SHEARMAN & STERLING

INCENTIVISING INVESTMENT IN EUROPEAN RENEWABLE HYDROGEN PRODUCTION

A proposed framework for state revenue support

December 2022

Contents

1. EXECUTIVE SUMMARY

1.1 Framing the Issue

(a) The European Commission (**EC**) has made clear that renewable hydrogen (**RH2**) is necessary to meet the decarbonisation targets enshrined in Europe's Climate Law.[1] In 2021 the Fit for 55 package set out binding RH2 usage targets and quotas which will apply from 2030 to enable the European economy to achieve these decarbonisation goals. In 2022, REPowerEU,[2] the European strategy for reducing dependence on Russian fossil fuels, set even more aggressive targets, including RH2 production within Europe of 10 million tonnes / year (plus the same quantity in imports).

(b) However, the high cost of RH2, whether produced in Europe or imported, threatens achievement of these objectives. For consumers, RH2 is not sufficiently competitive relative to the non-renewable energy or production processes it needs to replace, because:

(i) these do not incur a sufficiently high cost for associated greenhouse gas (**GHG**) emissions;

(ii) RH2 production costs are high and will remain so until the supply chain is scaled-up and the resulting technology improvements materialise;

(iii) potential RH2 offtakers are delaying up-take decisions with the expectation that the price of RH2 will decrease (although whether this will in fact occur is debatable given significant supply chain bottlenecks and increasing capital financing costs facing the renewable energy industry in general), a decision which, collectively prevents the industry from achieving early ramp-up and benefiting from economies of scale; and

(iv) there is insufficient supply to motivate the midstream and downstream infrastructure and other supply chain investments necessary to incentivise and implement large-scale offtake.

(c) Until RH2 becomes cost-competitive, demand will continue to be shaped by policy rather than market forces. This will likely be the case throughout the 2020s and into the 2030s.

(d) As with any commercial activity, capital for RH2 production projects in Europe will not be available at sufficient scale or on commercially acceptable terms until there is certainty that revenues from RH2 sales will cover investment,

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1 Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999

2 REPowerEU: Joint European Action for more affordable, secure and sustainable energy COM(2022) 108 final

financing and production costs and provide a reasonable return for investors. Until then, investment will generally be limited to pilot projects, other small projects, and projects producing solely for captive or local consumption. The roll-out of key infrastructure and other necessary investments will be delayed in turn as investment in infrastructure will not achieve scale until supply has ramped-up concurrently. This creates a cycle of underinvestment where a lack of sustained demand for RH2, prevents investments in production and distribution infrastructure, which (in turn) further prevents demand from materialising.

(e) These facts are acknowledged by the EU in its recently adopted Climate, Environment and Energy Aid Guidelines (**CEEAG**).[3] The CEEAG recognises that the Fit for 55 targets and quotas alone may not generate investment in RH2 production at the scale or speed required during the 2020s to facilitate meeting the 2030 requirements and State aid will therefore be required.

(f) European countries are increasingly falling behind other economies, such as the US, Canada, North-East Asian and Middle Eastern states, in producing the policy and investment conditions necessary to meet RH2 targets. Capital is therefore mobilising to produce RH2 abroad, putting Europe at risk of being permanently and structurally dependent on imports of RH2, increasing both cost and supply risks whilst missing the opportunity to create European jobs, technology centres, manufacturing hubs and climate leadership.

1.2 The Proposed Solution

(a) This paper proposes that MSs should establish aid schemes that would direct aid through competitive auctions. To be effective in scaling-up supply of RH2, the intervention by EU Member States (**MSs**) (or other states outside the EU) needs to be simple, limited and target the revenue uncertainty facing RH2 producers (that is, the combination of uncertainty in demand for and price of RH2), which is stifling investment. It should be designed to comply with the requirements of the CEEAG relating to aid to support renewable energy projects.

(b) This paper analyses the issues to be considered by policy makers when designing RH2 production support schemes to achieve this objective. In doing so, it refers to available examples as well as the requirements of equity investors in, and external debt financiers of, RH2 production projects.

(c) Notably, the CEEAG permits support in the form of guaranteed remuneration structures to limit exposure to negative scenarios for private investors where there is significant uncertainty concerning future market developments (and therefore revenues). This explicitly includes State aid for the production of RH2.

(d) A support scheme of this kind would allow projects to raise equity and debt finance based on a more predictable revenue stream, facilitating larger

3 COMMUNICATION FROM THE COMMISSION Guidelines on State aid for climate, environmental protection and energy 2022 (2022/C 80/01)

scale projects and reducing the cost of capital and therefore the production cost of RH2.

(e) Today, a number of MSs are in the course of designing and pioneering aid schemes for the production of RH2, with different characteristics, each exhibiting pros and cons relative to the objectives they pursue and their effectiveness in addressing the risks for investors described in this paper. These include RH2 aid schemes in the Netherlands, Denmark, France, the United Kingdom, Germany and the USA. The key aspects of these support models are further considered in Section 3 of this paper.

(f) Competitive auctions are the dominant approach in the CEEAG (and the approach adopted in the United Kingdom's Low-Carbon Hydrogen Business Model) to ensure aid remains proportionate, avoids excessive distortion of competition, is kept to the minimum necessary and incentivises projects to produce RH2 at the cheapest possible cost. Such an approach will also encourage innovative project development, technology improvements and efficiency in financing, construction and operations, and ensure the best possible value for taxpayers.

(g) Supply-side support to catalyse investment in RH2 production (as proposed in this paper) is by no means the only option available to states seeking to develop their RH2 economy. Other approaches include directing state support to, and thereby incentivising investment in, the mid-stream (i.e. the infrastructure required for RH2 transportation and use, including pipelines and RH2 re-fuelling stations) and/or the demand-side (one example of which could be through addressing the costs associated with technology or fuel switching for potential industrial users of RH2).

(h) Different states around the world are likely to favour intervention in different parts of the RH2 supply chain. Ultimately, though, a range of approaches is likely to be required with different interventions in the supply-side, mid-stream infrastructure and the demand-side, each of which would need to be structured independently with regard to the market dynamics of that particular part of the supply chain. However, these other potential interventions fall outside of the scope of this paper.

(i) This paper focuses on supply-side support from states to incentivise investment in RH2 production. However, this should not be taken as suggesting that interventions in other parts of the supply chain would not be effective, or indeed preferable, for particular states globally depending on their priorities and political agendas. A supply-side intervention in Europe is aligned with the industrial policy priorities of many European states in relation to the RH2 market (in terms of job creation, developing technology centres and stimulating indigenous sources of supply) as well as their experience with similar supply-side support schemes in other technologies (and therefore their willingness to adopt similar schemes).

(j) Details and discussion of the pros and cons of structuring options are included in Section 0 of this paper. Whilst, the key features of an ideal revenue support model are set out in Section 4.12(c) of this paper.

2. ISSUES A RH2 SUPPORT SCHEME NEEDS TO ADDRESS

2.1 Legal framework for public intervention to stimulate RH2 production

(a) The need for MS intervention is already acknowledged in the CEEAG which permits MSs to award aid for the reduction and the removal of GHGs (which explicitly includes the production of RH2) without the need to demonstrate market failures, as they are mostly assumed. It is explicitly accepted in the CEEAG that the ETS does not fully internalise external costs of GHG emissions.

(b) There is adequate opportunity within the framework of the CEEAG for MSs to design support models that address the needs of private sector investors. In particular, this can be achieve where such schemes are structured as competitive auctions.

2.2 Demand-side quotas not enough on their own to stimulate RH2 production

(a) The Fit for 55 package sets binding RH2 usage targets and quotas which will apply from 2030 (anticipated to represent up to 5.6 million tonnes / year of demand); while REPowerEU sets a higher but voluntary target of 20 million tonnes / year of RH2 consumption in the EU by 2030 (with 10 million tonnes / year coming from intra-EU production and the remaining 10 million tonnes / year from imports).

(b) In general, while some parts of the Fit for 55 package (e.g., the Fuel EU Maritime and REFuel EU Aviation packages) explicitly establish targets for RH2 derivatives products to come into force before 2030, these are limited. The most important targets and quotas relevant to RH2 will apply only from 2030 (in particular, those under the Renewable Energy Directive as well as the higher targets under other parts of the package), once adopted and transposed into national law by MSs.

(c) Although some MSs may choose to impose transitional targets when implementing the 2030 targets under the Fit for 55 package, this is currently uncertain and is unlikely to be sufficiently widespread to create a uniform and stable market demand on its own. There are, therefore, few and insufficient demand-side incentives to use RH2 before 2030.

(d) However even once the 2030 quotas take effect, the market dynamic will not change overnight. It will take time for these demand-side mechanisms to establish sufficient credibility such that the private sector will invest capital in reliance upon them. In any case, faith in the demand-side quotas (assuming the current implementation deadlines are retained) would only likely apply to the legally binding quantities under MSs implementing legislation and not the higher, voluntary targets under REPowerEU to achieve 20 million tonnes of demand per year.

(e) To meet the 2030 targets and quotas in the Fit for 55 package (as well as to meet the REPowerEU targets) RH2 production will need to come online at scale during the 2020s. However, these prospective demand-side obligations do not give investors sufficient volume and price certainty to make the investments in RH2 production required now to meet them. Few potential producers (and prospective financiers) will be willing to adopt a "build it and it will come" model on a meaningful scale.

(f) At this stage of market development, there is limited appetite amongst offtakers to enter long-term offtake contracts on terms that would be required by European producers to make projects financeable because offtakers: (i) cannot be sure of the price and demand they will be able to achieve in the market at this early stage; and (ii) expect the price of RH2 to fall over time, potentially below the current cost of production (although, as noted above, it remains to be seen whether this will in fact occur given supply chain bottlenecks and increasing financing costs - it may be instead that there is a medium term increase in the price of green molecules before any price decreases can be achieved from technology efficiency gains).

2.3 **Key considerations for the design of a supply-side support scheme**

(a) The first thing to consider when designing a support scheme for RH2 production is the structure of the market for RH2 and / or RH2 derivatives (in relation to which, see Figure 1 below) and the existence (or absence) of associated infrastructure for transport, storage and distribution of those products.

(b) As demand for RH2 will almost exclusively be matched through bilateral offtake contracts, intervention on the supply-side will indirectly support the demand-side (by making RH2 more readily available at lower cost). In the long term, when transport infrastructure is in place, the market for RH2 is likely to evolve into a multilateral, liquid, market such as those for electricity and natural gas, which could allow trading of RH2 to take place based on similar mechanisms applicable to today's electricity and natural gas markets.

(c) Therefore, MSs wishing to support the production and use of RH2 which lack a comprehensive infrastructure for its storage and distribution (which is the case for most MSs) should design instruments suitable for a market based mostly on bilateral exchanges. These include variations of contract for difference and fixed premium schemes, which are further explained below.

(d) Investors and their potential financiers are not able to fully take on volume and price risk in new, unproven markets such as RH2 (because of the uncertainty over the capacity of a project's revenues to pay its operating costs and service debt over the life of a loan in such a sector). MSs therefore need to design support schemes to create revenue certainty for the early projects to make them investable but taking into account the bilateral nature of the early RH2 market described above. This support will be needed until such time as the price of RH2 becomes more competitive with the alternatives, allowing the private sector to be exposed to the full price risk for RH2 production.

(e) The two primary considerations for MSs in seeking to create revenue certainty for producers are if and how to address price and volume (demand) risk. Both of the main typologies of state support evidenced by the existing and proposed schemes analysed in this paper (namely, the fixed premium structure and the contract for difference (or variable premium) structure) can address these risks and do so (directly or indirectly) in various ways and to differing extents.

(f) In addition to these, the following table analyses other factors states should consider in designing a RH2 support scheme, specifically with a view to stimulating private sector investment.

Figure 1: *Key considerations for states when designing a hydrogen support scheme*

Risk	Description	Considerations
RH2 only or also RH2 derivatives	Should support be limited to RH2 production or also RH2 derivatives	RH2 derivatives (e.g., ammonia, methanol, other e-fuels) are traded, currently, in markets defined by multilateral exchanges as existing infrastructure can be used. As a result, MSs wishing to support the production and use of RH2 derivatives may use different mechanisms, suitable for a more liquid market. When deciding to design a support scheme, MSs should therefore clearly distinguish whether the aim of the scheme is to support RH2 production only or also the production of RH2 derivatives. Once a decision to this question has been made, the main characteristics of the scheme and risks that need to be addressed can be further considered, including the below (assuming support of only RH2 production).
High cost of production	High costs of RH2 production compared with alternative, competing products or technologies.	Early projects are likely to be more expensive than subsequent ones (as was the case with renewable power – although there may be a medium term price in increase, as noted above) but state support for early projects will help accelerate efficiency gains, as innovation and technology advances will be encouraged by scaling-up of the RH2 technologies. The private sector alone cannot mitigate this risk in time to meet the Fit for 55 and REPower EU policy objectives.
Demand/ volume risk	Uncertainty of market demand prevents RH2 producers from selling their entire production volumes.	This risk is mitigated through long-term offtake contracts (in the private sector). However, at this stage of the RH2 market development, many offtakers are unwilling to enter into long-term contracts because the level of demand and price that can be obtained (from the downstream customers for their products) is uncertain. This reluctance is exacerbated by the belief that the costs of RH2 will fall over time, thus incentivising offtakers to wait. The contractual protections and credit strength of offtakers that investors would require to make private sector offtake contracts financeable are likely to be more onerous than such offtakers would be willing to

		accept (in most cases) at this stage, given the foregoing risks. States could either: (a) provide explicit volume guarantees (at least for part of the RH2 production), thereby taking at least part of the demand risk itself - which may, if the market were to experience a downturn, come with a political downside should the state be seen to be protecting the private sector from its own failures; or (b) design a price support scheme that creates sufficient price certainty to allow RH2 to be sold for a price at which offtakers would be willing to enter into long-term contracts for guaranteed volumes (thereby allowing the private sector to resolve the volume risk through the state providing only price support). The RH2 market is (and for a time is expected to continue to be) characterised by bilateral contracts (i.e. there is no spot market for RH2 yet). Producers will need to negotiate with a small number of pre-determined offtakers to sell their volumes. States may therefore consider that the private sector is actually better placed to manage volume risk (i.e. by negotiating bilateral contracts) than the state. Further perspectives on this issue are considered in Section 4.6 below. However, a degree of volume support could be provided for an initial period to bridge the gap until demand-side quotas are in force and have proven to be sufficiently robust to support market demand. This could be designed as a payment-only obligation on states (i.e. no physical lifting of volumes would be required).
Price risk	A RH2 producer does not have certainty regarding the market price for RH2 and so cannot accurately model revenues.	Price risk could be mitigated (by the private sector) through pricing mechanisms in long-term offtake contracts with creditworthy offtakers. However, in the absence of support, this is unlikely to be acceptable to the majority of offtakers for early RH2 production projects because of the high price for RH2 today (especially when taken together with the absence of established demand) and the expectation that the costs of RH2 may fall over the medium term.

		A pricing regime for early RH2 production that ensures projects can recover all additional costs as compared to alternative, competing technologies and make an adequate return is key to unlocking investment in RH2 production because it would allow producers to enter into long-term contracts with offtakers, thereby also mitigating volume risk. When addressing price risk, state support should cover the entire funding gap for RH2 production projects (albeit the quantum of the funding gap would be determined through the competitive auction, rather than through a counterfactual analysis).
Policy change risk	The uncertainty surrounding future policy development (e.g. which may increase opex, create more favourable conditions for later competing projects, require additional capex or change/ remove the support offered).	Policy uncertainty is not a risk that the private sector can manage itself. While policy could develop to the advantage of RH2 projects, it could also reduce or remove the support provided (as happened in the Spanish renewables saga)[4] or implement changes to EU legislation on demand-side quotas and targets. Investors typically seek protection from this risk through investment treaty protection and mechanisms in private law contracts, providing cost recovery and revenue stabilisation in the event of a change in law. A support model will therefore need to adequately protect investors from the risk of any such change in law scenario – this is especially important in light of some MSs' (including Poland, Spain, the Netherlands and France) decision to withdraw from the Energy Charter Treaty. This requires MSs to facilitate structures where investment is routed via states that have good BIT coverage with EU MSs (such as the US, UK, Singapore and Switzerland).
Variable input costs / Indexation	A RH2 producer is exposed to variable input costs (e.g. purchased electricity) but the level of support is fixed; the real value of support may also be eroded	For RH2 projects exposed to electricity purchasing costs (e.g. without dedicated, directly-connected renewable power assets) investors will seek to manage this exposure through negotiating pricing under their power purchase agreements, using available hedging instruments and/ or purchasing power only when prices are low (or even negative). As a result, the producer is well placed to manage this risk and does not need to transfer that risk to the public sector. Protecting investors from currency inflation eroding the real value of the support given is a common protection given by states, since this cannot be managed by the

4 See the discussion in Noilhac Questions of International Law, *Renewable energy investment cases against Spain and the quest for regulatory consistency* available at http://www.qil-qdi.org/wp-content/uploads/2020/06/03_Renewable-energy-investment_NOILHAC_FIN.pdf

	by currency inflation.	private sector. However, other inflationary pressures (such as variable operating costs, aside from purchase of electricity) can be managed by the private sector contractually.
Eligibility conditions	Which technologies compete for the support.	Broad eligibility criteria (e.g. all technologies capable of achieving an equivalent reduction in GHG emissions, or even including other low-carbon hydrogen production pathways) will reduce the ability of RH2 to obtain support, since it faces higher production costs than alternatives. A technology neutral competitive auction would risk disadvantaging RH2 production and thereby would not be effective in achieving the goal of RH2 ramp-up.
Selection criteria	How winning bids are assessed.	This could be goal based (e.g. EUR / tonne CO2 abated) or value based (e.g. amount of EUR requested per quantity of RH2 produced).

3. PRESENTATON OF EXISTING / PROPOSED SUPPORT SCHEMES

3.1 Overview

(a) Several support schemes for RH2 production in Europe have either recently been launched (the Netherlands[5], the United Kingdom[6]) or proposed (Denmark, France, Germany[7]). In addition, the USA recently proposed a support scheme for RH2, which is also considered in this paper given its global significance. The key features of these schemes are summarised in the figure below and analysed in more detail in the reminder of this Section 3.

Figure 2: *Overview of hydrogen support schemes*

Topic	NL	UK	DK	FR	DE	USA
Price support	CfD	CfD	Fixed premium	Annual fixed premium	CfD	Fixed premium
Volume support	Partial (banking under-production)	Partial (sliding scale mechanism price support)	None	None	Yes	None
Capped support	Yes	Yes	Yes	Yes	Yes	Uncapped
Eligibility conditions	Yes	Yes	Yes	Yes	Yes	Yes
Award method	First-come, first-served	Competitive auction	Competitive auction	Competitive auction	Competitive double-auction	Application only
Award format	Bilateral contract	Bilateral contract	Bilateral contract	Bilateral contract	Bilateral contract(s)	Federal legislation
Selection criteria	Satisfy the eligibility criteria only; lowest EUR for CO2 abated if over-subscribed	Multiple criteria	Lowest EUR value per quantity of RH2 production	Lowest EUR for CO2 abated and other social / technological criteria	Lowest EUR for production and highest EUR amount consumption	Satisfy the eligibility criteria only
Duration	15 years	10 – 15 years	10 years	15 years	10 years	10 years
Indexation	Annual adjustment	Adjusted for CPI	Not decided	Considered	None	Adjusted for inflation

5 https://english.rvo.nl/subsidies-programmes/sde/features#

6 https://www.gov.uk/government/publications/hydrogen-business-model-and-net-zero-hydrogen-fund-electrolytic-allocation-round-2022

7 https://www.h2-global.de/

3.2 Netherlands

(a) The "Stimulation of sustainable energy production and climate transition" scheme (SDE++) is an operating subsidy for alternative energy and CO2 reduction technologies. EUR 13 billion of State aid has been granted in 2022 through 5 tender phases (which have now closed). Each tender phase was subject to a maximum limit on the EUR / tonne of CO2 abated that could be awarded. The SDE++ is a CfD mechanism, in which applicants bid for a strike price, with the government setting the reference price annually (with the aim of avoiding over-subsidisation).

(b) Multiple technologies (including renewable electricity, renewable heat, renewable gas, low-carbon heat, low-carbon production (including CCS, CCU, e-fuels and RH2) are eligible. However, each round and each technology is defined by a different maximum base rate above which applicants may not request SDE++ support. Electrolytic hydrogen production is defined by a maximum abatement cost of EUR 300 / tonne of CO2, a level which can only be achieved in the last round of applications.

(c) In the Netherlands, hydrogen competes with many other technologies for aid (renewable electricity, renewable heat, renewable gas, low carbon heat, low carbon production).

Topic	How addressed in support model
Price support	A CfD mechanism. The subsidy compensates for the difference between the applicant's proposed strike price and the "corrective amount", which is determined annually. Payments are made upfront with the correction applied annually in arrears.
Volume support	Partial volume support is available through the "banking" regime. SDE++ allows producers to "bank" their overproduction or underproduction from the previous year. For example, if production is less than predicted, the producer can use the unutilised shortfall in later years. However, this is still subject to the maximum annual production hours cap. Equally, producers can also carry over any excess output to the following year. This, however, does not smooth out cash flows for producers in the event of under production in a given year.
Capped support	The maximum subsidy intensity for which the SDE++ technology may be eligible is EUR 300 per tonne of CO2 reduction. There is a budget limit each day for awarding subsidies. RH2 produced after a given production limit, in terms of full load hours (4,200 hours / year, for grid-connected projects and 6,154 for directly-connected projects), is not eligible for subsidy. However, a ring-fenced amount is available for hydrogen and other low-carbon gases.

Topic	How addressed in support model
Eligibility conditions	The SDE++ subsidy is intended for companies and organisations (non-profit and otherwise) that produce sustainable energy or apply CO2-reducing techniques. Only the intended producer may apply for the SDE++ subsidy. Multiple technologies (including renewable electricity, renewable heat, renewable gas, low-carbon heat, low-carbon production (including CCS, CCU, e-fuels and RH2) are eligible. For each application round of the SDE++ scheme, a maximum of one application per category of production facility, and per address of the production facility is permitted. In addition, the producer must have completed its feasibility study and obtained key permits.
Award method	Competitive auction with multiple phases. Allocation works on a first-come, first-served basis: if there are more applications on one day than the remaining available budget, applications are ranked by subsidy intensity. This means that technologies with a lower required subsidy intensity will be ranked higher, which may be disadvantageous to RH2. The subsidy intensity translates the amount of money the government is spending to reduce 1kg of CO2 emission (i.e. the CO2 abatement cost).
Award format	Private, bilateral contract.
Selection criteria	First-come, first-served. However, if applications exceed the daily subsidy limit, they are awarded based on their subsidy intensity (i.e. lowest EUR per tonne of CO2 abated).
Duration	15 years.
Indexation	The level of the "corrective amount" is re-set every year. A project is also assessed one year after commissioning to ensure there is no over-subsidisation (findings may lead to a reduction in the subsidy level).

3.3 United Kingdom

(a) The Hydrogen Business Model (HBM) is a contractual business model for hydrogen producers to incentivise the production and use of low carbon hydrogen through the provision of ongoing revenue support. The UK launched the first round of their support scheme (aimed to support at least 250MW of electrolysis) in July 2022 (it closed in October 2022).

(b) The scheme is looking to fund a portfolio of projects that meet the allocation round's objectives, balanced across the relevant variables, including:

location, affordability, size and diversity of offtaker, energy input and operating model.

Topic	How addressed in support model
Price support	Contract for difference (i.e. variable premium) model, which guarantees producers a fixed price for their production (i.e. the strike price). The reference price against which the variable payment from the state is assessed is the actually achieved sales price, but with a price floor at the natural gas price (the HBM's logic being that this is, in their view, the most common fuel from which end users would be switching). However, to ensure that producers are not incentivised to maintain artificially low actual sales prices at the same level as the natural gas price (i.e. in the knowledge that the state support will make up the difference), the HBM will also include a price discovery mechanism, which may lead to a reduction in the level of subsidy over time.
Volume support	Partial volume support is provided indirectly via a sliding scale approach (through which the beneficiary receives greater price support for the first portion of production each year, thereby de-risking later volumes).
Capped support	The Industrial Decarbonisation and Hydrogen Revenue Support (IDHRS) Scheme has been set up to fund the HBM contracts. IDHRA will provide up to GBP100 million to procure up to 250MW of electrolytic hydrogen production capacity in 2023. Further funding for subsequent auction rounds is expected. In addition, the Net Zero Hydrogen Fund has been established to deliver GBP 240 million of grant funding to support the capital costs of low-carbon hydrogen production projects.
Eligibility conditions	There are multiple eligibility conditions under the HBM (electrolytic allocation round), as follows: (i) project location in the UK; (ii) achieve commercial operation date by end of 2025; (iii) technology readiness level of 7/10 or more; (iv) new build hydrogen production facilities only; (v) RH2 production only; (vi) identified electrolyser supplier; (vii) at least one qualifying offtake commitment; (viii) minimum of 5MW capacity per project; (ix) product must meet the UK Low-Carbon Hydrogen Standard; and (x) demonstrated access to finance. The same HBM is proposed for both RH2 production and CCUS enabled hydrogen production, however, these two technologies do not compete for support as they have separate funding rounds.
Award method	Competitive auction.

Topic	How addressed in support model
Award format	Private, bilateral contract.
Selection criteria	The selection will be made on the basis of a multi-criteria analysis, with scores being provided for: deliverability, costs, economic benefits, carbon emission and environmental factors, market development and learning and the additionality of the electricity source.
Duration	10-15 years, with a possibility (as yet unconfirmed) of contract extension or renewal.
Indexation	Proposed indexation based on the Consumer Price Index.

3.4 **Denmark**

(a) The 1.25 billion DKK (c.170 million EUR) Danish mechanism has been announced but, as at the time of writing, further details have not been published. Under the scheme, each kilogram of RH2 produced would receive a fixed subsidy, regardless of the revenues derived from the sale of hydrogen, over a period of 10 years.

(b) Eligibility will be limited to RH2 with no competing technologies. Support will be awarded through a single competitive tender to the lowest bidders (subject to a general cap on the amount of support that may be awarded).

Topic	How addressed in support model
Price support	Fixed premium mechanism.
Volume support	The subsidy is described as being paid per kg if RH2 of produced. However, further details to be confirmed.
Capped support	In addition to a general bid ceiling, which creates security against very high bid prices, a lower, budget-controlling bid ceiling will be set, which is the prerequisite for the entire budget to be allocated, if sufficiently attractive bids are received. Alternatively, two bidding rounds are held. The bid ceiling will be determined by the Danish Energy Agency.
Eligibility conditions	Only RH2 production (complying with RED II requirements). The possibility of extension to other renewable fuels is under consideration.
Award method	Market based tender. The total fund (1.25 DKK billion) is disbursed in a single tender round, although potential for a second tender round.

Topic	How addressed in support model
Award format	Private, bi-lateral contract is the assumed format.
Selection criteria	Lowest EUR value per quantity of RH2 production.
Duration	The support is provided for a 10-year period.
Indexation	No details at this stage.

3.5 **France**

(a) In France, a EUR 4.2 billion French mechanism has been proposed to support hydrogen production. The subsidy would be allocated through a competitive call for proposal with separate funding rounds for different end-uses (mobility or industry), the size of the electrolyser and the category of hydrogen (low-carbon or renewable).

(b) The production mechanism proposed in France exhibits many of the characteristics of a fixed premium scheme.

Topic	How addressed in support model
Price support	Fixed premium mechanism, with the subsidy paid annually.
Volume support	None.
Capped support	The support model is subject to two caps: (a) the aid can cover up to 100% of the additional investment costs and up to 100% of the extra operating costs compared to: (A) steam methane reforming unit with the best technological standards for the industrial sector, and (B) Fossil fuel for the mobility sector; and (b) the aid can allow for a maximum pre-tax project IRR of a certain amount, accounting for other subsidies that the project may benefit from. It is not clear whether this capping of support relates to setting the initial subsidy band within which applicants may apply for an award, or an adjustment to prevent over subsidisation in any given year (i.e. more akin to a variable premium mechanism). In either case, this type of capping is complex and difficult to calculate in practice. The link made with SMR technology is particularly problematic for the same reasons as the ones associated

Topic	How addressed in support model
	with variable premium schemes and the determination of the reference price with reference to natural gas prices. In addition, it is unnecessary to show a counterfactual under the CEEAG where the support is awarded through a competitive auction. There is also proposed to be an overall cap per tonne of CO2 avoided.
Eligibility conditions	The eligibility criteria will be limited to renewable hydrogen or low carbon hydrogen production (all technologies, except biogas) with no other competing technologies. Additionally: (a) hydrogen produced may have maximum emissions of 3 kgCO2 eq/kgH2 - aligned with the EU Taxonomy; (b) support is limited to new installations or existing facilities with significant modifications or expansions; and (c) there is a minimum capacity threshold of 30 MW of electrolysis for industry.
Award method	A competitive bidding procedure.
Award format	Private, bilateral contract.
Selection criteria	Projects will be selected based on: (a) their abatement costs expressed in EUR per tonne CO2 avoided (75% decisional weighting); and (b) other social and technological criteria such as site selection for conversion from carbon industry, energy efficiency, carbon impact of the chosen equipment, footprint, innovative nature of the process (25% decisional weighting).
Duration	Contract specific, but no greater than 15 years.
Indexation	An annual indexation will be applied based on parameters such as gas, electricity and carbon prices. The formula is, however, still to be confirmed. For the same reasons noted in relation to variable premium mechanisms, such linking to the ETS price is complex and problematic.

3.6 Germany

(a) Germany's H2Global mechanism is a EUR 900 million support scheme, dedicated to the purchase and sale of RH2 derivatives e-ammonia, e-methanol and e-kerosene (EUR 300 million for each). Eventually, the H2Global model's vision is to create a web comprised of multiple bilateral contracts on supply and demand-sides, which together function similarly to a multi-lateral market – with HINT.Co acting as an intermediary market-maker.

(b) The German Federal Ministry for Economic Affairs and Climate Action (BMWK) published its public consultation on the H2Global funding model in Summer 2022. The first global tender round under H2Global is still, at the time of writing, scheduled for the end of 2022. The EC approved EUR 900 million of State aid for this first tender on 21 January 2022.

(c) BMWK will award this EUR 900 million over 10 years to three ex-EU projects producing RH2 derivatives (specifically the funding will be split approximately equally between one project for each of e-ammonia, e-methanol and e-kerosene). BMWK has recently announced that further funding will be allocated for future rounds, up to EUR 4 billion.

(d) The scheme functions as a double auction mechanism whereby RH2 derivatives are purchased from sites located outside the EU and EFTA countries and are auctioned off to buyers situated in Europe. The bids with the lowest supply price and the highest demand price are awarded the purchase and sales contract respectively.

(e) BWMK has established the Hydrogen Intermediary Network Company (HINT.Co), a thinly capitalised entity fully owned by the German government, to act as an intermediary market maker. HINT.Co will conclude long-term (10 year) Hydrogen Purchase Agreements (HPAs) with ex-EU producers on the supply-side and short-term Hydrogen Sales Agreements (HSAs) on the demand-side with different domestic offtakers.

(f) The H2Global model is too small to make a meaningful difference. EUR 900 million split across three products and 10 years is only EUR 30 million per year per product. But it may form the basis of a similar mechanism proposed under REPowerEU which contemplates centralised purchasing of RH2. On 14 September 2022, the EC announced its intention to create a Hydrogen Bank with EUR 3 billion of funding to apply towards this objective. At the time of writing, further details are yet to be published. However, this amount is still too small to make a meaningful difference (for example, by comparison to the US Inflation Reduction Act as discussed in Section 3.7 below).

Topic	How addressed in support model
Price support	Fixed price guaranteed to the producer per unit of production (i.e. equivalent to a variable premium). A mechanism compensates for the difference in price between supply costs and the price tendered on the demand-side.
Volume support	Yes. If an HSA customer does not offtake product it has agreed to purchase or if HINT.Co is not able to sell any quantity of product, these events will constitute a take-or-pay event giving the Seller the right to payment of the full contract price.

Topic	How addressed in support model
Capped support	Approximately EUR 300 million for each of the three supported RH2 derivatives technologies for the first auction round. Further funding is anticipated to be available for future auction rounds, up to EUR 4 billion.
Eligibility conditions	On the supply side: limited to production of RH2 derivatives – namely, ammonia, methanol and e-kerosene (RH2 itself does not fall within the scope). Producers' production site must be located outside the EU and EFTA countries. On the demand side: downstream customers who are the end users of the product and who can be situated anywhere in Europe.
Award method	The scheme functions as a double auction mechanism whereby RH2 derivatives are purchased from sites located outside the EU and EFTA countries and are auctioned off to buyers situated in Europe.
Award format	Private, bilateral contract.
Selection criteria	The bids with the lowest supply price and the highest demand price are awarded the purchase and sales contract respectively.
Duration	10 years.
Indexation	Fixed support at time of award.
Other	Suppliers remain responsible for delivery to either one of the following Ports: Rotterdam; Hamburg or Duisburg. The support model requires the producer to retain significant supply chain and logistics risk and responsibility.

3.7 United States

(a) The Inflation Reduction Act (IRA) was passed on 16 August 2022. Amongst other things, the IRA aims to incentivise companies to adopt clean technologies, including hydrogen, renewables, CCUS and clean fuels, by offering investment tax credits (ITCs) and production tax credits (PTCs). Sections 45V & 48(a)(15) allow the producer of clean hydrogen to either opt for (i) an ITC (of up to 30%) or a PTC (of up to $3/kg), or (ii) elect for the facility to be considered as an energy storage property, instead of a production facility. Although the IRA outlines the framework for the PTC for "qualified clean hydrogen", a number of key details remain to be clarified through subsequent guidance, including the details of the methodology that will be used for calculating the GHG emissions intensity of production.

(b) In all, the IRA provides incentives for low-carbon supply chains that are officially estimated at over US$ 350 billion but actually are uncapped and have been foreseen by some commentators to be likely to be much greater. Further financial support is available in the US by way of federal grants and financing and local, state-based incentives.

(c) One notable difference between the Section 45V PTC under the IRA and the majority of other support schemes analysed in this paper, is that the IRA implements the state support through federal legislation rather than a private law contract (although as discussed below, Canada has recently announced a similar tax credit scheme). This, theoretically, makes the IRA support more susceptible to legislative change or challenge, which could lead to support being removed or reduced. However, in practice and in a jurisdiction such as the US, this would be unlikely given the risk of political repercussions from voters (who may have benefitted from job creation and upskilling) and investors.

(d) Generally, the IRA has had a significant ripple-effect around the world in accelerating states' desire to implement support schemes to attract investment in low-carbon technologies. One notable example likely to prove significant in the global supply chain for RH2 is the Canadian government's announcement (in its Fall Economic Statement 2022) of a support scheme (similar in structure to the IRA) for clean hydrogen production. Under the Canadian scheme, clean hydrogen producers could be awarded up to 40% ITC as well as an ITC of up to 30% being available for renewable electricity generation.

Topic	How addressed in support model
Price support	Fixed premium model, up to $3.00/kg clean hydrogen.
Volume support	None. It is a condition of payment that clean hydrogen has been used by the producer or sold to third parties.
Capped support	Uncapped amount of support available – so all qualifying investments would benefit from the award.
Eligibility conditions	To qualify as a “qualified clean hydrogen production facility” the facility must meet the following criteria: (a) It must be owned by the taxpayer claiming the PTC or ITC; (b) The facility must produce "qualified clean hydrogen"; and (c) The facility’s construction must begin before 1 January 2033. The concept is technology and neutral and applies equally to RH2 and CCUS enabled hydrogen production, however, these two technologies do not compete as they benefit from separate funding regimes. Although, producers cannot stack CCUS and clean hydrogen credits; they will have to choose one or the other.

Topic	How addressed in support model
	The definition of "qualified clean hydrogen" has the following eligibility criteria: (a) the hydrogen produced has a life cycle GHG emissions intensity below the maximum of 4kg CO2e / kg hydrogen; (b) the hydrogen is produced in the US by a US taxpayer in the ordinary course of its business; and (c) the production and sale or use of such hydrogen is verified by an unrelated party. However, to be eligible to receive the maximum PTC, producers need to produce "qualified clean hydrogen" with a GHG emissions intensity of 0-0.45kg C02 / kg hydrogen and comply with all applicable labour, wage and apprenticeship conditions.
Award method	Automatic award to any applicant that satisfies the eligibility criteria (i.e. no competitive auction).
Award format	Tax credit enacted through federal legislation (rather than private law contract).
Selection criteria	A producer only needs to satisfy the eligibility criteria to benefit from the Section 45V tax credit, there is no competition for the state support.
Duration	10-year period beginning on the date such facility is originally placed in service.
Indexation	Adjusted for inflation.

4. KEY CONSIDERATIONS FOR AN EFFECTIVE REVENUE SUPPORT MODEL

4.1 Introduction

(a) This Section analyses the key considerations relevant to each of the features that should be addressed by states in a support model. Recommendations and conclusions are provided in Section 4.12(c) of this paper.

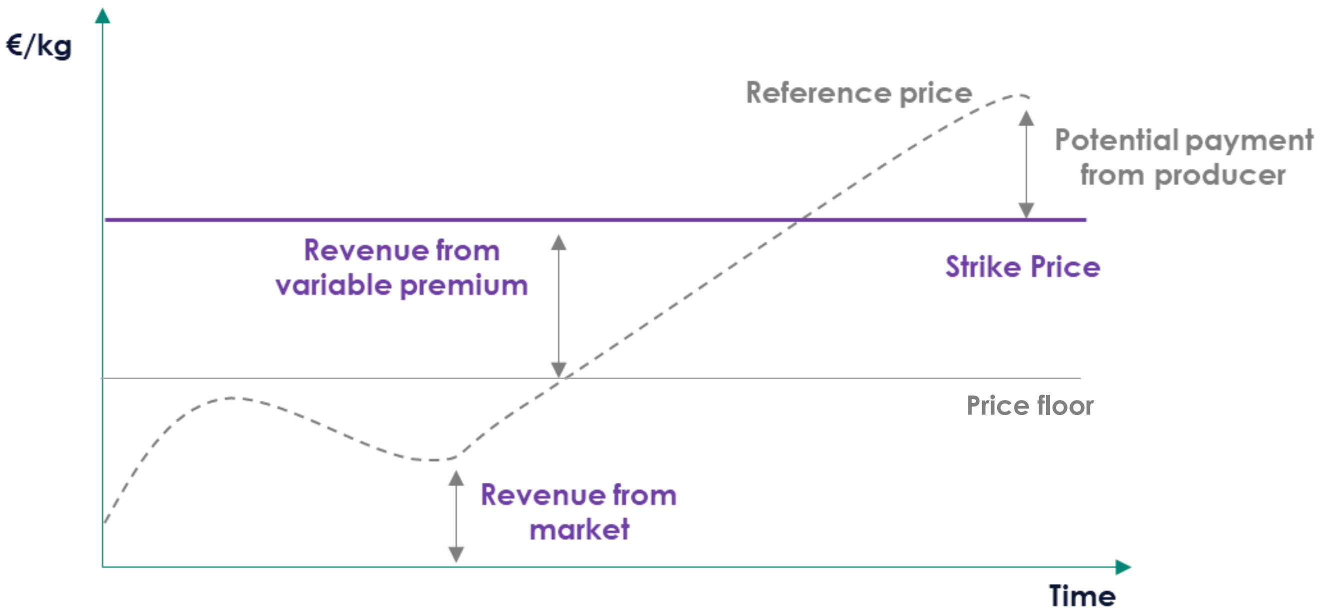
(b) A support model needs to address the barriers holding back investment that are described in Section 2. As the existing and proposed support models analysed in Section 3 illustrate, there are essentially two core designs that can be deployed (around which other details may vary): a variable premium model and a fixed premium model.

(c) In either case, private sector offtake solutions are envisaged to play a central role in mitigating volume (demand) risk (even where a degree of volume risk is assumed by the state).

4.2 Overview of a variable premium (contract for difference) model

(a) A variable premium (also known as a "contract for difference" (**CfD**)) is a mechanism under which the amount of the aid is calculated as the difference between (i) the agreed strike price and (ii) a reference price. In some cases, the amount of aid per unit of production is also capped by reference to a price floor. This can be illustrated as follows:

Figure 3: *Functioning of a variable premium / CfD mechanism*



(b) In a typical CfD model:

(i) the **strike price** represents the price (usually the sales price) that producers need to achieve to cover their production costs, financing costs and expected return on investment. The strike price value is typically determined through a competitive auction;

(ii) the **reference price** represents the value per unit of production against which the amount of aid is calculated. This could be a market price benchmark (as for the renewable electricity CfDs in the UK) or a proxy value aiming to achieve the same economic effect, which could be based on (i) a formula derived from natural gas prices (as is the case for the Netherlands), (ii) actual sales price achieved (as proposed in the UK) and/or (iii) linked to carbon prices (as is being discussed in the context of the proposed Innovation Fund Carbon Contract for Difference scheme); and

(iii) the **price floor** establishes a protection mechanism for states by capping the maximum value for the variable premium, irrespective of whether the reference price falls below the price floor.

(c) Where the reference price exceeds the strike price, producers are often required to pay back such premium to the state.

(d) The CfD model has been successfully used in the procurement of renewable electricity generation in the UK. However, in that model, the reference price used is the wholesale electricity market price, which directly reflects the price that the generator would receive for selling its power output without the support payment. This is therefore a liquid market with a transparent reference price, making the CfD model very efficient to administer and ensuring producers are not overcompensated.

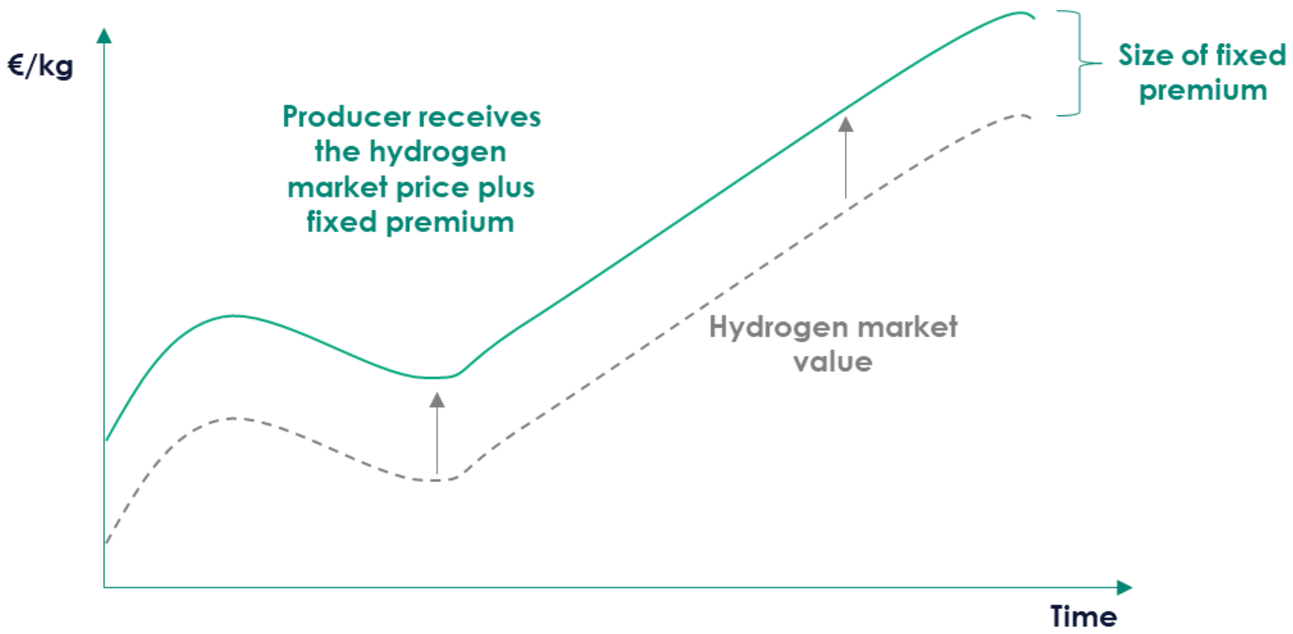
(e) The market for RH2 is different. There is no wholesale market and no widely established price benchmark for bilateral contracts. Although a variation of the CfD model has been adopted in the United Kingdom and in the Netherlands and is proposed by Germany for the H2Global model, these each have their own unique considerations (further analysed below) and have not yet demonstrated success at scale.

4.3 **Overview of a fixed premium model**

(a) In a fixed premium mechanism, each unit of production receives a fixed amount of aid, regardless of the revenues derived from the sale of product.

(b) The size of the premium can either be set based on certain pre-defined parameters (e.g. assumed costs of production and/or set by legislation) or can be established through an auction.

Figure 4: Functioning of a fixed premium support mechanism



(c) A fixed premium mechanism, therefore, creates an incentive for producers to seek the highest price for each unit of production they sell on the market (which will help in the long-term with private sector price formation). This can be seen as both an advantage and disadvantage of the mechanism, as will be further explored below.

(d) The fixed premium model is used in the USA (the Inflation Reduction Act) and has been proposed in France.

4.4 **Variable premium / CfD model – pros and cons**

(a) The key pros and cons of a variable premium / CfD model are:

Pros	• A CfD prevents the scheme from over-supporting the beneficiary because states can be repaid where the reference price exceeds the strike price. An alternative is that producers and states share any such premium. This would incentivise producers to achieve the highest possible price while also compensating the state for part of this gain, thereby reducing the overall cost to the state of the support provided. This revenue sharing scheme replicates (in part) the key commercial attraction for states of a CfD model and approved by the EC in the Hinckley Point C decision (i.e. where there is payback to the states above the agreed fixed strike price) while also incentivising producers to achieve highest possible prices. • A CfD is better able to compensate for a variable funding gap, e.g. if there is volatility in the reference price.

	• From a state's perspective, the price floor will protect from any potential over-exposure associated with low sale prices.
Cons	• There is no transparent market index for RH2 that can be used as the reference price. As a result, for RH2, the reference price would need to be a proxy based on (for example) a bespoke formula linked to either (i) natural gas prices, (ii) actual sales price achieved (iii) the ETS prices, or a combination of those. • Such an approach will be, in turns, difficult to link with any degree of accuracy to the costs of RH2 production and/or burdensome to administer. These factors are further considered below. • Producers are not incentivised to maximise the sales price since they know they will be kept whole between the price floor and the strike price.

Options for setting a reference price for RH2 production

Natural gas price

(b) A reference price linked to the natural gas price would not be the most appropriate benchmark to support RH2 production.

(c) Although many think of the natural gas price as the "counterfactual scenario" against which to compare RH2, the CEEAG does not require MSs to conduct a counterfactual analysis when a support scheme is to be implemented through an auction. In any case, the grey hydrogen price, which a natural gas benchmark indirectly references, is not always going to be a commercially relevant counterfactual for sale of RH2. RH2 will be used in different sectors with very different price and volume dynamics than grey hydrogen. For many reasons, there are applications for RH2 that grey hydrogen will not compete in (e.g. in the use of RH2 as a fuel where the competing technology is diesel/gasoline/kerosene or in the production of low-carbon steel, where the competing technology is coal-based blast furnaces). In Europe, RH2 and grey hydrogen are, in essence, going to be different markets.

(d) One illustration of this, is that a consumer of grey hydrogen cannot switch to RH2 easily, even if simplistically there were a cheaper available source of RH2 available, because switching would require such consumer to make capital investments and change production processes. Such changes take years to design, plan and build. The reason for this is that most grey hydrogen consumption at the moment in Europe is so-called "captive",[8] meaning that

8 In 2021, captive production capacity accounted for 72% of total conventional hydrogen production capacity in Europe (Source: Clean Hydrogen Monitor 2021, Hydrogen Europe)

the production and consumption of grey hydrogen takes place in integrated industrial facilities. In other words, comparing the price of RH2 with grey hydrogen is only useful for long-term and strategic planning, but not for the purposes of real-time competition and price formation.

(e) Furthermore, natural gas is not a cost input for RH2 production, therefore, changes to natural gas prices do not cause, or even correlate with, changes in a RH2 project's costs and revenues. As a result, any linkage of revenues to the natural gas price will create uncertainty and added complexity for investors and financiers. We are seeing this dynamic at present in European electricity markets, where renewable electrons are still priced by reference to gas-generated electrons, leading to calls for policy intervention to separate (or cap) pricing based on generation technology.

(f) The support model proposed in the UK makes reference to the natural gas price as one of a number of reference prices to be used to size the aid. However, this makes more sense in the context of the UK support model, which is seeking to support blue hydrogen as well as RH2. Although, in the context of RH2 projects, a number of market participants have questioned the logic of such link with the natural gas price, supporting the scepticism expressed above.

Carbon / ETS price

(g) A model in which the size of the aid is determined relative to the price of ETS allowances (or another relevant to carbon market price for projects outside the EU) is known as a "carbon contract for difference" (CCfD). However, a support payment linked to the ETS allowance price is also not fully suitable to support RH2 production (in particular not in the current version of the ETS).

(h) Firstly, the GHG emission savings from the use of the RH2 differs considerably depending on the sector in which it is used, therefore the break-even price (expressed as a function of the ETS price) at which RH2 becomes competitive with alternative technologies or fuels differs depending on its end use.[9] Use of RH2 is outside of the control of the producer. This makes the definition of a universally applicable formula for calculating the reference price by linking it to the ETS price impossible.

(i) Secondly, ETS allowances are not currently a revenue stream for RH2 production projects,[10] therefore, similar to natural gas prices, changes in ETS

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9 The use of 1 kg of RH2 avoids ~7-9 kg of Co2 when it replaces grey hydrogen (e.g. when used for ammonia production or in refineries), avoids ~22-43 kg of Co2 when it replaces the coal in the steel sector) and avoids ~20 kg of CO_2 when it replaces diesel in road transport.

10 The proposed revision of the ETS under Fit for 55 aims to change the definition of hydrogen production so that RH2 producers fall within the scope of the ETS, which would make them eligible to receive free ETS allowances (although how many will depend on a number of other changes to the ETS which have not yet been a tabled and therefore the significance of this to RH2 producers remains to be seen). In any case, these free allowances will be gradually phased-out as the carbon border

prices do not cause or even correlate with changes in a RH2 project's costs and revenues. If and when ETS allowances become a revenue stream for RH2 producers, there would then be more logic in linking the size of aid to the ETS allowance price. However, at that point there will be a number of other changes to the ETS (including the phase-out of free allowances) making any linkage to the ETS fraught with complexity and uncertainty, which will not be attractive to investors or financiers.

(j) Finally, many of the sectors with which RH2 will compete as an alternative technology receive free ETS allowances (but RH2 producers currently do not). Therefore, an increase in the EU ETS price will not necessarily improve RH2's competitiveness, since (theoretically) producers in those sectors will not pass on EU ETS costs to customers to the extent of the free allowances they receive.

(k) For these reasons, a CCfD would only be suitable where all of the above variables are known and the details of the aid can be specifically designed around them. That is to say, a CCfD would be more suitable as a demand-side aid measure but is not suitable for aid measures on the supply-side. Perhaps for this reason, none of the RH2 production support models currently proposed are explicitly linked to the ETS allowance price or to any other carbon market.

Final sales / estimated sales price

(l) A CfD could be designed to vary based on specific price estimates (established by the state) for the use of RH2 in specific sectors or based on the actual sales price achieved by beneficiaries. A variation of the final sales price approach has been adopted by the UK.

(m) The main drawback of a reference price based on the actual sale price achieved by the beneficiary is the administrative complexity involved with managing such a system. It would also limit the incentive of the beneficiary to maximise the value it could get from the sale of the RH2, as the beneficiary would be entitled to the same strike price, irrespective of the price negotiated with offtakers (at least down to the level of the floor price).

(n) The latter issue can be mitigated by a system in which the beneficiary and the state share any income achieved above the strike price, creating an incentive for the beneficiary to negotiate prices beyond this level, while also reducing the overall financial burden on the state.

(o) A mechanism using pre-determined reference prices for specific end-use sectors (e.g. which could be calculated on the basis of estimated break-even prices in each such sector) would avoid the administrative burden of needing to audit sales prices. However, there would be a significant administrative process involved in setting each technology-specific reference price in the first place (which would be likely to be highly controversial). In addition, this model removes one of the key attractions for states of a CfD model – i.e. the

adjustment mechanism (CBAM) is phased-in (and even if the CBAM does not extend to hydrogen in the first phase this is likely it will eventually).

ability to ensure no over compensation and allow states to recoup upside in the event the reference price exceeds the strike price.

(p) In conclusion, linking the support to a reference price at this early stage of the RH2 market creates significant complexity and uncertainty which will be unattractive for investors and financiers. Primarily, this is due to the difficulty in identifying a suitable reference price benchmark. As an established price benchmark for RH2 emerges, states could consider a CfD model for future support rounds. However, at this stage, it does not seem a suitable mechanism without significant administrative burden being placed both on the beneficiaries of the aid and the state (all of which will ultimately delay investments being made).

4.5 Fixed premium model – pros and cons

(a) The key pros and cons of a support model structured as a fixed premium are summarised in the following table:

Pros	• Simple to design with very low administrative input required to operate by states. • Predictable level of revenue for the lifetime of the support scheme, which will be attractive to investors. • Producers are incentivised to obtain the highest possible sales price, which is likely to help with private sector price formation as well as offering producers opportunity to maximise their up-side. Furthermore, producers which direct RH2 towards offtakers who value it the most are likely to be the ones bidding for the smallest aid premium, thereby, minimising state-aid support necessary for the investment to take place. • Similarly, it is also likely that there will be a correlation between the offtakers who value RH2 the most and the CO2 emission savings achieved for each kg of RH2 consumed, thereby such a mechanism will be likely to have the highest impact on the reduction of GHG emissions.[11] • A fixed premium leaves more price risk with the RH2 producer thereby potentially aligning more closely with the principle in para. 123 of the CEEAG that the risk of price variation should remain with the beneficiaries of aid (at least to the extent consistent with achieving the objectives of the aid in the first place).
Cons	• The fixed premium may not cover the entire funding gap (but this will be driven by the competitive tension and level of uptake during the auction). Ultimately, this may be seen as an

[11] Although, it should be noted this is not always the case, such as in the case of steel, where the break-even price is lower than in the transport sector (with lower emissions reductions than in the steel sector).

advantage for states because this would only be the case if there is sufficient competition for the private sector to be required to take some of this risk, which will reduce the amount of aid.

- May be seen to have the potential to "over compensate" RH2 producers, if market revenues evolve such that RH2 production would have been competitive even without the aid. Although this is a theoretical possibility, in the immediate term due to supply chain bottlenecks, high prices of energy and increases in capital financing costs, it is unlikely that the cost of RH2 production will fall. In any case, this could alternatively be seen as part of the incentive for producers to maximise sales prices and therefore maximise their return. Such an approach will help with the development of the RH2 market and private sector price formation, thereby reducing the role of aid to facilitate future projects. Although, in the long term, with technology improvement and economies of scale, prices of RH2 production may well fall, states can control for this during subsequent auction rounds (since such efficiency gains would not impact on projects already under construction).

- The RH2 use cases with the lowest break-even price will be the last ones to adopt the technology. This may run contrary to some long-term policy goals that some states may wish to pursue. Should states, due to long-term and deep decarbonisation objectives, want to pursue policies which enable the adoption of RH2 in areas with low break-even points, they should consider deploying demand-side incentives in addition.

4.6 Demand (volume) risk

(a) The CEEAG states that market risk (otherwise known as volume or demand risk) should remain with the beneficiary of the aid (unless this undermines the objectives for which the aid is required). Given, as noted above, the early market for RH2 is characterised by bilateral offtake agreements it seems plausible that, given the right level of price support, the private sector would naturally manage volume risk by entering into such long-term sales arrangements. This would be a producer's route to market in any case.

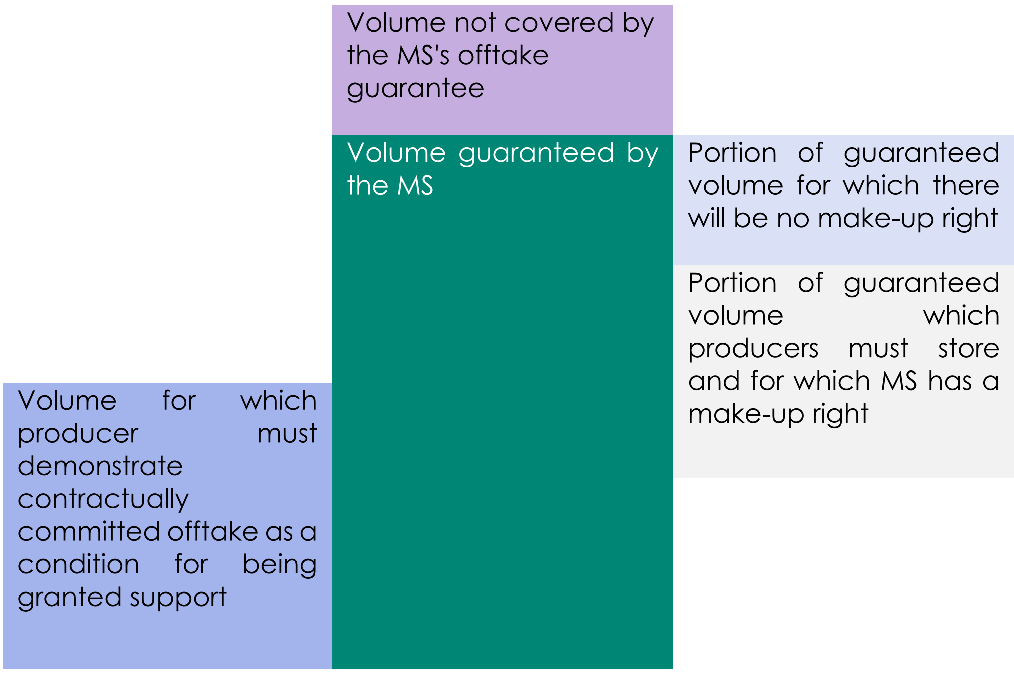
(b) To provide volume support in a CfD model (which typically requires the sale of the product therefore the aid payment is triggered), states would need to act as a form-of "offtaker of last resort". This would essentially provide a guaranteed level of volume offtake to the project if the project cannot sell its volumes in the market. This could potentially be for less than 100% of volumes or at a discounted price.

(c) This would not necessarily require physical lifting of products by the state because it could be settled through a 'take-or-pay' obligation (i.e. the state can pay for the volumes without having to lift them). To avoid situations of "curtailment" of RH2 production, minimum levels of storage could be envisioned on site (or off-site, in appropriate storage facilities) which may be used for unsold volumes, alternatively, unsold volumes subject to take-or-pay obligations could be injected into the national gas grid on behalf of the state (up to the level at which it is feasibly possible). This will ensure that all RH2 produced, still carries with it a residual value, at least equal to its energy content replacing the equivalent amount of natural gas. However, achieving this would likely require a number of other regulatory interventions which may be complicated.

(d) Take-or-pay payments could be combined with a 'make-up' right for the MS (similar to gas sales arrangements) – i.e. in this case, the state would have the right to be repaid for the volumes for which the take-or-pay payment has been triggered when they are actually sold to arms-length customers and producers could be obliged to sell some of these volumes before any new production. To further mitigate the state's exposure, the award of support could be conditional on demonstrating a certain volume of contracted offtake commitments. This is illustrated in the following figure.

(e) Such a backstop mechanism is similar to the "shadow-tolls" used for toll-road operators where states provide traffic-level guarantees.[12]

Figure 5: *Illustration of volume support under a CfD mechanism*



12 See for example, State aid No N 149/2006 – Ireland Traffic guarantee for M3 Clonee to North of Kells and N7 Limerick Southern Ring Road Phase II

(f) Similarly, fixed premium support schemes typically only apply to volumes that have been produced and delivered to offtakers and thereby do not shift any volume risk away from producers.

(g) However, the fixed premium level at which a producer will bid for support is likely to be sufficient to allow the establishment of long-term contracts with reliable offtakers for a sufficiently large portion of the production volume, thereby indirectly resolving inherent volume risks.

(h) An alternative, would be to apply a sliding scale mechanism (as is the case in the UK) which pays out a higher proportion of the overall aid for the first volumes sold in any year, thereby removing some of the volume risk in relation to later volumes.

(i) Ultimately, it is likely to be politically very challenging for states to accept giving a full, or significant, volume guarantee for RH2 production. The reason for this is that the early market for RH2 will be characterised by private sector clusters of demand (e.g. industrial users) meaning that any such state guarantee may be perceived to benefit only a minority of private sector actors. By contrast, states providing guarantees to procure greater renewable electricity capacity typically justify such action as being in the national interest (i.e. enhancing availability of low carbon electricity for the population as a whole).

(j) However, before the 2030 quotas have come into force, private sector offtakers are unlikely to be able to commit to the volumes required to make RH2 production projects bankable (even with the price support described in this paper). States should therefore consider providing temporary volume support (e.g. until 2030) at a level sufficient to ensure long-term private sector offtake contracts can be entered into with bankable volume commitments. Essentially, states would be bridging the gap before the mandatory demand-side quotas come into force to support market demand (that is, if states do not introduce such quotas earlier).

4.7 **Eligibility conditions**

(a) A key choice to be made when designing support schemes is whether to open the scheme to competing technologies or to ringfence different rounds / windows for specific technologies. The CEEAG generally prefers schemes that are open to a broader range of potential beneficiaries as they are likely to have a more limited distortive effect on competition than support targeted at a limited number of specific beneficiaries only.

(b) However, the CEEAG acknowledges the right of MSs to restrict eligibility to certain objectives (where it has justification for doing so). MSs must give reasons for proposing measures which do not include all technologies and projects that are in competition – for example, all undertakings producing substitutable products and which are technically capable of contributing efficiently to GHG emissions.

(c) Perhaps the most important justification relevant to limiting the aid to RH2 production, is that doing so targets a specific sectoral or technology-based target established in EU law (namely, the targets under Fit for 55 for RH2 use). This would be a justification for limiting a support scheme to RH2 only (excluding blue hydrogen as well as other forms of decarbonisation measures).

(d) The scheme in Denmark is limited to hydrogen produced from renewable sources (no competing technologies) while the schemes in France and the UK are open to renewable hydrogen or low carbon hydrogen production (all technologies, except biogas) with a maximum of 3 CO2kg/H2kg / 2.4 CO2kg/H2kg respectively. In the Netherlands, hydrogen competes with a number of other technologies for aid.

(e) Given the early stage of market deployment, it is to be expected that the abatement cost of RH2 technologies is higher in the short term, than other, more established, technologies such as biofuels and CCS. This will severely disadvantage RH2 technologies in broad competitive auctions awarded on the basis of abatement costs alone.

(f) Given the imperative of achieving the RH2 targets established under Fit for 55 and REPower EU, aid measures should be designed in a way that does not favour the more mature, abatement technologies to the detriment of RH2. In order to achieve this, it is necessary to restrict eligibility for schemes only to RH2.

(g) Similarly, the introduction of RH2 in industry and in the mobility sectors are characterised by different break-even points / CO2 abatement costs. As RH2 is necessary for the long-term decarbonisation of both sectors, it may be beneficial for separate aid schemes to target each sector, allowing both sectors to start ramping up this decade.

(h) In addition, sub-quotas of aid for specific industrial applications could be adopted (e.g. similar to the approach under H2Global) to ensure adequate distribution across industrial uses.

(i) A differentiation between projects with dedicated new-build renewables and existing electricity generation supply may also be considered. The support model should allow for (but may differentiate between) both projects that utilise dedicated new-build renewable power assets (and therefore have significant power generation capex to amortise) as well as projects that use power purchased under PPAs with electricity suppliers from existing / third-party built assets (and therefore have significant opex, although this could be managed through hedging).

4.8 Selection / award criteria

(a) The selection criteria employed in the currently proposed aid schemes varies significantly. The criteria used are (i) the abatement cost in FR and NL, (ii) the amount of subsidy (fixed premium) in DK and (iii) a multi-criteria assessment in the UK.

(b) In the EU, from 1 July 2023, the subsidy per tonne of CO2 equivalent emissions avoided must be estimated for each subsidised project under State aid rules, however, this does not mean, according to the CEEAG, that the abatement cost must necessarily be used as the (sole) selection criteria.

(c) The selection criteria used for ranking bids and, ultimately, for allocating the aid in the competitive bidding process should, according to the CEEAG, as a general rule, put the contribution to the main objectives of the measure in direct or indirect relation with the aid amount requested by the applicant. This may be expressed, for example, in terms of aid per unit of environmental protection or aid per unit of energy (i.e. RH2 produced).

(d) The CEEAG recognises that it may also be appropriate to include other selection criteria that are not directly or indirectly related to the main objectives of the measure. In such cases, these other criteria must account for not more than 30% of the weighting of all the selection criteria. This opens up for the possibility to add other criteria which are relevant to the policy objectives pursued, but not necessarily linked with the amount of RH2produced / sold or the CO2 abatement achieved.

(e) It is important to note that there may be two distinct objectives that can be pursued by states (i) reducing emissions as much and as cheaply as possible and (ii) support the development of technologies (such as RH2 production and use) in different sectors which can have a higher abatement cost.

(f) Expressing the selection criteria in terms of abatement cost is cost-effective in terms of illustrating CO2 reduction. However, depending on the choices made with respect to eligibility, this approach may have two drawbacks.

(g) Firstly, the actual CO2 abatement achieved for each unit of RH2 sold is not always and fully known in advance by the RH2 producer, as it is highly dependent on the sector in which the RH2 is sold and the fuel / technology it replaces (as noted above). Therefore, it may not always be possible for the applicant to express its bid in such terms, without fully secured offtakers (and even then, it may not be certain, if the offtakers are traders).

(h) Secondly, in attaining deep decarbonisation and/or longer-term objectives, certain MSs would wish to pursue the use of RH2 in sectors in which the CO2 abatement cost is currently higher than in other, more accessible applications. Something that would not be achievable if aid beneficiaries would seek to maximise their chances by targeting low-hanging fruit in terms of CO2 abatement costs.

(i) The drawbacks above can be overcome by either expressing the main selection criteria in terms of EUR/ KG of H2 (which can then be converted to EUR/ tonne of CO2 for illustration only, as required under CEEAG). This is also more aligned with the objective of stimulating sufficient volume of RH2 production to meet the targets in Fit for 55 and REPower EU (which are described in terms of quantity of RH2, rather than CO2 abatement).

4.9 **Selection process**

(a) The CEEAG illustrates a very strong preference for competitive auctions as the most appropriate means to enable compliance of the aid measure with proportionality requirements, ensuring the cost-effective allocation of aid and reducing competition distortions.

(b) Importantly, the disbursement of aid via competitive auctions frees MSs from the requirement to conduct detailed assessments of the net extra cost (funding gap) for each project awarded.[13] This eliminates many of the difficulties associated with the need to link the aid to a generally applicable counterfactual situation, such as the natural gas, or grey hydrogen price, which, as explained above, are unsuitable for supporting RH2 production projects.

(c) For this reason, states should implement support schemes through a competitive auction process. In addition, states should designate the amount of available funding for each auction round. This would be both a matter of good public financial management as well as align with the principle in the CEEAG of imposing budget or volume restrictions in competitive bidding processes to ensure adequate competition between bidders for the available support levels.

4.10 **Indexation of aid over time**

(a) Indexation of the support payments might include adjustments to reflect inflation, electricity prices, carbon prices and/or other specific taxation of competing products (e.g. grey hydrogen). Some of the support mechanisms proposed consider indexation based on a variation of these. For example, in France the amount of the premium provided will be indexed based on a formula that will take into account electricity prices, ETS allowance prices and taxation of grey hydrogen.

(b) *Inflation:* Given the current macro-economic scenario, indexation linked to inflation should be included as part of the support model, since the risk of currency inflation eroding the value of the support payment cannot easily be mitigated by the private sector.

(c) *Electricity prices:* As discussed above, RH2 producers could be required to mitigate this risk through their PPA terms and pricing (or hedging) prior to submitting their bid, which will need to assume a fixed input cost for electricity purchases. This will incentivise the most efficient purchasing choices by producers (e.g. producing RH2 only when electricity prices are low or even negative where using grid electricity).

(d) *Carbon prices and taxation of grey hydrogen:* As explained in the section associated with the determination of the reference price in variable premium schemes, carbon prices and grey hydrogen taxation (both of which are part of the cost structure of grey hydrogen) are not relevant in determining the costs nor the revenues of renewable hydrogen producers, therefore, they are

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13 Para. 49, CEEAG: *A detailed assessment of the net extra cost will not be required if the aid amounts are determined through a competitive bidding process, because it provides a reliable estimate of the minimum aid required by potential beneficiaries*

not appropriate criteria for altering the amount of aid received by such beneficiaries.

4.11 **Delivery mechanism**

(a) Delivery through a private law contractual framework with appropriate governing law and dispute resolution forum (especially via investment treaty protection) has advantages over establishing the framework for the support payment through regulation.

(b) A private law contract framework will be more acceptable to producers and their financiers than a regulatory framework model. A private law contract typically gives investors better protection against the risk of policy change through customary "change in law" protection mechanisms (e.g. cost and revenue stabilisation) in the event a change in policy exposes producers to higher costs, reduced revenues or even withdraws the support mechanism. However, the choice of law and dispute resolution forum will also need to take into account the protections that international investors will require to raise financing. This will strongly favour English or New York governing law with non-EU arbitration as a dispute resolution forum, to reduce the difficulties caused by the ECJ's current approach to investment treaty protection.

(c) In addition, in many jurisdictions, investors and their financiers will be keen to ensure that the beneficiary of the support is established in a jurisdiction which would allow enforcement off claims against the relevant state and applicable bilateral investment treaties (BITs). Since intra-EU BITs have been abolished and some MSs have opted to leave the ECT, if EU MSs wish to capitalise foreign direct investment to support RH2 production, they will need to facilitate the beneficiary of the aid being established in a jurisdiction which has a suitable BIT in place (in practice, this likely means the US, UK, Switzerland or Singapore).

4.12 **Others**

(a) **Organise multiple rounds, with limited budget** to limit a state's exposure. The support could be limited to an initial target volume of RH2 project capacity and/or a fixed funding budget (or combination of the two). This support model would be designed as a 'kick-start' to bring production online in the 2020s. After this initial batch of projects, the level of support offered by states could be reduced (and, potentially, eventually removed) as the market matures. States are not committed to providing the same support mechanism for future rounds of projects and do not need to commit to future funding obligations at this stage.

(b) **Volume scaling** should only be permitted if it is contractually committed to by the developer at the point the project is awarded support (and therefore the relevant funding for such expansion can be committed by the state) i.e. a phased development. This should, though, be subject to meeting prescribed development milestones and longstop dates (i.e. to ensure the support has the desired effect of bringing production online in the 2020s and is not open-ended).

(c) **The duration of the support contract** awarded to each individual project will need to be for the maximum duration amount allowed under CEEAG – i.e. 10 years. Even this period may be challenging, since the tenor of the financing for the construction of the project is likely to be longer than this (e.g. 15 years, at least). Outside the EU (e.g. in the UK), investors should seek longer to more closely align the duration of the support with the tenor of project financing.

5. CONCLUSION

(a) The high costs of RH2 production compared with alternative, competing fossil-based products or technologies is the main barrier to ensuring long-term and sustained demand for RH2. Until this issue can be resolved (through reduction in the production cost of RH2 overtime) states will need to play a role in supporting the development of the nascent RH2 market.

(b) The key features of an ideal revenue support model are summarised in the table below.

***Figure 6:** Key features of ideal revenue support model*

Topic	Description
Method of award	States should design support schemes as competitive auctions through which potential RH2 producers compete for aid. The economic value of the aid should, in theory, be designed so as to cover the funding gap, although what the value of this funding gap is would be determined through the competitive auction.
Price support mechanism	States should award a fixed premium for each unit of RH2 sold. States thereby absorb a degree of price risk. The amount of the premium awarded per unit of RH2 would be determined through the competitive auction. A fixed premium scheme appears more suitable to catalyse rapid investment in RH2 production at this stage of the market then a CfD model. Primarily, this is due to the uncertainties and complexities associated with defining and administering a suitable reference price, which are likely to complicate the design and implementation of a suitable CfD model, thereby holding back investment.
Volume (demand) support	The fixed premium price support will enable RH2 producers to enter into long-term supply contracts with offtakers for a sizeable portion of their production, thereby mitigating volume (demand) risk. However, states should provide partial volume support to bridge the gap before mandatory demand side quotas come into force and have operated for a sufficient period of time to prove stability and robust market creation.

Topic	Description
	This could be done through a sliding scale mechanism, whereby a greater multiple of the fixed premium is paid for the first quantities of RH2 sold in each year. Such quantities would be determined through the competitive auction.
Limited to initial projects / funding cap	States should define the initial total value or capacity of projects to be supported. There is no obligation on states to offer support to additional projects after the scheme value / capacity has been awarded. This is the way for states to manage risk associated with excessive spending as happened with Spanish renewables.
Narrow eligibility criteria	Eligibility under each funding window should be defined narrowly in the first stage, restricted only to RH2. If support to low-carbon hydrogen is pursued as a policy, it should be done in a separate window, to avoid competition between the two types of production methods. Otherwise RH2 production risks being pushed out by more mature solutions with lower abatement costs in the short term (e.g. CCS). Separate aid windows targeting industry and mobility applications may also be considered, ensuring ramp-up of RH2 use in both sectors. However, these could also be supported through demand-side measures.
Selection criteria	The main selection criteria should be the fixed premium value, expressed in EUR/KG of RH2.
Adjustment / Indexation	An annual indexation based on inflation may be considered, however, direct links to natural gas prices and/or carbon prices should be avoided, as they do not represent cost and revenue streams for producers.
Period in which support scheme is required	Projects taking final investment decisions between 2023-2025. Potential extension post-2025 depending on the evaluation of RH2 market conditions. A short availability period will better incentivise rapid investment decisions by RH2 producers, to ensure they can take advantage of the state support.
Duration of support	The maximum period allowed under CEEAG requirements (10-year term), longer outside of the EU.
Delivery mechanism	Private law contract. This protects investors from change in law risk. The choice of law and dispute resolution forum both need to be ex-EU and, ideally, with the beneficiary incorporated in a jurisdiction with adequate BIT coverage with EU MSs (e.g. the US, UK, Singapore and Switzerland).

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Hy24 is a joint venture between Ardian, Europe's largest private investment house with managed assets of c. $114 billion, and FiveT Hydrogen, the 360° financial partner exclusively to the clean-hydrogen industry. Hy24 combines Ardian's premier infrastructure fund management record with FiveT's unparalleled hydrogen expertise and network. It will scale up the global hydrogen economy through first-mover investment opportunities perfectly aligned with the universal ESG agenda.

Hy24's first impact fund closed at €2 billion of allocations on 10'th October 2022, exceeding its initial ambitions. This makes it the world's first and largest infrastructure fund to invest exclusively in the entire clean hydrogen value chain.

The Fund's creation has been supported by the founding anchor investors Air Liquide, VINCI Concessions, TotalEnergies, Plug Power, Chart Industries and Baker Hughes.

It has then attracted more than 50 prominent investors from 13 countries in the Americas, Europe and Asia, including major industrial companies, corporations, banks, pension funds and insurance companies – industrial anchor investors, including LOTTE Chemical, Airbus, and Snam, Enagás, GRTgaz (together as one anchor partner), and the financial anchor investors AXA, Crédit Agricole Assurances, CCR, Allianz, CDPQ and JBIC – as well as other key investors, including Ballard, Schaeffler, Groupe ADP, EDF, Caisse des dépôts, DBJ and Itochu.

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