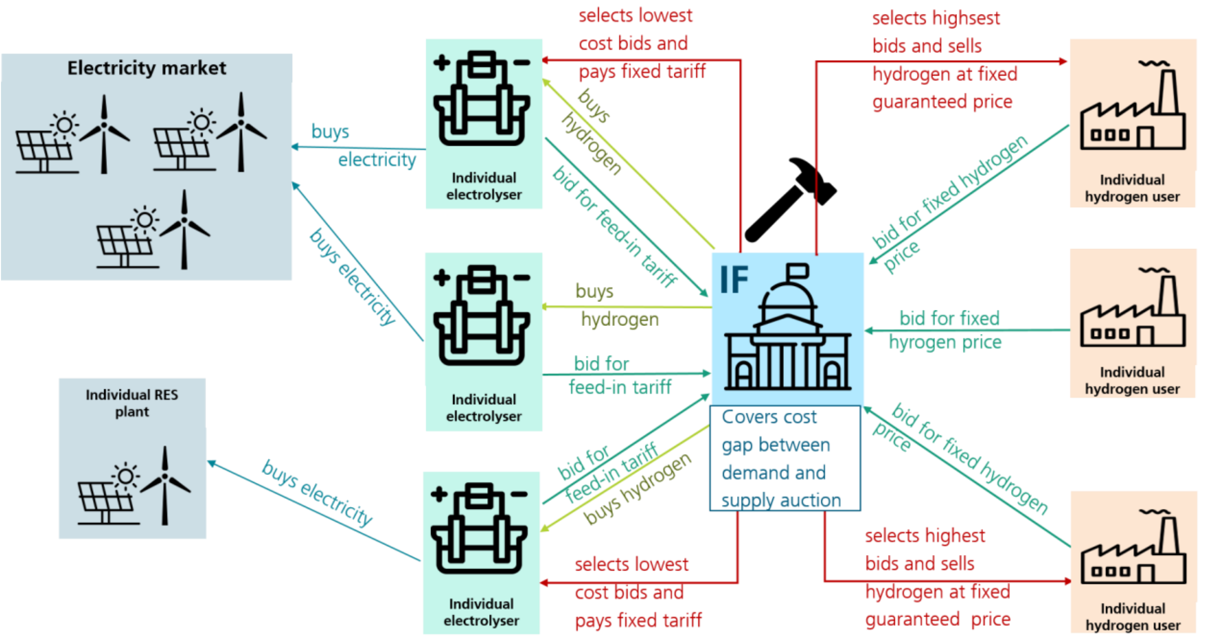
Table 7: Overview of main advantages and drawbacks of the option

Advantages	Drawbacks
• Stronger commitment from offtakers that would be part of the final contract	• Substantial problems once infrastructure is available: ○ Low competition levels and lower support cost efficiency, ○ Neglects optimisation potential from a system's perspective, ○ Geographical distribution depending on industrial sites.

2.7 Double-sided auction (supply & demand) for hydrogen

In a double-sided auction mechanism for demand and supply of hydrogen, the gap between the lowest possible green hydrogen offtake prices (on the supply-side) and the highest willingness to pay for green hydrogen (on the demand-side) is determined. This price gap is then covered by the public subsidy provider. In addition, the provider of support also purchases and re-sells the supported hydrogen volumes, making the provider of support the owner of the hydrogen at least for a certain period of time This could pose a major problem of implementation. Figure 7 shows how a double-sided auction would work.

Figure 7: Schematic depiction of a double-sided auction (demand and supply) for H2



Icons taken from https://www.flaticon.com/free-icon/electrolysis_4272195, https://cdn-icons-png.flaticon.com/128/1098/1098423.png, https://cdn-icons-png.flaticon.com/128/46/46290.png, https://cdn-icons-png.flaticon.com/128/4173/4173904.png,, https://cdn-icons-png.flaticon.com/128/2634/2634255.png, https://cdn-icons-png.flaticon.com/512/658/658120.png, https://www.flaticon.com/free-icon/lorry_605863, https://cdn-icons-png.flaticon.com/512/2979/2979654.png

Table 8: Overview of main advantages and drawbacks of the option

Advantages	Drawbacks
• Incentivises electrolyser ramp-up and investments of offtakers in green hydrogen applications at the same time through taking away supply and offtake risk. • Competitive price-discovery for hydrogen demand and supply in the absence of liquid hydrogen market. • Potentially higher support cost efficiency in the absence of liquid hydrogen markets.	• High marketing risks and liabilities for the intermediary, due to the role of hydrogen trader (e.g. in case of default of supplier or offtaker). • High complexity and administrative effort. • High funding requirements to reach a sufficient scale (due to coverage of price risks for demand and supply).

2.8 Comparison of auction configurations

Based on the high-level assessment presented above, two options for designing a competitive bidding mechanism were selected for further elaboration, namely the supply-side auction for operational support based on a CfD or a fixed premium, and the demand side auction using a CCfD support. In the following, we provide a short summary why these approaches were selected:

The **supply side auction based on a CfD or a fixed premium** directly targets the ramp-up of hydrogen technologies. When compared to the **CCfD auction for hydrogen supply** it enables a more level playing field for different electrolysers, because the impact of green hydrogen on carbon emissions highly depends on the use of hydrogen. Thus, while production costs remain relatively constant, bid prices can differ substantially depending on where the hydrogen is used. If a fixed value for the emission reduction is applied, the CCfD has very similar results compared to the CfD or fixed premium but implies a higher degree of complexity. Compared to the double-sided auction, supply side CfDs leave the negotiation of offtake contracts with the private sector, because the private sector is supposed to be better suited for that. The **joint supply and demand-side auction for industry clusters** will probably deliver very similar results to a pure supply side auction for hydrogen as long as no (or only limited) transport infrastructure is in place. The latter configuration would probably bring stronger commitment from offtakers that would be part of the final contract. In the longer term, the joint approach is less flexible and needs to be adapted if non-cluster electrolysers are to be included. Among the supply side options, the supply side auction based on a CfD or a fixed premium is most promising for the IF competitive bidding mechanism.

The **demand side auction for a CCfD support** aims at reducing a maximum of greenhouse gas emissions. It also contributes directly to the target of decarbonising hard-to-abate sectors. Compared to the **demand-side auction for a CfD or fixed premium**, it implies a lower juridical risk provided that output instead of input is supported and facilitates the inclusion of technologies beyond hydrogen in later auction rounds. Nevertheless, a contribution to the ramp-up of hydrogen is still possible if the participation is restricted to those sectors using hydrogen. Thus, the CCfD auction is further elaborated even though it is more complex than a CfD demand side auction.

The **double-sided auction for supply and demand for hydrogen** was not chosen mainly because the public authority in this setting outright owns the hydrogen, needs to become an active hydrogen trader and can face risks related to physical delivery. As a consequence, the public provider of support would incur substantial marketing risks and liabilities compared to a conventional one-sided support scheme. Furthermore, the negotiation of offtake contracts is a core private sector skill and should thus be left with the private sector.

3 Detailed design options of a supply-side auction with a CfD or a fixed premium, and a demand-side auction with CCfD

3.1 Supply-side auction for operational support based on CfD or fixed premium

Chapter 3.1 presents options for a number of key design elements for a supply side auction for CfDs. These design elements focus on the market price risks for both hydrogen sales and electricity supply and on the question of how these risks should be allocated and distributed between the auctioneer and the hydrogen producers. The most important design elements in this context are the remuneration form, the reference price and design options for addressing the electricity price risk.

When designing an auction for hydrogen, it is possible to draw on experiences with auctions in the area of supporting electricity from renewable energy sources. Some lessons learnt can be considered and transferred to supporting hydrogen, but some arguments differ from supporting renewables in the electricity market. As a consequence, choices for or against a certain design element may be different. Before we discuss the options for the mentioned design criteria, we briefly identify differences in the RES-E and hydrogen setting and explain why these pose different challenges to support scheme design.

Box 1: Learning from experiences with renewables support

- First, electricity is traded on liquid and transparent markets with price signals that offer a clear indication about the support gap. In principle, renewable electricity producers have the chance to sell their electricity on these markets, taking into account their production profiles. In contrast, there is **no liquid market available for hydrogen trade** at the moment. The use of hydrogen is still much more limited. Grey hydrogen using steam reformation from natural gas is typically produced in integrated projects closed to demand or sold bilaterally over-the-counter without using a market platform. Green hydrogen production using electrolysis with green electricity is currently still restricted to pilot plants.

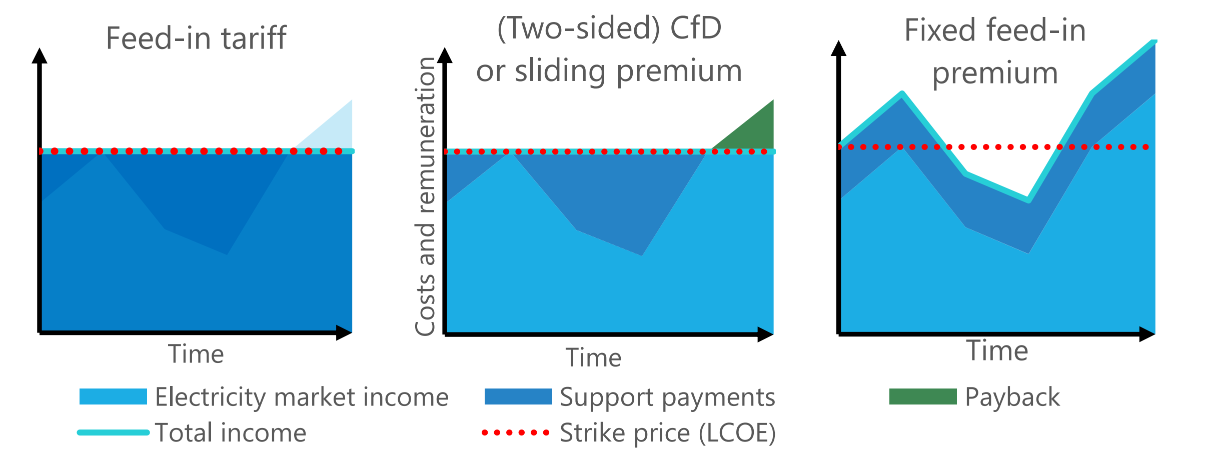
  In addition, the **price setting mechanism and behaviour** is unknown, leading to a high uncertainty about future hydrogen prices. It is not clear, whether the price of grey or blue hydrogen would be the price-setting technology or whether green hydrogen would be the price-setting technology. Of course, this could also change over time depending on the share of green and grey/blue hydrogen. Hydrogen prices could therefore rather be influenced by the gas prices, in case grey/blue hydrogen sets the price or electricity would mainly determine hydrogen prices if green hydrogen was the price-setting technology.
- Second, there is **no existing infrastructure** covering the transport of hydrogen from production to consumption, as opposed to electricity which counts on a well-developed transmission and distribution grid.
- As a result of the missing market and infrastructure, hydrogen producers have strong incentive to enter into long-term **hydrogen sales contracts**, similar to the power purchase agreements (PPA) in case of renewable electricity.
- The described setting poses additional challenges to setting an **adequate reference price** for the hydrogen price in particular with regard to a CfD scheme. Errors in estimating the hydrogen reference price are highly probable and imply a considerable revenue risk for hydrogen producers.
- A CfD is a scheme aiming at covering **a competitiveness gap** on the one hand and **reducing price risks for investors** on the other hand. It needs to be clear that risk reduction for investors implies an increased budget risk for the entity providing the financial operating support. In case of renewable electricity, CfDs are well suited to address revenue risk of fluctuating electricity prices, provided that electricity generation costs are well-known and liquid markets are available. Thus, the CfD addresses the revenue risk with fluctuating market values and fixed and well-known generation costs.
- In case of hydrogen, there is an additional risk factor due to **changing input factor costs** of electricity. CfDs against the hydrogen price (revenue) do not address the highly relevant electricity price risk affecting variable LCOH. Addressing the revenue risk for LCOH is at least challenging due to absence of liquid and transparent hydrogen markets.
- A further difference between renewables and hydrogen is the **economic maturity of the technology**. Whilst RES-E generation is already quite close to competitiveness, the use of hydrogen is still in its infancy. Therefore, for reaching the market-uptake of hydrogen not only an instrument for reducing investment risks but one that actually fills the funding gap is required. This also implies that the possibility for pay-backs is not as relevant for hydrogen when compared to renewables.

3.1.1 Remuneration form

Operation-based support schemes are so far mainly used to support renewable electricity. As described above, there are several differences between hydrogen and renewables. Therefore, the impact of different remuneration forms on offtake price risks differs. While the support schemes cannot reduce overall market price risks, they can impact the allocation of risks between supported parties (investors) and the support provider (EC).

In principle, the same (operation-based) remuneration forms as for renewables can also be used for hydrogen production, i.e. fixed premiums, one- or two-sided Contracts for Difference and feed-in tariffs[7]. Figure 8 shows the revenues and development of support payments for the different premium options: a sliding premium at the left side including a payback, and a fixed premium at the right side.

Figure 8: Fixed and sliding premium payments



The difference between the different remuneration forms concerns mainly the risk allocation and how market integration of the supported technology is incentivised.

A fixed **feed-in tariff** (left figure) implies that hydrogen producers receive their full (estimated) costs from the support system and are not responsible for selling and marketing the hydrogen they produce. While this approach implies minimum risks for hydrogen producers (if long term electricity supply contracts are available), there is no incentive for producers to participate in the market and to assume certain market risks.

The next options consist in **sliding premium** approaches, shown in the middle of Figure 8. A one-sided sliding premium covers the gap between the bid price and the hydrogen market price. In the case of a two-sided premium, payments from the plant operator to the auctioneer ("reflows") are foreseen in case the market price rises above the bid price. In both systems, when auction participants expect that their market revenues do not cover the costs, the bid price (or strike price) will be in the range of (expected) hydrogen production costs. As long as the expected market revenues are below the estimated production costs there are no differences between one- and two-sided premium schemes.

If a sliding premium is implemented, the calculation of actual support payments requires the **definition of a reference price**. The absence of a liquid hydrogen market implies that the functioning of CfDs with regards to risk reduction is heavily reduced when compared to renewables in electricity markets (see also chapter 2).

[7] One-sided contracts for different are often called sliding premiums.

The support payment in case of a **fixed premium** (see right graph in Figure 8) is a constant premium paid per unit of hydrogen produced. It shall cover the expected cost gap between revenues from selling the hydrogen and the costs of green hydrogen production. The fixed premium approach implies that hydrogen producers need to manage long-term and short-term hydrogen (and electricity) price risks, e.g. by entering into long term contracts with hydrogen offtaker (or investing in an integrated project). In the auction, hydrogen producers bid for the fixed premium and typically consider market price expectations for their bid.

Table 9 summarizes the options for the remuneration form and their respective advantages and disadvantages.

Table 9: Options for the remuneration form

Options	**Feed-in tariff**	**Sliding feed-in premium or CfD (one-sided)**	**Contracts for difference (CfD, two-sided)**	**Fixed premium**
Description	A stable payment from the auctioneer that covers all costs, central actor sells the hydrogen	Premium on top of the market price, sliding to cover the difference between market price and bid/strike price	As one-sided CfD, pay-back if market price > bid/strike price	Fixed premium on top of the market price
Advantages	• Very low risk for investors if they have a long term electricity contract	• Risk reduction for investors if hydrogen market becomes liquid	• Risk reduction for investors if hydrogen market becomes liquid	• Very low risk for support provider • Good fit with integrated projects • Incentivises long term hydrogen sales contracts
Drawbacks	• Limited risk reduction if long term electricity contracts are not available • High transaction costs for tendering authority • Intense intervention in hydrogen trading • Uncertainty regarding support requirements and	• Very limited risk reduction for investors due to non-liquid hydrogen market (see below for more details) • Uncertainty regarding support requirements • Risk of inadequate support payments (too high or too low)	• Very limited risk reduction for investors due to non-liquid hydrogen market (see below for more details) • Uncertainty regarding support requirements • Uncertainty regarding support requirements and potential	• No risk reduction for investors • Risk of inadequate support payments (too high or too low)

potential overcom-pensation		overcompensa-tion	

3.1.2 Reference price

Currently and probably for the next years there is no liquid, deep and transparent market price for hydrogen. For a CfD however, a reference price needs to be defined.

In principle, two approaches exist for calculating a reference price for hydrogen. One is based on the electricity market price, the other one based on the price for natural gas. The electricity-based approach reflects the production costs of green hydrogen (and thus potentially the future market price for hydrogen). The gas-based approach simulates the current market price for grey hydrogen and is also an indicator for the market price developments of blue hydrogen (once this becomes attractive due to sufficiently high CO_2 prices). In addition, there are commercial indices available for hydrogen prices. These are however also built and calculated based on electricity and/or gas prices.

An alternative to using such "synthetic" (i.e. calculated) hydrogen reference prices is to apply the individual off-taker price as a reference. This option reduces the price risk for the hydrogen offtake. It does however not correspond to a usual CfD approach.

In all cases, the price risk of the hydrogen production depends on the contractual arrangements between the hydrogen producer and the off-taker, e.g. whether prices are fixed or indexed.

Table 10 provides an overview of different options and their advantages and drawbacks. Option 1 and Option 2 can also be combined.

Table 10: Options for defining a reference price for hydrogen

Options	**Reference price based on electricity price index**	**Reference price based on natural gas price index**	**Available commercial index**	**Individual offtaker price**
Description	Calculation based on liquid electricity price index (can be adapted based on definition of green hydrogen) and assumed electrolyser efficiencies	Calculation based on liquid natural gas price (plus CO_2 price) index and efficiency of blue/grey hydrogen generation	Commercial indices like HYDEX which are also calculated based on production costs of green hydrogen	The hydrogen producer must prove an offtaker agreement (disclosed to EC). The agreement can change during the support period
Advantages	• Cost fluctuations for generating green hydrogen are covered • Differences between MS can be covered	• Revenue fluctuations are covered (if these are linked to the price of grey hydrogen) • Differences between MS can be covered • Existing experience (Dutch SDE++)	• Might be perceived as more neutral • No need for own calculations	• Incentivises the use of PPAs for hydrogen producers • Enables risk reduction for hydrogen offtake price
Drawbacks	• Revenue-fluctuations not covered as no link to current hydrogen prices (for grey hydrogen) • Limited risk reduction due to uncertain relation between index and real hydrogen price	• Cost fluctuations not covered (depending on correlation between natural gas and electricity prices) • Limited risk reduction due to uncertain relation between index and real hydrogen price	• Lower transparency of calculation method, resulting in legal risks and uncertainty • Limited risk reduction due to uncertain relation between index and real hydrogen price • Reliance on third party to deliver the index	• Possibilities for strategic bidding8 • Missing transparency for public on prices • Limited relation to general hydrogen price once this becomes available

[8] For example, the auction design needs to exclude the possibility that bidders participate in the auction with a high hydrogen offtake contract price (and thus a low support requirement) and change this to a much lower offtake price after a relatively short period.

Another challenge with all synthetic price indices is their **phase-out once a real liquid market index for low carbon hydrogen becomes available**. This phase-out can pose an additional risk for investors as the structure of the real market index is not clear yet and might differ substantially from the synthetic index. Also, it needs to be defined if, when, and how the reference market price will be based on the real market price (e.g. when the market is deemed sufficiently liquid and transparent). One option here is to remain with the synthetic price index for the plants already awarded and only use the new existing index for future auction rounds.

3.1.3 Indexation of electricity prices

Uncertainties with regards to electricity procurement are one of the main risk factors for green hydrogen production. It is uncertain if long term electricity price contracts are available at a sufficient quantity and quality to ensure the profitability of electrolysers.

In order to reduce investment risks, the provider of support could take over these risks. Two main options exist here: First, an indexation to the electricity price could be implemented in the support payment based on different electricity price indices. Second instead of a payment for the production of hydrogen, the purchase of electricity could be supported via a CfD contract based on the electricity price. The latter option is described above in section 2.3 and represents a complete support scheme option. In contrast, the indexation of electricity would need to be combined with a support premium for green hydrogen.

Table 11: Options for indexation of electricity prices

Options	**Indexation of electricity prices based on average EU electricity price index**	**Indexation of electricity prices based on national/zonal electricity price index**
Description	Fluctuations in electricity costs are balanced out based on an EU-wide pre-defined index (i.e. average EU yearly day-ahead electricity prices). The support payment is adapted to the fluctuating electricity prices.	Fluctuations in electricity costs are balanced out based on a national pre-defined index (i.e. average national yearly day-ahead electricity prices). The support payment is adapted to the fluctuating electricity prices.
Advantages	• Relatively simple implementation based on existing liquid electricity market prices • Accounts to a certain extent for electricity price risk	• Relatively simple implementation based on existing liquid electricity market prices • Accounts for electricity price risk
Drawbacks	• Fluctuating support payments as support giver takes on electricity price risks • Project-related budget caps reduce risk reduction • Differences between electricity price developments in MS not addressed • Divergence between electricity price index and actual electricity procurement costs (if PPAs contracts based on LCOE are achieved) • Potentially reduced demand for fixed price PPAs	• Fluctuating support payments as support giver takes on electricity price risks • Project-related budget caps reduce risk reduction • Country-specific indexation requires more data • Potential divergence between electricity price index and actual electricity procurement costs (if PPA contracts based on LCOE are achieved) • Potentially reduced demand for fixed price PPAs

3.2 Demand side auction with Carbon Contracts for Difference

In the following, we present options for a number of key design elements for the demand side auction for CCfDs. These design elements include options for the indexation of support, prequalification and award criteria as well as a discussion of realization periods.

3.2.1 Possible Indexation to cover other risks

The CO_2 price only covers a small part of the risks for investments in green hydrogen or other low carbon technologies in industry. Therefore, an indexation of energy costs can be helpful to reduce further the investment risk and thus financing costs. Using indexation does however make the mechanism more complex and increases fluctuations in the support payments as the auctioneer takes on additional risks. Caps on the maximum amount of indexation would be needed, as the auctioneer cannot provision budget for an infinite amount of indexation. However, a budget cap which is too high, will lead to large amount of budget that needs to be allocated, whereas a budget cap that is too low will not take over sufficient risks through the indexation. Table 12 summarizes the advantages and disadvantages of a varying degree of indexation:

Table 12: Options for indexation of input parameters in demand side CCfD auctions

Options	**(1) No indexation**	**(2) Indexation for hydrogen only**	**(3) Indexation for energy carriers (hydrogen, electricity, natural gas, coal)**	**(4) Indexation for energy carriers and other input factors (e.g. scrap)**
Description	The support payment only fluctuates based on CO_2 prices	The support payment also includes a component for addressing hydrogen price risks	The support payment also includes components addressing energy price risks	The support payment also includes components addressing price risks of raw material or other input factors
Advantages	• simple implementation • clear reference price • clear focus on emission reduction • lower budget risk	• highest risk factor for hydrogen technologies addressed	• further risk reduction for bidders	• further risk reduction for bidders
Drawbacks	• Major investment risks not addressed and therefore potentially prohibitive to new investments • Potentially higher financing costs and support expenditures	• More complex support schemes • Potentially higher fluctuations of support payments and thus lower amount of projects that can be supported (depending on necessary budget allocation) • Suitable hydrogen index difficult to define (gas-based, electricity-price based, mixed)	• Drawbacks of option 2 • Many indexes need to be defined	• Drawbacks of option 3 • Industry has better information about raw material markets than auctioneer and is thus able to manage better the associated risks

To implement an indexation, the exact index used for each component needs to be defined. These can be MS-specific or based on an EU level index. The advantages and drawbacks of an EU-wide or MS-based index are comparable to those shown for the case of electricity in Table 11 on page 24.

3.2.2 Sector and technology focus

Multi-sector approaches can increase competition, a one-sector approach is easier to implement and potentially more attractive for bidders. Table 13 shows the options for restricting the participation of certain industries. This is in particular relevant for the potential use of a demand side instrument with a broader focus than only hydrogen, which could be used for future auctions within the IF.

Table 13: Options for designing a broader or narrower focus

Options	**(1) All industrial sectors**	**(2) Restriction to basic industries**	**(3) Industries using hydrogen**
Description	All industrial sectors are allowed to participate in the auction	Only basic industries i.e. sectors with the highest emissions are allowed in the auction	Only industries using hydrogen technologies are allowed in the auction
Advantages	• Higher degree of competition	• Focus on industries with highest possible emission reduction	• Clear focus on hydrogen ramp-up
Drawbacks	• Potential problems for basic industry • Potential restrictions to a small number of technologies (low and mid temperature heating) • Unclear effect on hydrogen ramp-up	• Restriction to a smaller number of countries • Unclear effect on hydrogen ramp-up	• Less focus on decarbonisation • Restriction to a smaller number of countries

3.2.3 Award criteria

A price-only approach reduces complexity and ensures cost-efficiency. However, if a broad range of sectors and technologies shall be awarded e.g. their respective contribution to energy efficiency or the relative GHG emission reduction they reach might also be of interest. In general, criteria need to be objectively quantifiable[9].

[9] If more than one award criterion is used the criteria need to be converted into scores that can be combined into an overall score. While this requires some thoughts on how this should be done (e.g. based on which assumed price ranges) it is used in many auctions globally and in the EU and therefore does not pose a major challenge.

Table 14 Options for award criteria

Options	**Price-only**	**Other criteria**
Descrip-tion	Price is the only selection criterion	Other criteria such as energy efficiency or relative emission reduction could be used in addition
Ad-vantages	• Simple implementation • Potentially higher competition	• Potentially higher CO_2 emissions re-duction, better efficiencies or earlier hydrogen usage can be preferred
Draw-backs	• Less flexibility • Lowest cost options preferred (e.g. plants that use natural gas for a longer time)	• Higher complexity

4 Questions for design of hydrogen pilot auctions (2023-25) under the Innovation Fund (IF)

4.1 General questions

1. What type of hydrogen should be supported under IF pilot auctions, *multiple choice*:
   a. Renewable hydrogen, in line with Delegated Acts of REDII
   b. Biogenic hydrogen (from biomass)
   c. Hydropower hydrogen
   d. Low-carbon hydrogen, including "blue" hydrogen (i.e. with CCS)
   e. Low-carbon but not "blue" hydrogen
   f. Difficult to assess at this stage

2. When supporting hydrogen, which demand sectors and applications should the IF pilot auctions focus on? *multiple choice*:
   a. Transport
   b. Industry
   c. Refineries
   d. Power to Gas, Power to Liquid production
   e. Steel sector
   f. Chemicals sector
   g. Other
   h. Difficult to assess at this stage

3. Should light-duty transport, be excluded from IF pilot auctions on hydrogen, *single choice*:
   a. YES
   b. NO
   c. Difficult to assess at this stage

4. What should be the main objective of IF pilot auctions on hydrogen, *single choice*:
   a. Hedging against main reference market price fluctuations
   b. Hedging against several market prices fluctuations (e.g. with indexation, or prices composites)
   c. Hedging and providing subsidy to cover the funding gap/green premium
   d. Difficult to assess at this stage

5. Should hydrogen transport infrastructure costs be part of the bidding price under IF pilot auctions, *single choice*:
    a. Yes, even though mostly integrated and co-located projects are expected to participate in the pilot auctions.
    b. Yes because already in pilot auctions there could be projects that have transport infrastructure elements.
    c. No because there will be no level playing field between projects that have no infrastructure costs and those that have them.
    d. No because there are other support mechanism for supporting hydrogen infrastructure.
    e. Difficult to assess at this stage.

6. Which auction configuration would you find most attractive for IF pilot auctions, *single choice*:
    a. Supply-side auction using CfD or fixed premium
    b. Supply-side auction using CCfD
    c. Supply-side auction for electricity using CfD
    d. Demand-side auction using CfD or fixed premium
    e. Demand-side auction using CCfD
    f. Joint supply and demand-side auction
    g. Double-sided auction
    h. Difficult to assess at this stage

4.2 Questions regarding a supply-side scheme

7. If a supply-side auction using CfD is chosen to be awarded under IF pilot auction, which reference price would be best suited to hedge price risks, *single choice:*
    a. Natural gas price (TTF)
    b. Grey hydrogen price (market price)
    c. Grey synthetic hydrogen price
    d. Project specific offtake prices
    e. CO_2 price
    f. Electricity price
    g. Synthetic green hydrogen price (given a mix of assumptions)
    h. Difficult to assess at this stage

8. Do you see sufficient demand for hydrogen to establish the offtake contracts for the duration of the CfD support (likely to cover 10 years), *single choice*:

a. Yes there is sufficient demand to have offtake agreements committed throughout CfD support period
b. There is sufficient demand to have only initial offtake agreements committed - for the first years of CfD support
c. No, there is no sufficient demand and offtakers will have to be found at the time of financial close.
d. Difficult to assess at this stage

4.3 Questions regarding a demand-side scheme

9. What is the most relevant price risk factor that hydrogen consumers need a hedge against, *single choice*:

a. CO_2-price
b. Electricity price
c. Natural gas price (TTF)
d. Hydrogen supply price
e. Non-energy related input prices
f. Other
g. Difficult to assess at this stage

10. For which sectors would carbon price be a good reference price, *multiple choice*:

a. Hydrogen production
b. Chemicals
c. Metals
d. Cement
e. Glass
f. CCUS
g. None
h. Difficult to assess at this stage

11. Should a subsidy scheme for GHG abatement reduction be primarily aimed at cost-effectiveness?

a. Yes
b. No, it should also aim at fostering innovation
c. No, there it should also address industrial policy concerns (jobs, competitiveness)

Annex 1: Overview of auction design elements

The following descriptions of the potential competitive bidding mechanisms for the IF require a basic understanding of auction design elements. The selection of auction design elements and their specific implication impact substantially the auction results as well as their assessment. Therefore, Table 15 - Table 19 list and describes the design elements which need to be considered and defined when designing the competitive bidding mechanisms for the IF.

The design elements are split into five categories:

- General auction design elements
- Auction procedure
- Qualification requirements (eligibility criteria)
- Obligations, deadlines and penalties
- Auction framework conditions

Table 15: Overview of design elements for the IF competitive bidding mechanism - general design

Design element	Description and options
Auctioned good and auction volume	The auctioned good is the object of the auction to be procured by the auctioneer. The auction volume is the aggregated amount of the auctioned good. In the context of the IF, this could be **budget, saved CO_2 emissions or hydrogen produced/ demanded or electrolyzer capacity installed**.
Remuneration type	The remuneration auctioned for a project can be either capacity-based (e.g. payment for each installed MW of electrolyzer capacity) or output-based (e.g. payment for each unit of hydrogen produced). In the case of the IF competitive bidding mechanism, the **remuneration will be paid based as operational support.**
Remuneration form	The remuneration form defines the details of the payment. There are several options for operational support including **feed-in tariffs** (fixed payments covering all costs), **fixed premiums** (covering only part of the costs and require to sell the product on the market), one-sided (without payback) or two-sided (with payback) **contracts for difference**.
Reference market price	(Carbon) contracts for difference require the definition of reference market values, which is particularly challenging in the absence of liquid markets. For the IF competitive bidding mechanism, the reference market values for CO_2, **hydrogen** and potentially other energy carriers such as **natural gas** or **electricity** can be relevant. The absence of liquid hydrogen markets requires the use of **artificial indexes** (based on production costs for example).
Limits to the support	The duration of support needs to be defined and can be based either on a **temporal span** (i.e. years), a **certain project output** or a **maximum support budget**. These options can also be combined. Budget limits can be beneficial for the provider of support, whilst they tend to increase the risks for investors.
Banking	Banking of support can reduce risks and allow for more flexibility by moving support to later years e.g. if an offtaker goes bust and hydrogen production is paused.
Indexation of support	Support payments can also be adapted to other price developments such as inflation.
Aggregation of technologies, regions, actors etc.	Auctions can focus on a specific sector or technology or include multiple sectors and technologies. Auction design covering a specific sector with similar attributes is generally easier. In order to enable different sectors and technologies to compete, **minimum** and/or **maximum quotas** or **shares** or **bonus/malus systems** can be implemented. This can also be used in case different countries compete in one auction or different actor groups need to be considered.

Table 16: Overview of design elements for the IF competitive bidding mechanism - auction procedure

Design element	Description and options
Single vs. multiple-item auction	In the auction either one project for which several bidders compete (single item, often used in offshore wind auctions) or several projects (multiple-item) can be awarded. **The IF competitive bidding mechanism will be a multiple-item auction.**
Award criteria	After the bids are received and processed, the auctioneer ranks them and awards the auctioned good following a criterion. Auction awards can be **price-only** or include **additional decision criteria** or multi-criteria auctions. Price-only auctions deliver the most cost-efficient results, further relevant criteria can be included in the prequalification process. If differences in fulfilling other criteria shall be considered, a multi-criteria approach is useful but criteria need to be defined in a transparent and clear way.
One-stage or two-stage auction	The auction can be organized in a **one-stage** or **two-stage format**. In the latter, the auction is usually divided in a request for prequalification (RFQ) to prequalify the prospective bidders and a request for proposals including the financial bid. Both options can work well, and the choice often depends on local regulatory requirements.
Auction type	The auction can be **static** or **dynamic**. In static auctions, the bidders bid one price which is not changed afterwards. The dynamic auction includes a price-discovery process during which bidders receive some information about the bidding of other auction participants (descending or ascending clock designs). Both options can also be combined in a hybrid format. For the IF competitive bidding process, a **static design** is envisaged.
Pricing rules	Pricing can be pay-as-bid or uniform. In the case of pay-as-bid pricing, every bidder receives the amount required in his own bid. In the case of uniform pricing all successful bidders usually receive the amount of the last accepted bid. While there are some theoretical drawbacks and advantages of both mechanisms, empirical assessments tend to find very small differences between both approaches. The IF envisages **pay-as-bid** as it is less prone to misunderstandings by bidders.
Pricing limits	**Ceiling or maximum prices** can be introduced to limit possible support ranges if the budget is restricted and if a low competition level poses a risk for strategic bidding. **Minimum prices** are used in settings where costs are unclear and aim among others to ensure realistic bids. The auctioneer also needs to decide whether the level of the ceiling or floor prices are **disclosed** or not.
Marginal bid and tiebreaker rule	Bids are awarded based on the submitted price until the auctioned volume is covered. If the "marginal" project exceeds the predefined auctioned volume the last bid can either be awarded and the auction volume increased, it can be rejected and the auction volume decreased, the project can be partly awarded (requested to reduce its size) or the remaining auction volume can be filled with more expensive smaller projects. If two projects have the same score a tiebreaker rule must be defined.

Table 17: Overview of design elements for the IF competitive bidding mechanism - qualification requirements (eligibility or access criteria)

Design element	Description and options
Prequalification requirements (access criteria)	Bidders need to fulfil prequalification requirements in order to participate in the auction. Prequalification aims at making sure that bidders are capable of realizing the project, the project is sufficiently advanced to be realized and the participation in the auction is not just used as an option, i.e., the bid is realistic. Prequalification requirements can include material (as for example minimum requirements for CO_2-abatement, bidder qualification criteria (selection criteria, e.g., previous experience, financial and technical capacity) and financial requirements.
Minimum or maximum restriction for project size and for bid volume	Limits to project sizes and bid volumes each bidder can submit can be implemented for different reasons, such as local acceptance, environmental protection, market concentration, etc. Maximum size requirements can encourage diverse and smaller actors to participate but also limit economies of scale. On the other side, minimum size requirements can reduce the transaction costs associated with smaller bids, but also limit its participation and thus can reduce competition levels. Besides, limits to the maximum amount of bid volume each bidder can submit can be imposed to prevent one strong bidder being awarded with most or all the auctioned volume.

Table 18: Overview of design elements for the IF competitive bidding mechanism - Obligations, deadline and penalties

Design element	Description and options
Realisation periods	Realisation periods define a certain date or period after the auction until when the project needs to be realized. After this date, penalties can be applied and unused auction volumes can enter the auction process again. The definition of realisaton rates requires knowledge about the length of the planning and production process of the technologies covered in the auction.
Penalties (combined with bid / completion bonds)	Penalties (usually in combination with financial prequalification requirements) are used to ensure the seriousness of a bid and therefore effectiveness of an auction. They can also be in different levels (e.g. shortening the duration of support in case of delays or now support if the delay is too long). Penalties are sanctions that increase bidders' costs of non-compliance with contractual obligations and discourage underbidding. Penalties are usually applied in in combination with financial prequalification requirements, i.e., bonds. They can adopt different nature, such as shortening the duration of support in case of delays; canceling the allocated support or the signed PPA if the delay is too long; or even exclude the bidder from future auction rounds. Penalties can be applied gradually, considering the extent of the delay or the failure to comply with obligations.

Table 19: Overview of design elements for the IF competitive bidding mechanism - auction and framework conditions

Scheduling/auction frequency	Auctions can take place regularly (daily, monthly, quarterly or yearly etc.) or non-regularly. Presenting a schedule with regular future auction rounds and volumes deliver clarity and build trust among investors and in the involved industries. For the IF, an **annual schedule** probably makes sense to align with the main IF mechanism.
Timing of the auction (early stage or late stage auction)	The timing of the auction relates to the development stage in which competing projects are or need to be in to participate in the auction. A late auction can contribute to higher realization rates since projects have already overcome issues that could stop the project until they are resolved. However, late auctions require bidders to invest more money and time before participating in the auction (which would imply sunk costs if they are not awarded),
Implementing authority	An important framework element is the designation of an authority or institution who manages the auction. It is important that the counterparty is endowed with sufficient creditworthiness and liquidity. A credible implementing authority is crucial to ensuring project bankability (e.g. financially viable public or state-owned entity or private industrial off-taker).
Accumulation with direct (national) support schemes	Projects eligible for the IF competitive bidding schemes could also be eligible for other (national) support schemes. The auction design needs to implement rules for such cumulation of support schemes or exclude it.
Accumulation with indirect (national) support schemes	Projects eligible for the IF competitive bidding schemes could also be eligible for indirect support schemes. The auction design needs to determine in how far such loans or tax exemptions can be combined with IF support.