Key considerations for green hydrogen offtake agreements

Executive summary

Genuinely 'low carbon' and 'green' hydrogen sectors are expected to play an increasingly significant role beyond 2040 in a carbon-neutral energy system. This is particularly true for hard to abate sectors where electrification is only partially possible – for example, in the heavy industrial, chemical, and long-haul transportation sectors.[1]

However, given the nascent stage of the sector, one of the key hurdles to establishing a global green hydrogen market will be the development of bankable offtake arrangements which regulate the sale, purchase, storage and supply of green hydrogen (and its derivatives).[2] Research by BloombergNEF reports that, of all clean hydrogen capacity planned by 2030, only 10% of announced projects have identified a buyer.[3] This gives rise to an important 'chicken-or-egg' scenario for the green hydrogen sector: developing green hydrogen projects at scale will remain challenging without bankable forms of offtake agreements and, similarly, it will be difficult to negotiate bankable hydrogen offtake agreements without there being sufficient projects to establish an international market to trade hydrogen and its derivatives.

There is, however, a strong and growing appetite to invest in the production and supply of green hydrogen globally. Governments are keen to attract inbound investments for hydrogen projects in their jurisdictions, project developers are motivated to invest in green hydrogen technologies as part of their decarbonisation ambitions, and project financiers and development finance institutions are looking to fund green hydrogen projects as part of their plans to transition away from fossil fuels. This appetite is reflected by the fact that several of the public and private funding processes held to date have been oversubscribed.[4] There are also a growing number of notable contract-

[1] United Nations Economic Commission for Europe, *Technology Brief – Hydrogen* (17 February 2022), 1.

[2] Some examples of these adjacent chemical compounds include (i) 'green ammonia', which is carbon-free ammonia produced using methods such as combining green hydrogen and nitrogen separated from the air; (ii) 'green methanol', which is made from green hydrogen and biomass or captured CO_2; (iii) 'safe aviation fuel' (or SAF) using green hydrogen; and (iv) low-carbon iron that can be used in steelmaking, such as 'Hot Briquetted Iron' (or HBI) ('*Adjacent Chemical Compounds*').

[3] 'Hydrogen offtake is tiny but growing', *BloombergNEF* (Blog Post, 14 November 2023) <https://about.bnef.com/blog/hydrogen-offtake-is-tiny-but-growing>.

[4] For example, the NEOM green hydrogen project in Saudi Arabia. This project achieved financial close in May 2023 and was over 2x oversubscribed, being financed on a non-recourse basis by a consortium of 23 banks and investment firms. See 'NEOM Green Hydrogen Company completes financial close at a total investment value of USD 8.4 billion in the world's largest carbon-free green hydrogen plan', *NEOM* (Web Page, 22 May 2023) <https://www.neom.com/en-us/newsroom/neom-green-hydrogen-investment> ('*NEOM Green Hydrogen Project*'). In addition, applications for the European Hydrogen Bank's recent subsidy auction exhausted the allocated budget of €800m several times over (see section 2.3(d)); see Rachel Parkes, 'EU's maiden hydrogen subsidy auction attracted enough bids to blow the budget many times over', *Hydrogen Insight* (Blog Post, 20 February 2024) <https://www.hydrogeninsight.com/production/oversubscribed-eu-s-maiden-hydrogen-subsidy-auction-attracted-enough-bids-to-blow-the-budget-many-times-over/2-1-1600749>.

for-difference schemes and other market mechanisms led by governments around the world to facilitate investment in hydrogen projects.[5]

Considering this growing appetite, **hydrogen offtake agreements that balance the interests of producers, consumers, funders and investors alike will be critical to the bankability and commercial viability of individual projects and the sector as a whole**. While a range of market mechanisms including financial incentives, contracts for difference schemes and demand targets will be needed to bridge the price gap between green and fossil fuel hydrogen, offtake agreements and pricing mechanisms can also contribute to reducing offtake risks. These arrangements will, in turn, provide a bridge between the supply and demand markets for hydrogen and will be a key factor in determining whether hydrogen can realise its potential as a sustainable alternative to fossil fuels.

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[5] Refer to section 2.3 of this paper for an overview of various state support schemes which have been announced as at the date of this paper.

Summary of key considerations

As part the project "Good Green Hydrogen Legislation and Contracting – for People and Planet", the Green Hydrogen Organisation has worked with a group of law firms to considers the key structuring options when negotiating hydrogen offtake agreements. This paper looks at how hydrogen producers and buyers can effectively allocate risk in early-stage arrangements to improve commercial viability, bankability and give confidence to market participants. It also considers key provisions in hydrogen offtake agreements, particularly in relation to hydrogen pricing and volume regulation in long-term arrangements.

The specific areas discussed in this paper are:

Pricing options to balance risks.

- **Different pricing models and risk allocations between sellers and buyers.** In the absence of a widely accepted market practice for pricing hydrogen, parties to hydrogen offtake agreements will need to consider the pricing model which works most effectively for their specific project. Some pricing models discussed include a hydrogen Contracts for Difference model and a cost recovery plus margin model. Each pricing model have their strengths and weaknesses in respect of a particular project.

- **Integrated projects for closer risk management.** Offtake agreements for early-stage hydrogen projects will require a high-degree of trust and risk-sharing between producers and buyers. This will ultimately flow through to project structuring and offtake pricing, and is reflected by the fact the key green hydrogen projects to date have signed offtake agreements with parties that have also taken an *equity investment* or a *joint development* role with the project sponsors.

- **Price review mechanics to balance price risks.** Parties to hydrogen offtake agreements will need to consider whether to include price review mechanics in their contractual arrangements. For example, to allow the parties to adopt a more competitive pricing model if one becomes available during the offtake term.

Price review provisions typically provide a mechanism through which the parties will review the existing pricing formula under an agreement on a periodic basis or on the occurrence of certain trigger events. An example of a price review trigger may be the establishment of a widely accepted market price or index for hydrogen. An alternative is to refer to comparable sales contracts to determine market prices (an approach commonly adopted in LNG sales contracts).

Regulating volumes.

- **Flexible take-or-pay thresholds or production thresholds.** The volume regulation provisions in an offtake agreement will be critical to the producers and buyers when negotiating the contractual arrangements. This sits alongside the pricing mechanics as the key regime to be negotiated between parties, given the need to balance the interests of:

  - producers, who will want to impose strict 'take or pay' obligations on the buyer to sure up project revenues and seek external debt financing; and

  - buyers, who will be keen to ensure their contractual obligations to purchase hydrogen are commensurate to their demand requirements, whilst also ensuring that producers are on the hook for meeting minimum supply obligations.

  Regulating volumes through *flexible take-or-pay thresholds or production thresholds* can help strike a balance between providing certainty for the producer and flexibility for the offtaker.

Guaranteeing the 'green' origin of hydrogen produced

- **Robust guarantee of 'green' origin certification to mitigate greenwashing risks**. The parties will need to agree on a regime for *certifying the 'green' origin* of the hydrogen traded under an offtake agreement. The lack of physical traceability in the hydrogen delivered, particularly for grid-connected projects, can make it challenging for buyers who are keen to ensure that the hydrogen they receive, and use, is green. Parties should therefore seek to mitigate the risk of greenwashing with clear requirements specifying relevant and robust 'green' certifications required under an offtake agreement.

Technical specifications and standards for hydrogen

- Offtake agreements will need to regulate the **technical specifications and standards** for the hydrogen being delivered to the buyer. This will be heavily driven by, and vary based on, the offtaker's intended end use of the hydrogen and the regulatory reporting requirements in the relevant jurisdiction the hydrogen will be used. When negotiating hydrogen offtake agreements, producers should be careful to ensure that the hydrogen it intends to produce can comply with the offtaker's required specifications, and that there is a clear contractual regime governing the treatment of any **'off-spec' hydrogen**.

Creditworthiness and credit enhancement of offtake agreement parties

- The **creditworthiness of the parties** to an offtake agreement will be key to the **investment and bankability assessment of a project**. This will require a careful assessment of the parties' balance sheets and require adequate controls in relation to any changes in ownership of the parties.

  In particular, given the offtaker's payment obligations will underwrite project revenues, project sponsors and their financiers may require the offtaker to provide credit support (such as a letter of credit) in support of the offtaker's payment obligations, particularly if the offtaker is not *'investment grade'*.[6] Producers may also be required to provide credit support where an offtake agreement provides for two-way payment flows, such as where a CfD model is adopted.

Broader risk allocation: Force majeure and changes in law / regulations

- The broader risk allocation in a hydrogen offtake agreement will also need to be carefully negotiated to ensure risks such as **force majeure** and **changes in laws or regulations** are sufficiently robust and meet international bankability standards. This includes any **changes in the hydrogen standards** applicable to a project during the offtake term. One option to mitigate this risk is to agree an initial period during which the seller's obligations will be defined by reference to a specific version of the relevant standard, following which the seller will be required to comply with any updates to that standard.

Social licence and community engagement

- **Transparent and responsible supply chains that respect and benefit local communities**. Social licence and community engagement considerations are increasingly becoming critical to the success of individual projects, and working with and sharing the benefits of early-stage hydrogen projects with local communities will be key factors in the establishment and flourishing of a global hydrogen sector. Offtake agreements should require that project developers have obtained and comply with all relevant regulatory approvals, accreditations and certifications.

[6] See section 6.1.

1. Introduction

1.1. Context

As global efforts to achieve net-zero emissions continue to gain momentum across the international community, the 'low carbon'[7] and 'green'[8] hydrogen sectors are expected to play an increasingly significant role beyond 2040 in a carbon-neutral energy system. This is particularly true for hard to abate sectors where electrification is only partially possible – for example, in the heavy industrial, chemical, and long-haul transportation sectors.[9]

However, given the nascent stage of the sector, one of the key hurdles to establishing a global green hydrogen market will be the development of bankable offtake arrangements which regulate the sale, purchase, storage and supply of green hydrogen (and its derivatives).[10] This gives rise to an important 'chicken-or-egg' scenario for the green hydrogen sector: developing green hydrogen projects at scale will remain challenging without bankable forms of offtake agreements and, similarly, it will be difficult to negotiate bankable hydrogen offtake agreements without there being sufficient projects to establish an international market to trade hydrogen and its derivatives.

Highlighting the scale of this challenge, research recently published by BloombergNEF in November 2023 reports that, of all clean hydrogen capacity planned by 2030:[11]

- only 10% of announced projects have identified a buyer; and
- of the contracted volume, only 13% of that volume is contractually binding, another 7% is documented in pre-contractual agreements (with a strong chance of becoming binding contracts) and the remaining 80% is made up of either memorandums of understanding or is unspecified.

There is, however, a strong and growing appetite to invest in the production and supply of green hydrogen globally. Governments are keen to attract inbound investments for hydrogen projects in their jurisdictions, project developers (particularly the oil and gas majors) are motivated to invest in green hydrogen technologies as part of their decarbonisation ambitions, and project financiers and development finance institutions are looking to fund green hydrogen projects as part of their plans to transition away from fossil fuels.

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[7] 'Low carbon' or 'low emissions' hydrogen is a reference to hydrogen produced through a variety of pathways with lower carbon emissions.

[8] 'Green hydrogen' refers to hydrogen that is produced by electrolysis using renewable electricity. This is discussed further throughout this paper.

[9] United Nations Economic Commission for Europe, *Technology Brief – Hydrogen* (17 February 2022), 1.

[10] Some examples of these adjacent chemical compounds include (i) 'green ammonia', which is carbon-free ammonia produced using methods such as combining green hydrogen and nitrogen separated from the air; (ii) 'green methanol', which is made from green hydrogen and biomass or captured CO_2; (iii) 'safe aviation fuel' (or SAF) using green hydrogen; and (iv) low-carbon iron that can be used in steelmaking, such as 'Hot Briquetted Iron' (or HBI) ('*Adjacent Chemical Compounds*').

[11] 'Hydrogen offtake is tiny but growing', *BloombergNEF* (Blog Post, 14 November 2023) <https://about.bnef.com/blog/hydrogen-offtake-is-tiny-but-growing>.

This appetite is reflected by the fact that several of the public and private funding processes held to date have been oversubscribed.[12] There are also a growing number of notable contract-for-difference schemes and other market mechanisms led by governments around the world to facilitate investment in hydrogen projects.[13]

The demand market for green hydrogen and its derivatives also appears to be strong, albeit still developing. For example, Japan and South Korea have demonstrated a strong and long-standing desire to have hydrogen play a key role in their energy systems, and have made recent announcements of their plans to increase their target consumption in the coming decades.[14] There is also growing momentum across the manufacturing sector to leverage green hydrogen in the manufacturing process to market products as 'green' (for example, green steel).[15] There have also been emissions reductions targets announced in the shipping industry,[16] coupled with increasing orders for ammonia carriers by shipping companies, which show the early signs of a growing global demand for hydrogen.

Considering this growing appetite, hydrogen offtake agreements that balance the interests of producers, consumers, funders and investors alike will be critical to the bankability and commercial viability of individual projects (and the sector as a whole). These arrangements will, in turn, provide a bridge between the supply and demand markets for hydrogen and will be a key factor in determining whether hydrogen can realise its potential as a sustainable alternative to fossil fuels.

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[12] For example, the NEOM green hydrogen project in Saudi Arabia. This project achieved financial close in May 2023 and was over 2x oversubscribed, being financed on a non-recourse basis by a consortium of 23 banks and investment firms. See 'NEOM Green Hydrogen Company completes financial close at a total investment value of USD 8.4 billion in the world's largest carbon-free green hydrogen plan', *NEOM* (Web Page, 22 May 2023) <https://www.neom.com/en-us/newsroom/neom-green-hydrogen-investment> ('*NEOM Green Hydrogen Project*'). In addition, applications for the European Hydrogen Bank's recent subsidy auction exhausted the allocated budget of €800m several times over (see section 2.3(d)); see Rachel Parkes, 'EU's maiden hydrogen subsidy auction attracted enough bids to blow the budget many times over', *Hydrogen Insight* (Blog Post, 20 February 2024) <https://www.hydrogeninsight.com/production/oversubscribed-eu-s-maiden-hydrogen-subsidy-auction-attracted-enough-bids-to-blow-the-budget-many-times-over/2-1-1600749>.

[13] Refer to section 2.3 of this paper for an overview of various state support schemes which have been announced as at the date of this paper.

[14] By way of example, the 'Basic Hydrogen Strategy' released by the Japanese government in June 2023 announced an increase in its intended hydrogen use to 12 million tonnes annually by 2040 and 20 million tonnes annually by 2050. See Naoko Tochibayashi, 'Hydrogen is developing fast in Japan, edging nearer to wider use in society', *World Economic Forum* (Blog Post, 10 April 2024) <https://www.weforum.org/agenda/2024/04/hydrogen-japan/#:~:text=Government%20and%20municipalities'%20hydrogen%20boost&text=This%20strategy%20identifies%20nine%20key,million%20tons%20annually%20by%202040>.

[15] A clear illustration of this trend is the H2 Green Steel Project, the world's first large-scale green steel plant which is to be located in Northern Sweden. In January 2024, the project announced that it had secured €4.2 billion in project financing from a combination of commercial banks, the European Investment Bank and the Nordic Investment Bank, a €250 million grant from the EU Innovation Fund and €2.1 billion of equity funding. See 'H2 Green Steel raises more than €4 billion in debt financing for the world's first large-scale green steel plant', *H2 Green Steel* (Web Page, 22 January 2024) <https://www.h2greensteel.com/latestnews/h2-green-steel-raises-more-than-4-billion-in-debt-financing-for-the-worlds-first-large-scale-green-steel-plant> ('*H2 Green Steel Project*'). See also *Adjacent Chemical Compounds* (n 2) regarding HBI in the manufacturing process to make green steel.

[16] '2023 IMO Strategy on Reduction of GHG Emissions from Ships', *International Maritime Organization* (Web Page) <https://www.imo.org/en/OurWork/Environment/Pages/2023-IMO-Strategy-on-Reduction-of-GHG-Emissions-from-Ships.aspx>; International Maritime Organisation, *2023 IMO Strategy on Reduction of GHG Emissions from Ships*, MEPC Res 80/17/Add.1 (7 July 2023, adopted 7 July 2023) annex 15 s 3.3.

1.2. Purpose of this paper

As part the project "Good Green Hydrogen Contracting – for People and Planet", the Green Hydrogen Organisation has worked with a group of eight law firms to establish good contracting standards and practices in the green hydrogen industry.

This paper was prepared by Herbert Smith Freehills and considers the key structuring options when negotiating hydrogen offtake agreements. It also considers:

- how hydrogen producers and buyers can effectively allocate risk in early-stage arrangements to improve commercial viability, bankability and give confidence to market participants;
- key provisions in hydrogen offtake agreements, particularly in relation to hydrogen pricing and volume regulation in long-term arrangements; and
- the various state-funded market mechanisms introduced by governments around the world, and other initiatives of development finance institutions supporting governments of developing countries, to facilitate investment in hydrogen projects.

1.3. Terms of hydrogen offake agreements

The terms of a hydrogen offtake agreement will vary on a project-by-project basis.

Given the different avenues for producing and delivering hydrogen, these agreements will, by their nature, incorporate characteristics from offtake agreements across different parts of the energy sector. Green hydrogen offtake agreements will therefore likely resemble a 'hybrid' blend of concepts commonly used in:

- power purchase agreements (**PPA**) for power generation projects; and
- gas supply and purchase arrangements (**GSPAs**).

There are already a small number[17] of notable recent examples of project-financed green hydrogen projects with long-term offtake agreements. In addition, the liquidity of global ammonia markets will provide an important reference point for the development of offtake agreements in the hydrogen sector (particularly in respect of pricing). However, notwithstanding these important factors, the variability between hydrogen projects will make it challenging to adopt a 'one size fits all' approach when negotiating the offtake arrangements for a specific project.

Although there will no doubt be common themes across the industry, the suitability of an offtake arrangement will depend on several factors specific to the relevant project. This may include, for example, the proposed end-use for the hydrogen, the project's jurisdiction and location (including political risk and the potential impacts of the project on the host community and the local environment) and whether the project is a standalone project or part of an integrated structure. Other key factors include the proposed method of delivery to the customer, the customer's required volume and specifications for the gas and, importantly, whether the customer intends to use the hydrogen domestically or requires

[17] See *NEOM Green Hydrogen Project* (n 4); *H2 Green Steel Project* (n **Error! Bookmark not defined.**).

export to regional or international markets. For this reason, this briefing paper does not set out model clauses for parties to adopt when negotiating hydrogen offtake agreements. Rather, parties will need to carefully consider the specific requirements of their project and tailor the contractual mechanics and risk allocation therein to best suit their project's needs.

The key considerations presented are intended as a guide only, and by no means provide an exhaustive list of the matters to be considered by parties when negotiating green hydrogen offtake arrangements.

When reviewing this paper, readers should also note the following:

- Although framed through an international lens, the factors discussed in this paper will need to be viewed in the context of the specific local and regional requirements relevant to a project's jurisdiction, the proposed jurisdiction of the end use (including from a regulatory perspective) and the political risk in the jurisdictions of production, transport and consumption.
- While the primary focus of this briefing paper is on offtake arrangements for green hydrogen projects, the topics discussed herein may also be relevant to offtake arrangements for other chemical carrier compounds related to hydrogen (for example, green ammonia or green methanol). Furthermore, given the focus on green hydrogen, this paper does not consider additional specific considerations for CCS projects (which are more relevant in the context of 'blue' or 'brown' hydrogen projects).
- Although this paper includes factors that will be relevant to offtake arrangements entered into for hydrogen export projects, the predominant focus is to consider the fundamental components of a hydrogen offtake agreement in a general sense. Given the current lack of 'fit for purpose' port and shipping infrastructure globally, the need for technological improvements, and the fact that the current 'delivered' cost of hydrogen in export markets does not present commercially viable alternative to fossil fuels across the market, it is expected that many early-stage hydrogen offtake arrangements will be limited to domestic supply contracts.[18] As such, there may be additional considerations relevant to hydrogen export projects which are not addressed in this briefing paper. This includes, by way of example (i) differences in offtake arrangements where the relevant product is being liquefied before export; and (ii) the specific shipping requirements for the relevant project.
- Other than expressly stated (for example, in section 2.2(a)(2)), this paper does not consider offtake arrangements involving volumes sold to a risk-taking intermediary.

[18] It is acknowledged that the *NEOM Green Hydrogen Project* (n 4) is a hydrogen for export project, however this statement is intended as a reference to the broader market as a whole.

2. Pricing and term

Pricing and term will be the primary consideration for parties when negotiating offtake agreements for green hydrogen projects.

Where a project is being project-financed, financiers will typically require long-term offtake arrangements to be in place which provide for a predictable revenue stream based on reliable technology and a creditworthy offtaker. This revenue stream is generally provided by either:

- setting a fixed price (or fixed price range) for the commodity being traded under an offtake agreement, against which payment flows are determined by reference to an agreed commodity index or spot price; or
- setting a fixed price for the relevant commodity (based on what the parties agree to be the 'market' price for that commodity), with the offtaker paying that price for the contracted volumes over the offtake term (subject to agreed escalation factors – see section 2.6 below).

For example, in the context of offtake agreements for grid-connected power generation projects, it is common for amounts payable to be calculated by reference to the difference between the agreed 'fixed' price in the contract and the spot or 'floating' price for electricity in the relevant market over an agreed period. These arrangements are commonly referred to as '*contracts for difference*' (**CfD**).

'*Take or pay*' arrangements are another option for providing sellers with a predictable revenue stream, by ensuring the seller receives an agreed level of revenue over the term of the contract. These arrangements are commonly adopted in gas supply arrangements and are discussed further in section 3.1(a) below.

To mitigate a financier's exposure to a project, financiers will usually require that an offtake term is at least as long as the tenor of the debt, plus a 'tail'. This will be a key consideration where the relevant offtake agreement provides for price review mechanics, which are considered further at section 2.4 below.

2.1. Hydrogen benchmark pricing

There is currently no uniform or global approach for pricing hydrogen, in the same way there is for other commodities. As such, the hydrogen trading market currently lacks sufficient liquidity to support the bankability assessment of a project on a merchant basis. This makes the pricing mechanics and creditworthiness of the parties to early-stage hydrogen offtake agreements critical from a bankability perspective.

Given this, a key consideration for parties seeking to negotiate these arrangements will be how best to price hydrogen in the near term until there are more established pricing benchmarks for green hydrogen. This challenge is analogous to that faced by the liquefied natural gas (**LNG**) sector in the early stages of that market.

1. Hydrogen pricing index

Noting the above, in May 2023 the European Energy Exchange (**EEX**) launched the world's first green hydrogen price index, called 'Hydrix'.[19] EEX has reported that:

> *HYDRIX provides information on actually traded prices for green hydrogen, which is determined from supply and demand prices of hydrogen together with renowned partners from industrial and energy sectors to ensure the necessary price transparency crucial for the growing market.*[20]

The current scope of the Hydrix index is limited to the German hydrogen market. The current methodology of the index relies on industry contributors (on both the supply and demand side) submitting a single buy or sell price for hydrogen that they would be willing to receive or pay on a weekly basis.[21] In addition, the pricing of the index is calculated on a EUR / MWh basis (rather than EUR / kg) to facilitate comparisons between power and gas prices and to account for the all-in cost of production.[22]

However, acknowledging that this is an important step in establishing a price for green hydrogen, at this early stage there are limitations in the ability of the Hydrix index to be applied across the market given:

- it is limited to a single jurisdiction;
- it relies on contributions from industry regarding actual traded prices for hydrogen, which are typically commercially sensitive and will vary significantly depending on the specific arrangements for a project; and
- pricing for long-term offtake arrangements will require long-term forecast price assessments which cover the offtake term (see below).

Hydrogen price assessments

In addition to Hydrix, some platforms have begun publishing regular hydrogen price assessments for select countries and regions. These assessments may serve as a useful pricing benchmark for projects in those jurisdictions.

This includes S&P Global Commodity Insights, which recently began publishing daily hydrogen assessments for each of Canada, the United States of America (10 regional sets of prices), the Netherlands, Japan, United Kingdom, Australia (regional pricing, except for Northern Territory and Australian Capital Territory) and several countries

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[19] Polly Martin, 'World's first green hydrogen price index launched — despite there being no trade in renewable H2', *Hydrogen Insight* (Blog Post, 25 May 2023) <https://www.hydrogeninsight.com/production/world-s-first-green-hydrogen-price-index-launched-despite-there-being-no-trade-in-renewable-h2/2-1-1456231>.

[20] European Energy Exchange, 'EEX Press Release - Transparency for Hydrogen Market with HYDRIX: EEX publishes first market-based hydrogen index' (Press Release, 22 May 2023) <https://www.eex.com/en/newsroom/detail?tx_news_pi1%5Baction%5D=detail&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Bnews%5D=7158&cHash=9fbfa2bafb7c6a75bb4241b303838893>.

[21] 'HYDRIX FAQ', *European Energy Exchange* (Web Page) <https://www.eex-transparency.com/service/hydrix-faq>.

[22] Ibid.

across the Middle East (Saudi Arabia, UAE, Oman, and Qatar).[23] These price assessments include both a hydrogen commodity price and a commodity plus production cost, and relate to the:

- commodity production cost for various hydrogen production pathways (including green hydrogen pathways such as proton exchange membrane (**PEM**) electrolysis and alkaline electrolysis (**ALK**)); and
- capex associated with developing a hydrogen production facility.

S&P Global Commodity Insight also began publishing daily values for 'blue' and 'grey' ammonia in April 2022[24] and, in December 2022, it launched ammonia price assessments based on renewable power production pathways. These newer assessments will reflect values into the prime low carbon ammonia import regions of Northwest Europe and Far East Asia on a price per metric ton and price per 'One million British Thermal Units' (**MMBtu**) basis.[25]

In addition, in September 2022 Independent Commodity Intelligence Services (**ICIS**) launched Europe's first market-based hydrogen price assessments which accounts for the market value of renewable electricity generation.[26] ICIS considers the most likely form of green hydrogen production in the near-term will be via grid-connected electrolysers.[27] Reflecting this, ICIS's price assessments factor in the market price for long-term renewable PPAs when analysing the cost of hydrogen production (based on various renewable technology types, using data provided by Pexapark).[28] The ICIS pricing assessment builds on the foundation of ICIS's Dutch Title Transfer Facility (**TTF**) gas benchmark, and currently focuses on European markets such as France, Germany, Italy and the Netherlands.[29]

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[23] 'Platts Hydrogen Assessments', *S&P Global Commodity Insights* (Web Page)<https://www.spglobal.com/commodityinsights/en/our-methodology/price-assessments/energy-transition/hydrogen-price-assessments>.

[24] 'S&P Global Commodity Insights Launches Platts Ammonia Forward Curve Assessments', *S&P Global Commodity Insights* (Web Page) <https://www.spglobal.com/commodityinsights/en/about-commodityinsights/media-center/press-releases/2022/042622-sp-global-commodity-insights-launches-platts-ammonia-forward-curve-assessments>.

[25] 'S&P Global Commodity Insights Launches New Platts Renewable 'Green' Ammonia Prices', *S&P Global Commodity Insights* (Web Page) <https://www.spglobal.com/commodityinsights/en/about-commodityinsights/media-center/press-releases/2022/120122-s-p-global-commodity-insights-launches-n>. For a recent analysis on hydrogen pricing published by S&P Global Commodity Insights, see Santiago Canel Soria et al, 'Hydrogen markets progress towards price transparency', *S&P Global Commodity Insights* (Web Page, 26 April 2024) <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/042624-hydrogen-markets-progress-towards-price-transparency#:~:text=Global%20hydrogen%20production%20volumes%20are,Energy%20Technology%20Analytics%20Market%20outlook>.

[26] Independent Commodity Intelligence Services, 'ICIS launches Europe's first market-linked renewable hydrogen assessments' (Press Release, 27 September 2022) <https://www.icis.com/explore/press-releases/icis-launches-europes-first-market-linked-renewable-hydrogen-assessments/?intcmp=commodities-hydrogen_pressrelease> ('*ICIS market-linked renewable hydrogen assessments*').

[27] Jake Stones, 'ICIS Whitepaper: Renewable PPAs and a review of the commodity price spike on renewable hydrogen production costs', *Independent Commodity Intelligence Services* (Blog Post, 11 October 2022) <https://www.icis.com/explore/resources/news/2022/10/11/10813598/icis-whitepaper-renewable-ppas-and-a-review-of-the-commodity-price-spike-on-renewable-hydrogen-production-costs/>.

[28] Ibid. See also *ICIS market-linked renewable hydrogen assessments* (n 26).

[29] Ibid.

A further example is the Argus Media hydrogen price assessment platform, known as 'Argus Hydrogen and Future Fuels'. Argus' price assessments comprise of 155 hydrogen cost indices[30] and was most recently updated in February 2024.[31] The price assessments are modelled on a weekly basis for various production pathways (including PEM and ALK processes) for all key global points including the US, Europe, Abu Dhabi, Japan and Australia.[32] The hydrogen prices are calculated as the sum of capital, operating and variable costs per tonne of hydrogen output.

However, noting that these assessments may provide a useful preference tool for parties negotiating hydrogen offtake agreements, it should be noted that there is significant variation between the assessments given these are based on reported sales data and assumed values.

Ammonia indices

Acknowledging that pricing benchmarks for hydrogen (and particularly green hydrogen) are still in their early stages, there is a well-established and liquid global ammonia market which may serve as a useful reference point for pricing under green hydrogen (or green ammonia) offtake agreements.

Some examples of ammonia indices which parties may wish to consider when determining any index-linked aspects of their hydrogen offtake pricing include:

- S&P Global Commodity Insights – Ammonia Fertilizer Market and Price Analysis;[33]
- Argus Media – Ammonia price assessments;[34]
- ICIS – Ammonia price forecasts;[35]
- Quantum Commodity Intelligence – Quantum Ammonia Price Assessments;[36] and
- CRU Group – Fertilizer prices.[37]

The applicability of these pricing benchmarks, and the suitability for a specific hydrogen project, will need to be considered by the relevant parties on a case-by-case basis.

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[30] Argus Media, 'Argus brings transparency to emerging hydrogen markets' (Press Release, 17 February 2022) <https://www.argusmedia.com/en/about-argus/media-centre/press-releases/argus-brings-transparency-to-emerging-hydrogen-markets>. There are also other hydrogen price assessments such as BloombergNEF, Aurora, HyXchange's *Hydrogen Climate Certificate Index* and Lazard's *Levelised Cost of Hydrogen Analysis*.

[31] Argus Media, 'Argus Hydrogen and Future Fuels' (Guide, 2 February 2024) <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjoisqhzOmFAxW6avUHHTabD8oQFnoECBAQAQ&url=https%3A%2F%2Fwww.argusmedia.com%2Fes%2Fsolutions%2Fproducts%2Fargus-hydrogen-and-future-fuels&usg=AOvVaw3IVOUGUkbSlu4t7G18Oxz4&opi=89978449>.

[32] Ibid.

[33] 'Ammonia Fertilizer Market and Price Analysis', *S&P Global Commodity Insights* (Web Page) <https://www.spglobal.com/commodityinsights/en/ci/products/fertilizers-ammonia.html>.

[34] 'Argus Ammonia Analytics', *Argus Media* (Web Page) <https://www.argusmedia.com/en/solutions/products/argus-ammonia-analytics>.

[35] 'Ammonia', *Independent Commodity Intelligence Services* (Web Page) <https://www.icis.com/explore/commodities/fertilizers/ammonia/#testimonials-section>.

[36] 'Quantum Ammonia All Price Assessments', *Quantum Commodity Intelligence* (Web Page) <https://www.qcintel.com/ammonia/all-prices/>.

[37] 'Fertilizer prices', *CRU Group* (Web Page) <https://www.crugroup.com/prices/fertilizers/>.

2.2. Price structuring options

Considering the above, there are several options available to parties when determining how to structure the pricing provisions under a green hydrogen agreement. These options will need to be considered in the context of the requirements for the specific project.

For some earlier projects, parties have elected to invest in green hydrogen projects as both a joint venture partner in the project special purpose vehicle (**SPV**) and as the offtaker. Where relevant, this relationship will influence the dynamics of the offtake agreement and pricing structure (given the offtaker will need to balance its interests as both offtaker and equity investor in the project) and require the parties to work collaboratively to share the project risks. Such an approach was adopted in the recently closed NEOM Green Hydrogen Company project in Saudi Arabia, which involved Air Products as both a joint venture partner in the NEOM Green Hydrogen Company (together with NEOM and ACWA Power) and as 100% offtaker for the green ammonia produced.

Some potential pricing mechanisms for hydrogen offtake agreements are set out below.

2. **Hydrogen CfD**

   One potential form of offtake agreement for a green hydrogen project is a CfD model. Parties will need to carefully consider whether this model is appropriate for their project, particularly for early projects where there may not be an established market price for hydrogen in the near term (noting, however, that this is a developing area as highlighted in section 2.1 above). A CfD model is most typically used for network connection projects (compared to the other pricing models considered in this section 2.2 which are more commonly adopted for physical or direct supply offtake agreements).

   If a CfD model is preferred, parties will need to determine which aspects of the hydrogen offtake agreement will be priced by reference to a market index or market 'spot' price and, if applicable, which market index or spot pricing will be adopted. Although acknowledging that the publication of hydrogen and ammonia price assessments is a relatively new development, project developers may find these tools useful in indexing their pricing. Equally, however, given the early stages of these hydrogen price assessments, project sponsors may prefer to link offtake pricing to a more established market index (for example, a reputable ammonia or natural gas pricing index – refer to section 2.1(c) above).

   As a general comment, CfD contracts provide for two-way payment flows. The parties' payment obligations under a CfD will be determined by reference to the difference between the agreed 'fixed' price under the contract and the nominated 'floating' price (i.e. the relevant index price or market price over an agreed period). If the 'floating' price for a payment period is higher than the 'fixed' price, then the producer will need to pay the difference between the fixed and floating price to the offtaker, and vice versa. This is different to the other payment models considered in this section which provide for one-way payment flows. Under those models, the offtaker will pay the amount agreed (or determined) for the relevant payment period in exchange for the producer delivering the hydrogen produced to the offtaker (without reference to an underlying market index).

   Some governments around the world are considering how to best leverage CfD contracting models to incentivise investments in hydrogen (for example, through reverse auction processes). The specific CfD structure may vary between jurisdictions – for example, some of the hydrogen CfD initiatives announced to date are structured on pure revenue support models (providing top-up revenue where the achieved sales price under

a hydrogen offtake agreement falls below an agreed threshold), whereas other initiatives provide for a more direct role in the sale and purchase of hydrogen.

Some examples of the hydrogen CfD schemes currently being considered by governments are set out below:

1.a) United Kingdom (UK)

a. The 'Hydrogen Production Business Model'

The UK government recently considered hydrogen CfD contracts as part of its 'Hydrogen Production Business Model' (**HPBM**) announced in July 2022.[38] This program is closely modelled off the UK government's 'Contract for Difference' scheme which has been running since 2014, and which supports various forms of low-carbon electricity generation such as offshore wind.[39]

Revenue support from the HPBM is being offered jointly along with capex support from the UK's Net Zero Hydrogen Fund (**NZHF**) as part of the UK government's 'Hydrogen Allocation Rounds' (**HAR**) which allocates funding to low carbon hydrogen projects.[40] The first HAR (**HAR1**) was launched in July 2022 and offered support to proponents via revenue support from HPBM or joint HPBM revenue support plus capex support from the NZHF.[41] In December 2023, the UK government announced the results of the HAR1 process, with 11 successful projects totalling 125MW of capacity being invited to negotiate an LHCA (see below).[42]

At a similar time, the UK government launched applications for the second allocation round (**HAR2**), with an aim to support 875MW of hydrogen projects.[43]

The 'Low Carbon Hydrogen Agreement' (**LCHA**), being the contract underpinning the HPBM, comprises the Standard Terms and Conditions and a Front End Agreement. Drafts of these documents were released to the public

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[38] The UK Government recently also passed the *Energy Act 2023*, which contains provisions underpinning the delivery of the HPBM. In particular, section 57 grants powers to make regulations about revenue support contracts, which relevantly include hydrogen production revenue support contracts. See Department for Energy Security & Net Zero, 'Hydrogen production and industrial carbon capture business models' (Government Response, 26 October 2023) <https://assets.publishing.service.gov.uk/media/654103cc46532b000d67f630/hydrogen-production-icc-business-models-government-response.pdf>.

[39] 'Low Carbon Contracts Company', *Contracts for Difference (CfD)* (Web Page) <https://www.cfdallocationround.uk/about/low-carbon-contracts-company>.

[40] 'Hydrogen Production Business Model / Net Zero Hydrogen Fund: HAR1 successful projects', *Department for Energy Security & Net Zero* (Web Page, 14 December 2023) <https://www.gov.uk/government/publications/hydrogen-production-business-model-net-zero-hydrogen-fund-shortlisted-projects/hydrogen-production-business-model-net-zero-hydrogen-fund-har1-successful-projects> ('*Hydrogen Production Business Model*').

[41] Ibid.

[42] Ibid.

[43] Ibid.

in August 2023.[44] Similar to the UK government's CfD program used in the context of the renewables sector, the LCHA proposes to provide:

i. CfD-style revenue support for UK-based hydrogen projects; and
ii. support to assist hydrogen producers bridge the gap between the operating costs for low carbon hydrogen and high carbon fuel projects.[45]

To qualify under the HPBM, a proponent must not sell volumes of hydrogen to a 'non-qualifying offtaker' (being a party which is not a final user of hydrogen, such as a gas exporter or a party which blends gas into the gas grid). Eligible producers must therefore sell their volumes to final users of hydrogen, reflecting the UK government's efforts to encourage a growth in the demand for hydrogen in early-stage markets.[46]

Successful proponents (including those recently announced as part of HAR1) will be invited to sign a 15 year LCHA with a government-owned special purpose company in respect of the production, supply, sale and purchase of low carbon hydrogen.

b. Pricing under LCHAs

In the consultation phase of the HPBM, the UK government considered several options to determine the most appropriate hydrogen reference price to be included in LCHAs. These options included the:

- input energy price (for example, water and electricity prices in relation to electrolysis);
- natural gas price;
- counterfactual fuel prices (being the price of the fuel being replaced by hydrogen for the relevant customer); and
- achieved average sales price for hydrogen at the producer's facility.

[44] Department for Energy Security and Net Zero, 'LCHA Standard Terms and Conditions' (Terms and Conditions, Draft Version 1, 9 August 2023) <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1177336/low-carbon-hydrogen-agreement-standard-terms-and-conditions.pdf> ('*Standard Terms and Conditions*'); Department for Energy Security and Net Zero, 'LCHA: Front End Agreement' (Agreement Draft, August 2023) <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1177337/low-carbon-hydrogen-agreement-front-end-agreement.pdf> ('*Front End Agreement*').

[45] Department for Business, Energy & Industrial Strategy, 'Hydrogen Business Model and Net Zero Hydrogen Fund: Electrolytic Allocation Round' (Guide, 20 July 2022) <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1140928/hbm-nzhf-electrolytic-round-application-guidance.pdf>.

[46] RenewableUK, 'Demystifying the Hydrogen Business Model for Electrolysis' (Guide, 1 November 2023) 6 <https://cdn.ymaws.com/www.renewableuk.com/resource/resmgr/amended_renewableuk_business.pdf> ('*Demystifying the Hydrogen Business Model*').

The UK government concluded that, until a broader market reference price develops, its preferred reference price under the LHCAs is the higher of the (i) natural gas price and (ii) average achieved sales price for a project.[47]

The LCHAs are intended to provide price and volume certainty to projects by paying a subsidy through three separate cashflows (with an additional two cashflows for CCS projects[48]):

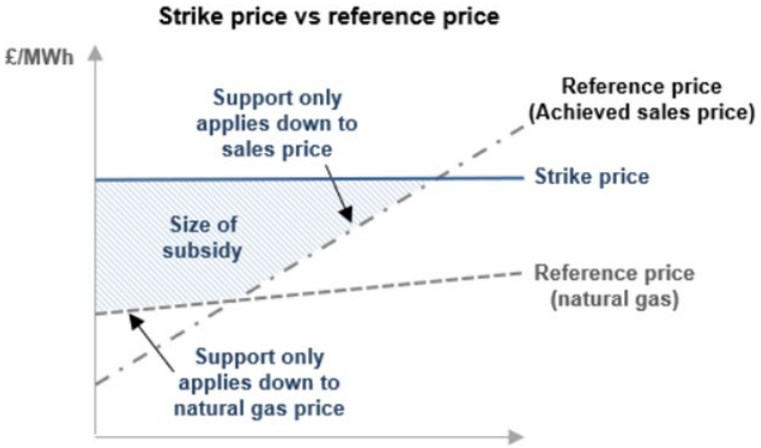
1. **Cashflow 1: CfD variable premium (price risk)**: Producers will be paid a variable premium which is calculated as the difference between the 'Strike Price' and the 'Reference Price' for each unit of hydrogen produced and sold for the relevant project. In this respect:[49]
    - **Strike Price (expressed in £ per MWh (higher heating value (HHV)):** the Strike Price is the price that a producer needs to achieve to cover its costs of production for low carbon hydrogen (including financing costs), plus an allowed return on investment. This includes the capital expenditure (**capex**) and operating expenditure (**opex**) for the construction and operation of the hydrogen production facility, and capex in relation to small-scale hydrogen transport and storage infrastructure; and
    - **Reference Price (expressed in £ per MWh (HHV)):** the Reference Price is intended to represent the market price the producer will receive for the low carbon hydrogen it produces. Until the establishment of an observable hydrogen market price, this will be the higher of the:
        - producer's '**Achieved Sales Price**', which will include the same elements as the Strike Price and be equal to the volume-weighted average price for low carbon hydrogen achieved for the relevant billing period; and
        - **Price Floor,** being the lower of the natural gas price (being the 'UK NBP Month Ahead Natural Gas Price') and the Strike Price.

[47] *Standard Terms and Conditions* (n 44); *Front End Agreement* (n 44); Department for Business, Energy & Industrial Strategy, 'Low Carbon Hydrogen Business Model: consultation on a business model for low carbon hydrogen' (Consultation Paper, 25 October 2021) 8 <https://assets.publishing.service.gov.uk/media/611a801ae90e07054a62c4f8/Consultation_on_a_business_model_for_low_carbon_hydrogen.pdf> ('*Low Carbon Hydrogen Business Model*').

[48] As noted in section 1.3, this paper does not specifically cover considerations for CCS projects. As such, the CCS-specific cashflows under the proposed LCHAs have not been addressed in this paper.

[49] Department for Business, Energy & Industrial Strategy, 'Agreement for the Low Carbon Hydrogen Production Business Model' (Heads of Terms, 16 December 2022) 15 <https://assets.publishing.service.gov.uk/media/639c470f8fa8f5069707c0fe/Low_Carbon_Hydrogen_Production_Business_Model_Heads_of_Terms.pdf>.

Given the two-way payment flows under a CfD model, where the Reference Price exceeds the Strike Price for a specific period, the relevant producer will be required to pay the counterparty to the LCHA the difference between the Reference Price and the Strike Price. A graphic from the UK government's consultation paper on the HBM provides a demonstration of how this pricing mechanism works in practice:[50]



2. **Cashflow 2: Price Discovery Incentive (price incentive):** The 'Price Discovery Incentive' was recently introduced in the LCHAs.[51] It seeks to disincentivise hydrogen producers from selling at the cheapest possible price to maximise their revenue under Cashflow 1 (which would be detrimental to the industry as a whole) by providing an incentive which pays producers a reimbursement for selling at a higher price. Put another way, the 'Price Discovery Incentive' encourages hydrogen producers to seek the highest possible sales price by reimbursing those producers for lost cashflows under Cashflow 1.[52]
3. **Cashflow 3: Sliding Scale Top Up (volume risk):** Similar to Cashflow 2, the 'Sliding Scale' support was also recently introduced under the LCHAs. This support has been introduced to provide volume support to hydrogen producers (see section 3 below) in the absence of a readily available liquid market for low carbon hydrogen.[53]

   Under this mechanism, if monthly (or billing period) volumes of hydrogen it sells fall below specified levels, the producer will be eligible to receive a top up payment on the hydrogen sold.[54] However, if the producer does not sell any hydrogen for the relevant billing period, it will not receive any support for this period.[55]

[50] *Low Carbon Hydrogen Business Model* (n 47) 48.
[51] Refer to *Standard Terms and Conditions* (n 44) cl 11.
[52] *Demystifying the Hydrogen Business Model* (n 46) 9.
[53] Ibid 10.
[54] Ibid.
[55] Ibid.

The sliding scale is currently proposed to be triggered when offtaker volumes drop below 50% of the monthly reference volume due to a "qualifying event" (being an event which reduces all volumes of hydrogen produced, except when it is due to events such as negligence, breach of contract or a facility outage).[56]

1.b) German Government 'H2 Global' scheme

The German government also recently announced its 'H2Global' instrument, which serves as another example of a state-led effort to promote the establishment of a scalable supply and demand market for hydrogen.

The 'H2Global Instrument' will operate as a 'quasi-CfD' scheme whereby a German state-owned intermediary, Hydrogen Intermediary Company GmbH (**Hintco**), will sign:

- long-term purchase agreements (**HPAs**), for terms of approximately 10 years, to purchase hydrogen (and its derivatives)[57] from producers *outside* of the EU; and
- short-term sales agreements (**HSAs**), for a term of approximately 1 year, to on-sell the hydrogen (or hydrogen derivative) procured under a HPA to customers *within* the EU.[58]

Hintco will assume price and volume risk under these arrangements. Like a CfD structure, the difference between the price paid to producers under HPAs and the price sold to consumers under HSAs will be covered by subsidies funded by the German government (and other private sector donors).[59] As such, by the German government effectively acting as a risk-taking intermediary, it is intended that these arrangements will provide greater investment certainty on both the supply and demand side for hydrogen projects and enable project proponents to seek project financing. In addition to providing price certainty, having a German-government backed offtaker will improve a project's bankability assessment. H2Global hopes this will accelerate a ramp-up of the market for green hydrogen (and its derivatives) on an industrial scale.[60]

Although the first phase is targeted at hydrogen producers outside of the EU, it is anticipated this will expand to apply to producers within the EU.[61]

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[56] Ibid. For a full list of "qualifying events" under the sliding scale mechanism, refer to the *Standard Terms and Conditions* (n 44).

[57] The H2Global Instrument seeks to facilitate trading agreements for green hydrogen and its derivatives, such as ammonia, methanol, and sustainable aviation fuel (referred to as 'Power-to-X' or 'PtX' products) at an industrial scale. See 'The H2Global Instrument', *H2Global Foundation* (Web Page) <https://www.h2-global.de/project/h2g-mechanism>.

[58] Ibid.

[59] Ibid.

[60] Ibid.

[61] Rainer Quitzow, Almudena Nunez and Adela Marian, 'Positioning Germany in an International Hydrogen Economy: A Policy Review' (Working Paper, Hydrogen Global Potential Atlas, March 2023) 12.

The price, product specifications and delivery arrangements under the HPAs and HSAs will be determined as part of separate competitive funding rounds.[62] Framework agreements for each of these agreements were published by H2Global in July 2023, and it is expected that auctions will take place for HSAs by the end of 2024 or early 2025.[63]

The H2Global instrument was announced in December 2021 by Germany's Federal Ministry for Economic Affairs and Climate Action, which committed €900 million to the scheme.[64] The H2Global Foundation, which owns Hintco, was established by the private sector and is backed by leading German, European and international companies such as Siemens Energy, RWE, Nordex, Engie, ThyssenKrupp and Fortescue Future Industries.

Noting the above, the viability of the scheme was recently called into question following a ruling from Germany's Constitutional Court in late November 2023. The court ruled that €60 billion of funds was unlawfully allocated to the country's Climate and Transformation Fund (from which the H2Global scheme is to be funded[65]). Although as at the date of this paper this ruling does not seem to be adversely affecting the rollout of the scheme (see section 2.2(a)(3) below), it remains to be seen whether the decision will have any long-term impacts on the scheme's implementation.

1.c) German 'Carbon Contracts for Difference' scheme

In addition to the H2Global instrument considered above, Germany's Federal Ministry for Economic Affairs and Climate Action has also announced a funding program for '(Carbon) Contracts for Difference' (**CCfDs**), with an anticipated €50 billion to be put towards covering the capex and opex costs of hard to abate industries transitioning to cleaner technologies.[66]

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[62] Hintco, 'Hydrogen Sales Framework greement' (Agreement Draft, 6 July 2023) cl 4 <https://files.hintco.eu/HSA-Framework-Agreement-incl-Annexes-6-July-2023-DRAFT.pdf> ('*Hintco Hydrogen Sales Framework Agreement*').

[63] 'Stakeholder survey on Draft Hydrogen Sales Agreement (HSA) Contract', *Hintoco* (Web Page) <https://www.hintco.eu/news/stakeholder-survey-on-draft-hydrogen-sales-agreement-hsa-contract>.

[64] Federal Ministry for Economic Affairs and Climate Action, '*Federal Ministry for Economic Affairs and Climate Action launches first auction procedure for H2Global - €900 million for the purchase of green hydrogen derivatives*' (Press Release, 8 December 2022) <https://www.bmwk.de/Redaktion/EN/Pressemitteilungen/2022/12/20221208-federal-ministry-for-economic-affairs-and-climate-action-launches-first-auction-procedure-for-h2global.html>.

[65] Leigh Collins, 'German government to spend €18.6bn on hydrogen from its Climate and Transformation Fund in 2024-27', *Hydrogen Insight* (Blog Post, 10 August 2023) <https://www.hydrogeninsight.com/policy/german-government-to-spend-18-6bn-on-hydrogen-from-its-climate-and-transformation-fund-in-2024-27/2-1-1499546>.

[66] Allison Burt, ''Carbon Contracts for Difference': Germany's €50 Billion Scheme to Help Companies Decarbonize', *Impakter* (Blog Post, 29 June 2023) <https://impakter.com/carbon-contracts-for-difference-germanys-e50-billion-scheme-to-help-companies-decarbonize/>.

Previously contemplated in the European Commission's 2020 hydrogen strategy publication,[67] the program will allocate CCfDs through competitive auctions to bidders committing to utilise 100% renewable technologies (such as green hydrogen or hydrogen based derivates) to reduce their carbon emissions. The CCfDs will be for a 15-year term.[68]

Companies will be required to submit a carbon price based on the additional costs that the company will incur in using low-carbon technology as opposed to the high-carbon alternative. Successful bidders will be guaranteed a 'strike price' in the CCfD for their low-carbon production, and the government will top-up the difference between the low-carbon and high-carbon option.

The CCfD structure has the potential to improve the competitiveness of low-carbon alternatives, ultimately incentivising the uptake of new technologies and accelerating the transition to clean energy.[69]

The first €4 billion bidding round of the CCfD programme was launched by Germany's government in March 2024.[70]

1.d) Japan's CfD scheme under the 'Basic Hydrogen Strategy'

In addition to the German and UK examples above, the Japanese Government recently announced in December 2023 that it would be introducing a CfD subsidy program to bridge the cost gap between "low carbon" hydrogen and its fossil fuel equivalents.

Low-carbon hydrogen has been defined in Japan's Basic Hydrogen strategy as 3.4kg or less of CO_2 emissions per 1kg of hydrogen produced.[71] Similarly, ammonia that is produced from hydrogen with emissions of 0.84 kg- CO_2 e/kg-NH3 or less per 1kg gate to gate (including the hydrogen production) is qualified as low-carbon ammonia.[72] As such, this process will be open to green hydrogen as well as blue hydrogen produced from fossil gas and CCS.

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[67] European Commission, 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Hydrogen Strategy for a Climate-Neutral Europe' (Communication No 2020/301, 8 July 2020) 13 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0301>.

[68] 'Carbon Contracts for Difference (CCfD) program for energy-intensive industries', *International Energy Agency* (Web Page, 11 May 2023) <https://www.iea.org/policies/17538-carbon-contracts-for-difference-ccfd-program-for-energy-intensive-industries>.

[69] Nikolaus J. Kurmayer, 'Berlin Launches €50 Billion 'Climate Contracts' for Industry', *Euractiv* (Blog Post, 5 June 2023) <https://www.euractiv.com/section/energy-environment/news/berlin-launches-e50-billion-climate-contracts-for-industry/>.

[70] Rachel Parkes, 'Germany opens first €4bn bidding round for Carbon Contracts for Difference', *Hydrogen Insight* (Blog Post, 14 March 2024) <https://www.hydrogeninsight.com/industrial/hydrogen-in-industry-germany-opens-first-4bn-bidding-round-for-carbon-contracts-for-difference/2-1-1612591>.

[71] The Ministerial Council on Renewable Energy, Hydrogen and Related Issues, 'Basic Hydrogen Strategy' (Policy Paper, 6 June 2023) 16 <https://www.meti.go.jp/shingikai/enecho/shoene_shinene/suiso_seisaku/pdf/20230606_5.pdf> ('*Basic Hydrogen Strategy*'). In addition, refer to Jonas Moberg, 'The role of hydrogen in decarbonising Japan: a key choice for government as it finalises its support scheme', *GH2 Green Hydrogen Organisation* (Blog Post, 4 March 2024) <https://gh2.org/blog/role-hydrogen-decarbonising-japan-key-choice-government-it-finalises-its-support-scheme>.

[72] Ibid 16.

The scheme is open to both domestically produced and imported "low carbon" hydrogen, and Japan plans to rollout ¥3trn (~USD $20.86bn) worth of subsidies for delivered hydrogen (and its derivatives) over a 15-year period.[73] The subsidies will be funded through Japan's 'GX (Green Transformation) Economic Transition Bonds' which were released and sold to the market in February 2024.[74]

The CfD programme will provide for two-way payment flows linked to a 'reference price'. Currently the reference price is based on LNG prices for hydrogen and coal prices for ammonia.[75] Hydrogen producers and importers will receive a top up payment from the government where their costs exceed the reference price and will be required to pay the government the difference if the actual production and transportation costs are lower than the reference price.[76]

Details of how the subsidies will be awarded to market participants have not yet been finalised, including whether this will be determined through an auction process or based purely on business plans submitted by proponents. However, Japan has stated that a "one-S and three-E" (**S+3E**) philosophy, which emphasises safety, energy security, economic efficiency and the environment, will be a guiding principle in this regard.[77] The bill setting out the regulatory framework for the scheme is currently being tabled during the current session of Japan's Parliament, which will continue until June 2024.[78] Once the bill becomes law, the government plans to request business plans from proponents before awarding subsidies by the end of the 2024.[79]

3. Fixed price model

One alternative to an index-linked pricing regime is a fixed price model, whereby the parties agree to a 'fixed' price at the time of contract execution. This will typically be:

- sized in a manner which seeks to cover the producer's anticipated development expenditure (devex) (including its costs in respect of securing land tenure and local planning approvals, pro-rated over the offtake term), capex (also pro-rated over the offtake term), opex (including water and electricity feedstock for electrolysis), insurance costs and (if relevant) its debt servicing costs, plus a margin of return; and
- subject to escalation in accordance with an agreed methodology (for example, inflation) over the offtake term.

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[73] Rachel Parkes, 'Japan to allocate clean hydrogen subsidies from $20bn pot to producers by the end of 2024: report', *Hydrogen Insight* (Blog Post, 31 January 2024) <https://www.hydrogeninsight.com/production/japan-to-allocate-clean-hydrogen-subsidies-from-20bn-pot-to-producers-by-the-end-of-2024-report/2-1-1590767> ('*Parkes*').

[74] Ibid. See also Sayumi Take, 'Japan hopes climate transition bonds draw more foreign investors', *Nikkei Asia* (Blog Post, 27 February 2024) <https://asia.nikkei.com/Business/Markets/Japan-hopes-climate-transition-bonds-draw-more-foreign-investors>.

[75] World Economic Forum, 'Enabling Measures Roadmap for Low-Emission Hydrogen' (Roadmap, July 2023) 29 <https://www3.weforum.org/docs/WEF_Accenture_Enabling_Measures_Roadmap_for_Low_Emission_Hydrogen_Japan_2023.pdf>.

[76] *Basic Hydrogen Strategy* (n 71) 25. See also *Parkes* (n 73).

[77] *Basic Hydrogen Strategy* (n 71) 7, 26.

[78] *Parkes* (n 73).

[79] Ibid.

If adopted, the key consideration for the parties will be how to set a fixed price in the absence of a prevailing hydrogen pricing benchmark (see section 2.1 above). Once agreed, the fixed price will be included in the offtake agreements and will form the basis for determining the amounts payable by the offtaker during the offtake term (either on a 'volume delivered' or 'take or pay' basis – see section 3 below).

Although this model provides the benefit to producers and financiers of a fixed revenue stream, the following considerations will also be relevant when negotiating these arrangements:

- Given the costs for constructing and operating a hydrogen production facility at scale are relatively untested, it may be difficult for hydrogen producers to accurately forecast their 'delivered' production costs at the time of contractual signing. Although these costs are anticipated to reduce in the coming years, if the actual costs of production are higher than initially anticipated (or higher than the fixed price in the agreement) producers may experience lower than modelled returns or potential cost overruns. This will be particularly relevant where the offtake agreement does not include price review mechanics (such as those referred to in section 2.4 or, more broadly, where the parties commercially agree to re-negotiate offtake pricing where the seller's capex or other key price inputs exceed an agreed threshold).
- To mitigate the producer's risks of such cost overruns, a producer may elect to hedge its exposure to market price fluctuations for key feedstock commodities in green hydrogen production (i.e. water and electricity) by entering into water supply contracts or power purchase agreements. Alternatively, for integrated projects which include both hydrogen production and renewable energy generation, producers may be better able to regulate water and power costs pricing given the control they will have in operating these facilities.
- If producers have not hedged their exposure to the cost of green hydrogen feedstock, or other commodities such as the steel price, the producer will be exposed to price fluctuations in those commodities.
- The volume of production the relevant offtaker is willing to contract for is another relevant consideration. If this is less than 100%, a producer will need to consider how it will sell the balance of the hydrogen produced on a merchant basis to recover its development costs (given the absence of a liquid hydrogen market).

However, noting the above, if a producer takes the view that the price of hydrogen production will reduce in future years (for example, as technology develops and improved infrastructure is deployed), that producer may be willing to accept potentially lower returns in the early years on the assumption it will receive higher returns in later years when the production cost curve declines.

4. **Partially fixed-price model**

Like the fixed price model outlined above, parties to a hydrogen offtake agreement may consider adopting a variable pricing model at the time of contract signing.

Under this model, the offtake price would comprise a combination of:

- components of the producer's development costs and costs of production which the parties agree to 'fix' (for example, certain capex components); and
- variable pricing for other components, which are be subject to price fluctuations (on an 'open book' basis) and passed through to the offtaker as part of the offtake pricing (such as the price of steel).

The parties to an agreement may decide that the variable price components will remain 'floating' during the entire offtake term, or only between contract execution and a specified end date (for example, until commercial operations is achieved), following which those variable price components will become fixed.

The benefit of this hybrid model is that it mitigates a producer's exposure to price fluctuations to certain price components (i.e. the variable price), whilst also providing the offtaker some price certainty (i.e. the fixed price). For this reason, parties may find a variable pricing model to provide greater flexibility when compared to a fixed price model (and therefore be a more attractive arrangement from a commercial and bankability perspective). With that said, this would require the offtaker to bear the risk of higher prices where there are upward fluctuations in the variable cost components (see further section 2.2(d) in relation to the 'cost-plus' model). Therefore, the suitability of this model will need to be determined based on the parties' appetite for risk and will require the parties to work together to confirm the relevant pricing components which will remain variable and for how long.

5. **Cost-plus model**

A further alternative to the pricing options outlined above is a 'cost-plus' model. Under this model, a producer will be paid an amount for the hydrogen produced, calculated by reference to its actual or anticipated costs of production, plus an agreed margin.

The costs that can be claimed by the producer under this model will need to be commercially agreed between the parties. Similar to the above, this may include the producer's devex, capex, opex, insurance and debt servicing costs.

The benefit of this model is that it allows producers to mitigate some of the cost overrun risks outlined in respect of the 'fixed price' or 'partially fixed' models above. However, as noted, given the 'delivered cost' of hydrogen is anticipated to be high and will be challenging to determine at the outset (at least in the near-term), this may expose an offtaker to higher than anticipated costs – for example, if the producer's production costs are higher than first thought.

To provide for a commercially viable arrangement which mitigates some of these risks, parties may seek to include terms addressing the following when negotiating an offtake agreement using a cost-plus model:

1. *Requiring the producer to provide regular updates of its financial model (for example, quarterly), which set out the producer's actual costs and modelled forecast costs on an 'open book' basis.*

2. *Providing for specified cost caps (either for (i) individual pricing inputs such as devex or capex; or (ii) the overall offtake price) which, if exceeded:*

    - require the parties to use reasonable endeavours to negotiate adjustments to these caps; and

    - failing agreement, permit the parties to walk away from the arrangement.

      Given the implications that terminating an offtake agreement will have on a project's revenue stream (and therefore bankability), particularly in the absence of a liquid hydrogen market with potential replacement offtakers, the parties' recourse rights following termination in these circumstances will need to be carefully considered.

3. *Providing for an assumed value range for each of the key pricing inputs which, if exceeded, trigger certain contractual obligations such as:*

    - requiring the parties to use reasonable endeavours to agree on adjustments to these assumed values and, if no agreement is reached within a specified timeframe, terminate the offtake (noting the considerations above); or

    - providing for a risk and reward sharing regime, whereby the producer is required to pass through an agreed percentage of (i) the benefit of any amounts that are lower than assumed values for a specific price input; and (ii) the downside of any amount that is higher than assumed values for the price inputs.

Given the variable pricing under this model, a key factor in determining the success of a cost-plus offtake arrangement will be the parties' willingness to share information and work co-operatively with one another. This model has been adopted on smaller projects involving offtakers that are also joint venture partners in the SPV as a means of fostering co-operation between the parties.

6. **Tolling model**

Another potential alternative pricing model is a tolling model. Under this model, the offtaker agrees to pay a fixed payment (or a 'toll') in exchange for the project owner making the facility 'available' to the offtaker and the offtaker having operational control of the facility. This is also sometimes referred to as a 'leasing' model.

Like some of the models considered above, the tolling charge may be agreed by the parties either at contract execution or remain variable prior to commercial operations (following which it will be fixed for the offtake term) in accordance with an agreed pricing methodology.

This model is often adopted for:

- LNG plants, whereby a customer (a natural gas supplier) pays a toll to run gas through a liquefaction plant owned by another company. In these circumstances, the plant owner is predominantly interested in providing the liquefaction services and collecting the toll; and

- energy storage projects (for example, pumped hydro or lithium-ion battery storage projects), whereby the customer (an electricity market participant, such as a retailer) pays a toll to operate the facility – for example, in a manner which takes advantage of favourable market conditions, such as providing arbitrage services to the electricity network.

Given the early stages of the hydrogen market, the utility of this model remains to be seen. This may be most appropriately adopted for fully integrated projects (for example, projects which integrate renewable energy generation, hydrogen production and an ammonia loop) to enable customers to determine how to most efficiently and economically operate the facility based on the prevailing market conditions.

2.3. State support[80]

State funding support mechanisms available to green hydrogen projects may also be a useful tool for parties when negotiating a hydrogen price under an offtake arrangement.

Several governments around the world have shown a willingness to support the development of a global green hydrogen industry. This enthusiasm has been demonstrated through the introduction of policy initiatives which look to underwrite or provide financial incentives to parties interested in investing in green hydrogen projects. Many of these initiatives also focus on strengthening the demand side of the hydrogen equation to ensure a balanced market, and to support the establishment of a liquid market where hydrogen volumes being produced can be traded – for example, the H2Global scheme announced by the German government (see section 2.2(a)(2)).

[80] See also GH2 Green Hydrogen Organisation, 'Fiscal Terms and Incentives' (Contracting Brief, December 2022) <https://gh2.org/sites/default/files/2022-12/GH2_Contracting%20Guidance_Fiscal%20Terms%20and%20Incentives_2022.pdf>.

If available, government subsidies or other initiatives may significantly reduce the price that a producer is able to offer under an offtake agreement, and therefore positively influence the commercial viability of a project and the broader sector.

This section considers some of the current policy and investment initiatives introduced by governments for this purpose.

Consideration is also given to broader policies that have been introduced by governments in other low carbon energy sectors (for example, wind and solar generation) which may be translatable to the hydrogen sector. Although most of these initiatives have been announced by governments of developed countries, the below has been included as a reference tool for hydrogen developers in developing markets (i) if similar initiatives are adopted in those markets in the future (including by regional or international institutions providing development funding); and (ii) to facilitate dialogue on the introduction of similar initiatives in those jurisdictions.

1. **CfDs and other government offtakes**

   Refer to section 2.2(a) above for a detailed discussion regarding the CfD schemes currently being implemented in the UK and Germany.

   CfD-style programs have previously been deployed by governments during the early-stages of a sector to encourage investment and promote cost competitiveness of that sector against other adjacent sectors (for example, the renewables sector in the UK and Australia, to promote cost competitiveness against fossil fuel generation). These arrangements help to improve a project's bankability by providing a long-term fixed revenue stream with a sovereign (and typically creditworthy) offtaker.

   CfD contracts with government entities are usually awarded to proponents following a competitive tender process, sometimes referred to as a 'reverse-auction' process. Successful proponents will be selected based on various factors including price, value-for-money and emissions reductions.

   As noted above, CfD contracts with government entities may take on different forms. In some cases, government entities (such as a state-owned utility) will sign CfD contracts with project developers to directly purchase the power generated or hydrogen produced based on an agreed market reference price and, in other cases, the CfD arrangements will be structured to provide revenue and cost support to projects contracting with the private sector (for example, through production credits).

2. **Direct investment**

In addition, state-owned investment funds are increasingly investing (or interested in investing) in hydrogen projects. A recent example is the investment by the Saudi Arabian Government's National Development Fund (**NDF**) and Saudi Industrial Development Fund (**SIDF**) in the NEOM Green Hydrogen Company project in Saudi Arabia, which achieved financial close in May 2023.[81] The USD$8.4 billion project will be the world's largest green hydrogen production facility once complete, and includes a 30-year offtake agreement with Air Products for the low-emissions ammonia produced. It is the first green hydrogen project to reach financial close on a fully non-recourse basis, having secured USD$2.75 billion in funding from the NDF and SIDF, along with private financing from a consortium of 23 institutions.[82]

3. **Tax credits**

Tax credits have recently been introduced in some countries to reduce a producer's tax liability (not taxable income) and improve the cost competitiveness of hydrogen production. Similar tax incentives have been used by governments in the past to improve the cost competitiveness of forms of renewable power generation (such as wind and solar) against more conventional forms of electricity generation (such as coal and gas) with demonstrated success.

In August 2022, the United States (**US**) passed the Inflation Reduction Act 2022 (**IRA**), which includes USD$369 billion worth of government tax credits and funding for clean energy and climate change measures. Specific to hydrogen, new hydrogen tax credits have been introduced, and existing tax credits have been amended to account for 'clean hydrogen' products. The amount of tax credit available varies depending on the emissions intensity of the hydrogen.

Hydrogen producers located in the US have the option of receiving the following tax credits:

- **Production Tax Credit (PTC):** Eligible recipients of PTCs will receive between USD$0.60 and USD$3.00 per kilogram of hydrogen produced, with the value of the tax credit increasing for lower emissions intensity forms of hydrogen production such as green hydrogen (which also meet specified labour requirements) (see further section 5.2(d)(2)); and
- **Investment Tax Credit (ITC):** As an alternative to PTCs, hydrogen producers may elect to receive a tax credit in the form of an ITC for investing in 'energy property'. Although the concept of ITCs are not new, the IRA expands the definition of 'energy property' to now include 'qualified clean hydrogen production facilities'.

The US model serves as a useful example of how tax credits may be used by governments to incentivise greater investment in low carbon hydrogen production or its derivatives. Depending on the success of this model in improving the cost competitiveness of green hydrogen against other fuel sources, similar models may be adopted by other countries around the world.

[81] *NEOM Green Hydrogen Project* (n 4).
[82] *NEOM Green Hydrogen Project* (n 4).

4. Production credits

European Hydrogen Bank's renewable hydrogen auction process

Like the tax credits contemplated by the US IRA, the European Commission recently held a competitive auction process to award production credits to European-based projects that will produce green hydrogen in the coming years. The purpose of the subsidy programme is to accelerate the commercialisation of renewable hydrogen.[83]

The production credits are accessible through the European Hydrogen Bank's 'Innovation Fund'. The scheme is being funded from revenue generated from the EU's emissions trading scheme channelled through the Innovation Fund.[84] To be eligible to receive the production credits, applicants were required to submit:

- bids for the value of the production credit, sized to cover the cost gap between producing renewable and non-renewable hydrogen (subject to a ceiling price of €4.50 per kg); and[85]

- a range of additional information regarding the applicant's or project's (as applicable):
    - renewable electricity sourcing strategy;
    - proposed hydrogen offtake and price hedging strategy;
    - electrolyser procurement strategy;
    - environmental and grid connection permits;
    - evidence of security from an acceptable financial institution;
    - technical maturity, based on application documents and project description; and
    - financial and operational maturity, including business plans and operational resources (such as competence and experience of the project team).[86]

[83] 'Competitive bidding', *European Commission* (Web Page) <https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/competitive-bidding_en> ('*Competitive Bidding*').

[84] For a related discussion, see section 2.4(a).

[85] Directorate-General for Climate Action, 'Upcoming EU Hydrogen Bank pilot auction: European Commission publishes Terms & Conditions' *European Commission* (News Article, 30 August 2023) <https://climate.ec.europa.eu/news-your-voice/news/upcoming-eu-hydrogen-bank-pilot-auction-european-commission-publishes-terms-conditions-2023-08-30_en>. See also Directorate-General for Climate Action, 'Innovation Fund Auction' (Terms and Conditions, European Commission, 29 August 2023) 3 <https://climate.ec.europa.eu/system/files/2023-08/innovationfund_pilotauction_termsandconditions_en.pdf> ('*Innovation Fund Auction*').

[86] *Innovation Fund Auction* (n 85) 10-14.

In April 2024, the European Union announced the results of the first round of the subsidy auction process. Seven green hydrogen projects across Europe, with an aggregated electrolysis capacity of 1.5GW, were awarded a combined total of €720 million in funding.[87] The funding will be allocated to the successful participants as a fixed production credit per kilogram of renewable hydrogen, payable every six months over a 10-year term.[88] The intention is that the successful proponents will be invited to sign grant agreements with the EU by November 2024, and will be required to start producing renewable hydrogen within five years of signing a grant agreement.[89]

European Hydrogen Bank: Oversubscription for the first auction

The first round of the auction process attracted 132 bids from projects located in 17 European countries.[90] The value of the bids for the production credits far exceeded the initial budget for the first round of €800 million and related to projects with a total planned electrolyser capacity of 8.5GW.[91]

To address this oversubscription, the European Commission has introduced an "Auctions-as-a-service" mechanism. This allows countries in the European Economic Area to use their national budget resources to award funding support to renewable hydrogen projects in their jurisdiction (subject to complying with State aid rules) while relying on the EU-wide auction mechanism to identify the most competitive projects.[92] Germany is the first EU country to make use of the "Auctions-as-a-service" feature, allocating €350 million from its national budget for renewable hydrogen production projects located in Germany that are eligible to receive funding in the EU's auction program but did not receive funding.[93]

[87] Rachel Parkes, 'EU awards €720m to green H2 projects in first European Hydrogen Bank auction, *Hydrogen Insight* (Blog Post, 1 May 2024) <https://www.hydrogeninsight.com/policy/eu-awards-720m-to-green-h2-projects-in-first-european-hydrogen-bank-auction/2-1-1635642>.

[88] *Innovation Fund Auction* (n 85) 9 (see table 2.4, row 4.3 for the 'Payment schedule').

[89] Ibid, 6 (see table 2.1, row 2.2 for the 'Completion guarantee').

[90] Directorate-General for Climate Action, 'European Hydrogen Bank pilot auction: 132 bids received from 17 European countries', *European Commission* (News Article, 19 February 2024) <https://climate.ec.europa.eu/news-your-voice/news/european-hydrogen-bank-pilot-auction-132-bids-received-17-european-countries-2024-02-19_en> ('*European Hydrogen Bank Pilot Auction*').

[91] Ibid.

[92] *Competitive Bidding* (n 83); *European Hydrogen Bank Pilot Auction* (n 90).

[93] European Commission, 'Joint EU-Germany statement on Germany's participation in the European Hydrogen Bank "Auctions-as-a-Service" scheme' (Press Release, 20 December 2023) <https://ec.europa.eu/commission/presscorner/detail/en/ip_23_5823>. See also European Commission, 'Commission approves €350 million German State aid scheme to support renewable hydrogen production' (Press Release, 5 April 2024) <https://ec.europa.eu/commission/presscorner/detail/en/ip_24_657>.

European Hydrogen Bank: Second round announced

In late April 2024, following the success of the first auction, the European Commission announced a second round of the renewable hydrogen auction which will commence before the end of 2024. It has also released the draft terms and conditions for this round,[94] which differ from the first round of auctions in that:[95]

- the ceiling price for eligible bids for the production credits is being lowered from €4.50 per kg to €3.50 per kg; and
- the successful projects will be required to commence production within three years of signing the grant agreement (rather than within five years).

Other production credit schemes

Another production credit programme being rolled out to aid the cost-competitiveness of low emissions hydrogen is the 'Hydrogen Headstart' initiative being run by the Department of Climate Change, Energy, the Environment and Water in Australia (**Australian DCCEEW**).[96] See further at section 2.3(f) of this paper.

5. Available green credits or certificates

Another mechanism which governments have used to improve the cost competitiveness of low carbon energy generation, particularly when traded under offtake agreements, is the creation of green products schemes.

The renewable power sector provides a useful case study for this point, where in some markets renewable energy generators are entitled to create regulatory instruments referable to the quantity of renewable electricity generated. These instruments may take the form of a certificate, credit or other benefit. In some jurisdictions, under the relevant regulatory scheme, certain entities (such as entities with a carbon emissions footprint above a specified threshold) will have an obligation to surrender these green products to offset their carbon emissions footprint and will face penalties for a failure to comply. The intention of these schemes is to create demand for these green products to facilitate secondary market trading.

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[94] Directorate-General for Climate Action, 'Innovation Fund IF24 Auction' (Draft Terms and Conditions, European Commission, 30 April 2024) <https://climate.ec.europa.eu/document/download/482b186d-fec0-4ee6-82d0-06eafa0b1f75_en?filename=Draft%20TC_2nd%20Round%20RFNBO%20H2_For%20Publication_CLEAN%20Final.pdf>.

[95] European Commission, 'Competitive bidding: A new tool for funding innovative low-carbon technologies under the Innovation Fund' (Web Page, April 2024) <https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/competitive-bidding_en>. See also Leigh Collins, 'EU plans to make significant rule changes for the second European Hydrogen Bank subsidy auction', *Hydrogen Insight* (Blog Post, 29 April 2024) <https://www.hydrogeninsight.com/policy/eu-plans-to-make-significant-rule-changes-for-the-second-european-hydrogen-bank-subsidy-auction/2-1-1634831> ('*Rule changes for second European Hydrogen Bank subsidy auction*').

[96] Department of Climate Change, Energy, the Environment and Water, 'Hydrogen Headstart program', *Australian Government* (Web Page, 9 February 2024) <https://www.dcceew.gov.au/energy/hydrogen/hydrogen-headstart-program>.

By way of example, the *Renewable Energy (Electricity) Act 2000* in Australia creates a scheme under which renewable electricity generators will receive 'Large-scale Generation Certificates' for each megawatt hour of renewable electricity generated, which can either be surrendered to the relevant regulator in satisfaction of its compliance obligations or traded with offtakers as a means of improving a project's revenue stream. The New South Wales government in Australia also introduced the 'Renewable Fuel Scheme' in 2021 to provide for a similar mechanism in the context of green hydrogen, and which is aims to encourage the production of green hydrogen in that State.[97]

Similar schemes have been adopted in India, the US, New Zealand and Chile. In India, Renewable Electricity Credits (**REC**) are issued to 'Eligible Generators' under the *Electricity Act 2003*. As in Australia, each certificate is referable to one megawatt hour of electricity exported to the grid from renewable energy sources. The entity issued with a REC can then sell it on a Central Electricity Regulatory Commission approved power exchange.

There are also non-hydrogen specific international emissions trading regimes which may be compatible with green hydrogen projects. Notably, the United Nations Clean Development Mechanism (**CDM**) is one such initiative pursuant to which projects in developing countries which reduce greenhouse gas emissions can be eligible for Certified Emission Reductions (**CER**) credits.[98] Each CER credit is equivalent to one tonne of CO_2 and can be traded and sold, and used by industrialised countries, to meet a part of their emission reduction targets under the Kyoto Protocol.[99] To be eligible, projects must use a previously approved emissions reduction methodology or otherwise submit a new proposed methodology to the CDM Executive Board. In late 2023, the Executive Board adopted a new methodology for "hydrogen production from electrolysis of water".[100] This creates a pathway for green hydrogen projects in developing countries to participate in the CDM where the offtaker will use the hydrogen supplied in an industrialised country, thereby providing project developers in developing countries an opportunity to improve their revenue profile as an additional revenue stream.

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[97] NSW Climate and Energy Action, 'Renewable Fuel Scheme' (Web Page) *NSW Government* <https://www.energy.nsw.gov.au/nsw-plans-and-progress/regulation-and-policy/energy-security-safeguard/renewable-fuel-scheme>.

[98] 'What is the CDM (Clean Development Mechanism)', *United Nations Framework Convention on Climate Change* (Web Page) <https://cdm.unfccc.int/about/index.html>.

[99] Ibid.

[100] United Nations Framework Convention on Climate Change, *CDM Executive Board meeting report*, 119th mtg, Agenda Item 4.1(b)(i), CDM-EB199 (27 September 2023) <https://cdm.unfccc.int/UserManagement/FileStorage/1S2KXO7FDQENGR83PBWCV6IUHL5ZAM>. Of particular note is that the Board defined this hydrogen production methodology as being "*applicable to project activities that involve the production of hydrogen through water electrolysis that would otherwise be produced using fossil fuels. The electricity consumed by the water electrolysis process is from a captive renewable power plant, or from a mix of electricity predominantly from a captive renewable power plant and residually from the electric grid, and the hydrogen produced is supplied to existing dedicated hydrogen consumers*".

Developers of green hydrogen projects should stay up to date as to whether any regulatory incentives (whether hydrogen-specific or not) similar to those discussed in this section are available in the jurisdiction relevant to their project:

- as a means of improving their overall project economics; or
- bundling such incentives with the sale of green hydrogen under a hydrogen offtake agreement.

6. Grant funding

Another state support mechanism deployed in the renewable power sector, which may be translatable to the green sector, is the provision of grant funding.

Like CfDs, grant funding will typically be awarded by governments to successful proponents following a competitive funding round. Given the nature of this funding, there is generally no obligation for successful proponents to repay the grants they have been awarded. However, it is likely that extensive conditions will attach to the provision of this funding – for example, limiting the scope of how such funds may be used and requiring successful proponents to share information on a 'lessons-learned' basis to accelerate development and efficiency across the relevant industry. Importantly, given the evolving nature of the hydrogen industry, grant recipients may need to consider how to manage the risk that, after grant funding has been awarded, the awarding government changes the conditions for providing grant funding to align with newly established standards, or for policy or economic reasons (see discussion below at section 7.2).

Several governments around the world have introduced grant funding schemes aimed at driving improvements in all aspects of the hydrogen value chain. Green hydrogen producers may wish to consider whether grant funding is available for their project as a means of improving the pricing which can be offered under an offtake agreement.

Examples of grant funding schemes which have been introduced around the world include:

- In Australia, the Australian Renewable Energy Agency (**ARENA**) announced in October 2023 that its 'Hydrogen Headstart Program' will provide up to AUS$2 billion of revenue support to fund large-scale hydrogen production projects.[101] The grant will be provided in the form of a 'Production Credit' per unit of hydrogen produced. This announcement follows ARENA's Renewable Hydrogen Deployment funding round which was conducted in 2021 and which granted a total of AUS$103.3 million in funding to three commercial-scale renewable hydrogen projects. Under this initiative, funding was allocated through a competitive tender process, with 36 expressions of interest. The grants were awarded to projects supplying hydrogen to produce green ammonia and involved in gas blending for use in the domestic gas network.[102]

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[101] Australian Renewable Energy Agency, 'Hydrogen Headstart', *Australian Government* (Web Page) <https://arena.gov.au/funding/hydrogen-headstart/>.

[102] Australian Renewable Energy Agency, 'Over $100 Million to Build Australia's First Large-Scale Hydrogen Plants', *Australian Government* (Web Page, 5 May 2021) <https://arena.gov.au/news/over-100-million-to-build-australias-first-large-scale-hydrogen-plants/>.

- In the United States, the Department of Energy has offered up USD$7 billion in funding towards the creation of seven regional clean hydrogen hubs to support the development of hydrogen adjacent infrastructure and accelerate the establishment of a national network of low-cost, clean hydrogen producers.[103]
- The Green Innovation Fund in Japan is offering funding of a total of 2 trillion Yen to projects formulated within the Green Growth Strategy (including the hydrogen and fuel ammonia industry).[104]
- The European Commission approved a €5.4 billion funding package, jointly funded by 15 EU member states and 35 private companies. The group will fund 41 projects relating to hydrogen.[105]

7. Hydrogen 'power' auctions

An alternative to the state-support mechanisms outlined above is the South Korean Government's introduction of the world's first 'hydrogen power' bidding market in mid-2023. [106]

Under the program, power producers can bid to sell electricity that is generated from hydrogen (or hydrogen compounds such as ammonia) to Korea Electric Power Corp. the state-run power distributor, or other regional operators. The bidding relates to the generation of power from 'general hydrogen' (being 'gray' hydrogen).[107] The winning bidders for the initial rounds will be required to start commercial operation within two years from the date of contract signing, and will therefore be required to supply hydrogen-generated electricity to the market from 2025 at the latest.

In August 2023 South Korea announced that it had selected the first winners from the first round of the auction process, awarding five projects with a combined 715GWh of annual generating capacity.[108] The second round of bidding commenced in September 2023 and aims to support up to 650GWh of electricity (noting once again that this will be through gray hydrogen).[109]

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[103] Department of Energy, 'Biden-Harris Administration Announces Historic $7 Billion For America's First Clean Hydrogen Hubs, Driving Clean Manufacturing and Delivering New Economic Opportunities Nationwide', *United States Government* (Web Page, 13 October 2023) <https://www.energy.gov/articles/biden-harris-administration-announces-7-billion-americas-first-clean-hydrogen-hubs-driving>.

[104] 'Overview of the Green Innovation Fund Projects', *NEDO* (Web Page) <https://green-innovation.nedo.go.jp/en/about/>.

[105] Foo Yun Chee, 'EU Launches 5.4-Billion-Euro Hydrogen Project with Alstom, Daimler, others', *Reuters* (Blog Post, 15 July 2022) <https://www.reuters.com/business/energy/eu-launches-54-bln-euro-hydrogen-project-with-alstom-daimler-others-2022-07-15/>.

[106] Shi Weijun, 'South Korea takes key step towards building a hydrogen economy', *Gas Pathways* (Blog Post, 27 July 2023) <https://gaspathways.com/-2129>.

[107] Ibid.

[108] Polly Martin, 'South Korea picks first five winners of hydrogen power plant auction, but no requirement to run on clean H2', *Hydrogen Insight* (Blog Post, 12 August 2023) <https://www.hydrogeninsight.com/power/south-korea-picks-first-five-winners-of-hydrogen-power-plant-auction-but-no-requirement-to-run-on-clean-h2/2-1-1500148>.

[109] Rachel Parkes, 'South Korea tenders for 650GWh of power generation from polluting grey hydrogen', *Hydrogen Insight* (Blog Post, 1 September 2023) <https://www.hydrogeninsight.com/power/south-korea-tenders-for-650gwh-of-power-generation-from-polluting-grey-hydrogen/2-1-1509833>.

2.4. Carbon pricing

In addition to the various state support regimes considered in section 2.3 which seek to support the revenue profile of green hydrogen projects, various governments around the world have also sought to introduce carbon price mechanism.

In its simplest form, a carbon price mechanism is a regulatory tool which 'prices' in the cost of carbon emitted during the manufacturing or production process for goods, with a view to make products produced with a lower carbon footprint more cost-competitive with similar goods produced through carbon intensive processes. An example of this is steel produced through conventional smelting processes compared to 'green' steel. One of the key challenges in the successful implementation of carbon price regimes is 'carbon leakage', whereby emissions-intensive industries relocate their operations to jurisdictions or regions that have lower or no carbon price mechanism, ultimately undermining a country's decarbonisation efforts.[110]

1. **EU's Carbon Border Adjustment Mechanism (CBAM)**

   One of these carbon price mechanisms is the EU's CBAM, which seeks to put a fair price on the carbon emitted during the production of carbon intensive goods entering the EU, and to encourage cleaner industrial production in non-EU countries.[111] The CBAM has been structured to ensure the carbon price of imports is equivalent to the carbon price of domestic production such that the EU's climate objectives are not undermined.

   The EU's CBAM is currently in its transitional phase which commenced in October 2023 and will continue through to 2026. This gradual introduction of the CBAM is aligned with the phase-out of the allocation of free allowances under the EU's Emissions Trading System (**EU ETS**). The CBAM will initially only apply to imports of specified goods and selected precursors where production is carbon intensive and at most significant risk of carbon leakage (being cement, iron and steel, aluminium, fertilisers, electricity and hydrogen).[112] In addition, during the transitional phase, importers of goods to the EU will only be required to report on the greenhouse gas emissions of their imports without the additional obligation to purchase and surrender certificates under the scheme (see further discussion regarding CER credits at section 2.3(e) above).

   Once in full effect 2026, EU importers of goods covered by the CBAM will be required to purchase and surrender certificates based on the number of emissions embedded in their imports.[113] The price of certificates will be calculated based on the weekly average auction price of EU ETS allowances (set at €/tonne of CO_2 emitted).[114]

[110] 'New UK levy to level carbon pricing', *United Kingdom Government* (Web Page, 18 December 2023) <https://www.gov.uk/government/news/new-uk-levy-to-level-carbon-pricing> ('*New UK Levy to Level Carbon Pricing*').

[111] 'Carbon Border Adjustment Mechanism', *European Commission* (Web Page) <https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en>.

[112] Ibid.

[113] Ibid.

[114] Ibid.

2. **Australian CBAM**

CBAM mechanisms are also being considered by other national governments, including in Australia.

The Australian 'Carbon Leakage Review' was announced by the Australian DCCEEW in March 2023, and has been established to assess the feasibility of an Australian CBAM, particularly in relation to steel and cement.[115] The consultation periods forming part of the review are ongoing, and a final report is due to be released in September 2024.[116]

3. **Japan carbon pricing scheme**

Similarly, Japan launched a carbon pricing scheme in April 2023, which comprises both emissions trading and a carbon levy, and involves a forum for "green transformation" called the "GX League".[117]

This forum will offer emission allowances to companies accounting for more than 40% of Japan's emissions and require them to set emissions-cutting targets in line with Japan's carbon neutrality goal.[118]

2.5. Price review mechanics

1. **Overview**

As noted above, a key bankability consideration for green hydrogen projects will be the provision of long-term offtake agreements which provide for a predictable revenue stream.

Given the importance of longer-term price certainty, and the current absence of a widely accepted market price for hydrogen, this presents a unique challenge for parties entering early-stage offtake agreements for green hydrogen projects. Parties to these arrangements will need to consider how to most appropriately price for hydrogen in the short-term (noting the considerations in paragraphs 2.1 and 2.2 above) whilst also balancing the need for flexibility and the ability to adapt to a more competitive pricing model in the later stages of their offtake term as the industry develops.

To provide this flexibility, parties may wish to incorporate price review mechanics in their hydrogen offtake agreements. These mechanics, if incorporated, will be of key interest to project financiers and financial investors given the potential impact on a producer's revenue stream, investor returns and the producer's ability to service its debt obligations. This may require, for example, project sponsors (which may include the relevant offtaker in its capacity as an equity investor) to provide additional levels of contingent equity upfront to secure their debt repayment obligations under their financing arrangements where a price review is triggered.

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[115] Department of Climate Change, Energy, the Environment and Water, 'Australia's Carbon Leakage Review', *Australian Government* (Web Page) <https://www.dcceew.gov.au/climate-change/emissions-reduction/review-carbon-leakage>.

[116] Ibid.

[117] Yuka Obayashi and Katya Golubkova, 'Explainer: Japan's carbon pricing scheme being launched in April', *Reuters* (Blog Post, 31 March 2023) <https://www.reuters.com/markets/carbon/japans-carbon-pricing-scheme-being-launched-april-2023-03-30/>.

[118] Ibid.

2. Price review triggers

Price review provisions typically provide a mechanism through which the parties will review the existing pricing formula under an agreement on a periodic basis or on the occurrence of certain trigger events. In the context of green hydrogen offtake agreements, a price review may be triggered by events such as:

- the establishment of a widely accepted market price or index for hydrogen (or another agreed chemical compound);
- the occurrence of specified market disruption events, such as:
    - a material change in the formula or method for calculating the relevant index to which the offtake price is linked; or
    - a temporary or permanent discontinuance of an index to which the offtake pricing is linked.
- the introduction of new 'green' certificates, credits or products (for example, green products referred to in paragraph 2.3(d) above) or, if such regulatory instrument are already being traded as part of the offtake arrangements, the repeal or material amendment of the regulatory regime underpinning these products;
- upon a change of law (including a change in policy or regulation or the imposition of a tax) which impacts the parties' financial obligations (usually above an agreed threshold) (see section 7.2 below);
- the occurrence of a specific date or upon the achievement of certain milestones; or
- upon pricing increases for production inputs above an agreed threshold (see section 2.2(d) above).

A further alternative to address price review provisions is to refer to comparable sales contracts to determine market prices, which is an approach commonly adopted in LNG sales contracts across the Asia Pacific region. This may be translatable to hydrogen in the future years as the industry develops, but may be challenging in the early years of the industry given the current lack of comparable sales contracts in the market. When used in the context of LNG sales contracts, these price review mechanics will generally:

- carefully restrict the type of contracts that can be referred to as part of the price review process, to ensure those contracts are genuinely commercially comparable (for example, by requiring that comparable contracts have a similar or the same contract term (or have been entered into within a period before the price review process), similar delivery requirements or the same delivery destination); and
- provide clear steps that parties must take when negotiating the new price, including an escalation mechanism before a party is able to commence arbitration proceedings.

Adopting price review mechanics such as those considered above may provide price certainty to parties in the short term (while the production costs for hydrogen are high), whilst also allowing a degree of flexibility over the long term – particularly if the view is that production costs will reduce over time. However, the specific list of price review triggers will need to be carefully considered by the relevant parties in the context of the specific project.

Noting the bankability considerations above, project financiers and investors will closely scrutinise and seek to limit the scope of price review events, and likely seek to ensure these triggers are defined by reference to an objective threshold. For example, this may require the parties to absorb the risk of price fluctuations within an agreed range referable to a specified market price or comparable sales contracts for projects of a similar size, with the price review only being triggered where the relevant thresholds are exceeded.

1. **Implications of a price review being triggered**

Under the terms of an offtake agreement, following the occurrence of a price review event, the parties will likely be under an obligation to negotiate in good faith and agree any changes needed to:

- account for the impact of the relevant price review event upon the affected parties; and
- put the parties in the same relative commercial position and risk allocation position as originally contemplated by the agreement.

Although acknowledging parties may be keen to include price review mechanics in their hydrogen offtake agreements, it should be noted that these provisions are frequently the subject of dispute, and that contracts often refer parties to arbitration (or, in some cases, expert determination) in the event of a failure to agree on a revised price. The escalation to dispute resolution will likely increase costs and cause delays, and therefore parties should carefully consider how the dispute resolution mechanics in their contracts are framed from the outset.

If an offtake agreement is terminated due to the default of one of the parties, the defaulting party will likely be required to pay an early termination amount to the non-defaulting party, which will be calculated as the mark-to-market replacement value of the agreement for the remainder of the offtake term.

Alternatively, an offtake agreement may offer parties an opportunity to walk away from the agreement upon mutual agreement where the parties cannot agree on the necessary amendments needed to address the relevant price review event. This may be particularly helpful to provide for in agreements where government support is key to the project's commercial viability, where the parties are unable to negotiate the required changes to the offtake agreement to reinstate the project's viability.

In some circumstances, a right for parties to walk away from an agreement may provide hydrogen producers with an opportunity to secure better pricing and terms on the prevailing market, however such a right will be closely scrutinised by financiers given the potential for this to be exploited and the potential disruption this would cause to the project's revenue stream during the tenor of the debt (noting that, following termination, the hydrogen volumes produced would be uncontracted and therefore be exposed to merchant risk).

2.6. Currency and inflation risk

Although not specific to green hydrogen, parties to an offtake agreement will need to consider how to incorporate the risk of inflation and currency fluctuations in their offtake pricing, and how to apportion risk most appropriately between them over the offtake term.

The parties will need to consider whether the risk of currency fluctuations is relevant to their offtake agreement. For example, this may be relevant where:

a. the transactions contemplated under the offtake agreement involve a multi-currency element – for example, where:

    i. the contracted hydrogen will be exported from, or imported to, a foreign jurisdiction; or

    ii. under a pricing model which allows a producer to pass through its costs of development (see sections 2.2(b) to 2.2(e)), the producer (or its contractors) will be procuring key equipment such as electrolysers in foreign currencies; and

b. the parties agree to link the contract price for hydrogen to a major currency such as the US dollar – for example, where the project is in a developing country – to secure international project financing.

How this risk is allocated will ultimately be a commercial point for the parties. One potential strategy to mitigate exposure to foreign exchange rate fluctuations is for the parties to adopt a currency hedging protocol.

In addition, parties may seek to address the risk of inflation in a hydrogen offtake agreement by including escalation mechanics in their pricing provisions. This may involve, for example, the parties (i) pre-agreeing the value of the price escalation during the offtake term at agreed intervals (most typically annually); or (ii) agreeing to escalate the contract price (or certain pricing metrics) by reference to an agreed pricing index such as the consumer-price index (CPI) or a wage-price index (WPI).

3. Volume regulation

3.1. Overview

Another key consideration when negotiating green hydrogen offtake arrangements will be how to best regulate the parties' obligations regarding the volumes of hydrogen traded. These mechanics will need to balance the interests of both hydrogen producers and consumers.

There is currently no readily available liquid market to trade uncontracted volumes of green hydrogen. As such, in the near-term, producers will be reliant on negotiating offtake contracts with individual offtakers. This presents a unique challenge for green hydrogen producers who need to enter contracts to sell sufficient volumes of the hydrogen they produce to cover their fixed costs of production and (if applicable) provide a steady revenue stream for bankability.[119] This risk is commonly referred to as "volume risk".[120]

Considering the above, parties negotiating green hydrogen offtake agreements will need to carefully consider their options for volume regulation and the structure that best suits their needs. As noted elsewhere in this paper, approaches taken to volume regulation in adjacent sectors may provide a useful reference point for parties in this context – for example, in the gas and renewables sectors (under GSPAs and PPAs).

Some relevant options from other sectors which may be considered by the parties include the following:

1. **Take-or-pay**

   Take-or-pay arrangements are common in sales contracts for natural gas and LNG projects. These are less common in the power sector, but do exist in specific scenarios.

   In take-or-pay arrangements, an offtaker contracts to 'take' an agreed minimum volume of gas over a specified period (for example, a year) and must pay for that minimum volume regardless of whether the offtaker actually takes that full volume. For GSPAs, the relevant agreement will include mechanics requiring the offtaker to nominate its required daily quantity of gas (up to a specified maximum quantity) and the producer will be required to deliver this quantity on the relevant day.

   The benefit of a take-or-pay model is that it secures a steady revenue stream for producers, which can be used to obtain project financing and more accurately model project cashflows over the long term.

[119] Some policy initiatives being taken by various governments around the world to encourage growth on the demand side of the hydrogen equation are considered in sections 2.2(a) and 2.3.

[120] *Demystifying the Hydrogen Business Model* (n 46) 10.

With that said, offtakers will typically be relieved of their take-or-pay obligations in respect of any:

- shortfall gas, where the offtaker has properly nominated a quantity of gas which is not delivered by the producer (subject to limited exceptions);
- breach of the producer's obligations under the relevant agreement;
- force majeure events; and
- in some cases (particularly for domestic contracts), 'permitted supply interruptions' – for example, scheduled outages for major maintenance at the production or receiving facility pursuant to an agreed schedule.

If the producer is unable to supply the nominated volume (i) the offtaker may be required to use reasonable endeavours to procure replacement gas to cover the shortfall (on commercially reasonable terms); and (ii) to keep the offtaker whole, the producer may be obliged to pay the difference between the price of any replacement gas the offtaker is able to procure and the GSPA price.

If the offtaker is unable to source replacement gas, or cannot source sufficient volumes to cover the relevant shortfall:

- the seller may be required to pay liquidated damages (up to a specified cap, subject to limited exceptions);[121] or
- the offtaker may be entitled to a credit or abatement of its take-or-pay obligations for future payment periods.

2. <u>Minimum production or supply</u>

Project owners will also usually be required to agree to minimum production or supply obligations in favour of the offtaker. These obligations are commonly referred to as 'send-or-pay' obligations.

For offtake agreements:

- in the gas sector, a producer will typically be required to make available to the offtaker a minimum volume of gas over a specified period to compliment the offtaker's 'take-or-pay' obligations; and
- in the power sector, a generator will usually be required to commit to generating a minimum volume of electricity (in MWh) over a specified period (with no take-or-pay obligations from the offtaker).

By way of example, in the context of a PPA for a power generation project, an offtaker's payment obligations will usually be determined by reference to the *actual* volume of electricity generated by the project. Where the volume generated by the project is below the project owner's 'minimum generation' threshold, the offtaker will only be required to pay for the volume that is generated or delivered (as applicable).

[121] Examples of such exceptions on the seller being required to pay damages include where the shortfall was caused by a force majeure event, emergency event, an act or omission of the offtaker. It will need to be determined whether this is applicable in the context of the relevant project.

This is distinct from 'take-or-pay' arrangements under a GSPA (outlined above), whereby an offtaker will be required to pay for the minimum contracted volume in exchange for the producer making that minimum volume available (irrespective of whether the offtaker takes the full volume of gas).

Under minimum quantity arrangements, if the seller falls short of its obligations for the relevant period, subject to limited exceptions (such as force majeure or network outages), it will usually be required to:

- remedy the shortfall in subsequent periods; and/or
- pay shortfall liquidated damages to the offtaker.

3.2. Key volume regulation considerations for green hydrogen projects

There are several factors which will influence the parties' decision as to the most appropriate volume regulation model to be adopted in a green hydrogen offtake agreement. These factors include (but are not limited to) a project's location, the offtaker's intended end-use of the hydrogen and the identity of the offtaker.

Given the early stages of the hydrogen market (and noting the absence of a liquid market to trade uncontracted volumes), parties to these arrangements will need to carefully consider whether:

- hydrogen producers are willing to commit to deliver minimum volumes of hydrogen (backed by obligations to pay liquidated damages for shortfalls and/or obligations to procure replacement hydrogen) given the high capital costs of development and the potential variability in production costs; and
- hydrogen customers are willing to commit to take-or-pay obligations, given (i) the level of demand for hydrogen across markets is potentially not high enough to support the consumption of large or scalable volumes of hydrogen; and (ii) given the current lack of uniform technical requirements, offtakers may not have confidence that the hydrogen produced will meet the specifications required for their intended end use (including, for example, across markets in the context of hydrogen export projects).[122]

[122] A number of governments around the world have introduced policy initiatives aimed at strengthening the demand market for hydrogen. Some of the key initiatives that have recently been introduced are considered in in sections 2.2(a) and 2.3.

In light of the above considerations, there are some steps that hydrogen producers can take to provide a credible volume offering to potential offtakers (as well as project financiers). A sample of some of these steps include:

1. **Water and electricity supply arrangements**

   Negotiating contractual arrangements for the supply of water and electricity to be used in green hydrogen production. This provides for several benefits, including:

   - to give producers an opportunity to present a credible production value chain to the market (in a similar way to LNG markets, where lenders look to understand the gas supply arrangements between the LNG plant owners, gas producers and pipeline owners to gain assurance that the relevant plant will be supplied); and
   - given electricity and water costs are key cost components in green hydrogen production, having formal supply arrangements in place for these commodities will assist in hedging the project's production costs against market fluctuations (strengthening a project's bankability, and giving offtaker's confidence as to the longer-term operating costs of the project).

2. **Integration with renewable energy generation**

   Another way for producers to gain further control of their production costs are to integrate renewable energy generation capabilities with their hydrogen production. Acknowledging this option may only be available for larger producers with stronger balance sheets, this option provides producers with greater operational control over electricity prices and the overall production of the integrated facility. For example, assuming the renewable energy projects are grid-connected, the project owner may elect to export power during high price periods and re-direct generation to the electrolyser for hydrogen production during lower price periods. See further the commentary at section 3.3(a) below regarding 'project-on-project' risk in this regard. The NEOM Green Hydrogen Company and H2 Green Steel projects are both examples of integrated project structures.

3. **Joint venture relationships**

   As noted, a number of early stage projects have established joint ventures which involve the offtaker as a shareholding party. This was the approach taken in the recently closed NEOM Green Hydrogen Company project referred to elsewhere in this paper.[123]

   This project structure provides the potential benefit of fostering collaborative behaviours between the shareholders and the offtaker to achieve common objectives.

[123] *NEOM Green Hydrogen Project* (n 4).

3.3. Contractual risk allocation considerations for volume regulation

In addition to the broader project structuring considerations above, from a contractual risk allocation perspective, parties will need to consider how to account for the following matters when negotiating offtake agreements for green hydrogen projects:

1. **Project-on-project risk**

   A key commercial and bankability consideration will be the ability of project developers to produce a steady volume of green hydrogen.

   Where green hydrogen is being produced by electrolysis from a renewable source, an important factor regarding volume will be whether the electrolyser being used to produce the hydrogen is being powered by firmed or intermittent generation. For the latter, the seasonality of renewable electricity may expose producers to 'project-on-project' risk in its production processes – for example, by exposing producers to irradiance or wind risk, and not being able to scale up production to meet its customer's demand when the sun isn't shining or the wind isn't blowing.

   This consideration is unique to green hydrogen production when compared to other types of projects (for example, natural gas projects) where production is not dependent on such variable production factors.

   One potential option to mitigate this risk is to locate the hydrogen production project at or near an energy storage facility site to firm up electricity supply (for example, a pumped hydro facility) or procure their own storage solution (for example, a battery energy system). However, when coupled with the cost of renewable power generation and the hydrogen production costs, this option may result in a project not being economically viable.

2. **Back-to-back coverage under procurement arrangements**

   The project-on-project considerations outlined above will need to be carefully considered in the context of a producer's minimum supply obligations under the offtake agreement.

   As such, a green hydrogen producer will need to:

   - have a clear understanding of how it plans to satisfy these minimum supply obligations; and
   - negotiate contractual mechanisms to mitigate the project's potential exposure in the event of a production shortfall.

One of the most effective ways to mitigate against this risk is through the negotiation of mechanics in its project contracts (such as those related to engineering, procurement, construction, operations and maintenance). In this respect, hydrogen producers should take care to:

- carefully negotiate a technical specification which clearly sets out the required design and performance standards for the production facility;
- to the extent the electrolyser supply and balance of plant works will be performed by different contractors, carefully consider how to manage the interfaces between the respective scopes of the contractors; and
- negotiate back-to-back performance warranties, backed by liquidated damages, which mitigate the risk of 'gaps' between the liquidated damage regimes between the project contracts and the hydrogen offtake agreement.

This will be a key consideration for the equity investors and (if applicable) project financiers, particularly given the producer may be liable under the green hydrogen offtake agreement for liquidated damages in respect of production shortfalls.

To the extent a producer is unable to negotiate back-to-back performance guarantees under the project documentation (or where there are gaps in the pass-through), producers should be aware that any residual risk will be borne by the equity parties. This will need to be accounted for in the project's financial model, and in some circumstances, lenders may require that the project sponsors deposit upfront equity into secured accounts to provide contingency funding for this gap risk.

3. **Excess hydrogen**

If take-or-pay options are adopted, parties will also need to consider whether:

- an offtaker will have the right to purchase 'excess hydrogen' produced above the relevant take-or-pay quantity; and
- the producer will have a right to sell any excess hydrogen to third parties;

This is a common mechanism included in LNG sale and purchase agreements (and the usual concerns regarding priority of supply and coordination of delivery schedules will apply equally to hydrogen offtake agreements).

The parties will also need to consider the arrangements and risk allocation with respect to storing any excess hydrogen. Although acknowledging the current technical limitations with storing hydrogen in a commercially viable way, this may be relevant for some parties to address in their green hydrogen offtake agreements.

4. **Volumes not taken by the offtaker**

   The parties will also relevantly need to consider:

   - if the offtaker notifies the producer that it does not wish to take volumes of hydrogen that are made available by the producer within the take-or pay volume:
     - whether the producer will be entitled to take steps to sell that hydrogen to third parties, and how the producer's proceeds from these sales will be treated; and
     - in respect of any volumes of hydrogen not able to be sold to third parties, the offtaker's liability if the seller's on-site storage facilities are at full capacity; and
   - as above, the arrangements and infrastructure in place to store any unutilised hydrogen.

5. **State support of volumes**

   Hydrogen producers may also wish to consider whether there are any state-support mechanisms to mitigate their volume risk – for example, the 'Sliding Scale' mechanism under the UK government's hydrogen CfD scheme (see section 2.3(a) above).

3.4. Additional options for hydrogen volume regulation

Given the considerations outlined above, parties may wish to consider alternative or hybrid options for regulating volumes under green hydrogen offtake agreements (particularly in respect of early-stage projects).

Some of these options include:

1. **Lower take-or-pay thresholds**

   Such an arrangement would resemble a revenue stream for a project on a partially contracted and partially merchant basis. This approach may be beneficial where an offtaker is reluctant to commit to a high take-or-pay threshold (particularly for early-stage projects) and where a seller is equally hesitant about its ability to meet an offtaker's nominations at a higher take-or-pay level.

   If adopted, the parties will need to consider what the parties' rights will be in relation to any hydrogen produced over and above the agreed take-or-pay threshold. Some potential options in this regard include:

   - regulating an offtaker's right to purchase hydrogen above the take-or-pay threshold (see paragraph 3.2 above in relation to 'excess hydrogen'); or
   - the offtaker having a hard take-or-pay obligation (at a lower threshold), with the seller having an obligation to use reasonable endeavours to produce and deliver hydrogen to the offtaker above the take-or-pay threshold.

However, although this will no doubt be attractive to offtakers, this will need to be balanced with the seller's interests – particularly if the seller intends for the project to be project-financed. Financiers will typically require high take-or-pay commitments from an offtaker and will base their financial modelling on the contracted revenue components of a project. As such, if a lower take-or-pay threshold is agreed, financiers may only consider the revenue the subject of those take-or-pay obligations (and not account for the merchant portion) when assessing its debt sizing. This will ultimately flow through to the project owner's commercial assessment of the project and whether this is viable without higher gearing levels under its debt financing arrangements.

2. **Lower minimum production thresholds**

   Noting the project-on-project considerations outlined above, the parties to a hydrogen offtake agreement may wish to provide for a lower minimum production threshold on the part of the seller.

   This would be beneficial in assisting producers to mitigate some of the volume regulation considerations outlined above, however, this will also need to be balanced with an offtaker's demand requirements.

3. **'Soft' take-or-pay obligations**

   Under such an arrangement, a producer will be under an obligation to use 'best endeavours' to deliver an offtaker's nominated quantities of hydrogen up to an agreed take-or-pay threshold, whilst not attracting liabilities to indemnify or pay liquidated damages to the offtaker in respect of any shortfall (in the absence of breach of other specific obligations in the offtake agreement).

   Noting this provides a more favourable position for hydrogen producers, offtakers may be less willing to agree such arrangements where a minimum volume is not guaranteed.

4. **Multiple offtake agreements**

   Noting that offtakers will potentially be reluctant to commit to high take-or-pay commitments (particularly for early-stage projects), a producer may seek to mitigate this risk by agreeing to multiple offtake agreements with different parties for smaller volumes.

   If available to a producer, this option may assist a project's bankability assessment by providing for a greater portion of contracted revenue than may otherwise have been available with a single offtaker. In addition, if an offtake agreement was to fall away (for example, where terminated due to the insolvency of the offtaker), the producer would continue to have a partially contracted revenue stream during the period it seeks to replace the terminated volume. However, whilst acknowledging these benefits, having multiple offtake agreements in place can be quite administratively burdensome for a project owner.

5. Supplementing shortfalls with 'non-green' hydrogen

Given the intermittent nature of renewable energy generation, one of the key hurdles to hydrogen producers agreeing to minimum volume commitments for 'green' hydrogen projects will be 'project-on-project' risk (discussed in section 3.1).

Acknowledging this challenge (particularly in the near term), to facilitate producers providing volume commitments, parties to an offtake agreement may agree that the producer can supplement any shortfall volumes of green hydrogen with 'non-green' hydrogen.

Noting an important consideration for offtakers will be certifying the 'greenness' of the hydrogen it receives,[124] initially there may need to be a trade-off to permit slightly lower standards to facilitate producers agreeing to minimum supply obligations. Where applicable, parties will need to carefully consider:

- whether they need to negotiate a lower price for any 'non-green' hydrogen (compared to green hydrogen which satisfies the relevant standards);
- whether amounts payable by the offtaker in respect of any 'green certificates' or other credits under the offtake agreement will be adjusted to account for any non-green volumes of hydrogen delivered,
- whether the producer may be liable to indemnify the offtaker for any liability it accrues under a regulatory regime for not surrendering the required volume of green certificates (or equivalent);
- whether a regime can be agreed which (i) permits the producer to achieve a slightly lower standard during an initial period (calculated as an average standard over time); and (ii) on and from the expiry of this initial period, requires the producer to ensure any hydrogen delivered satisfies the green standards or technical specifications required under the offtake agreement;
- how the delivery of any 'non-green' hydrogen will be treated in the context of the chain of custody and guarantee of origin requirements in the offtake agreement (see paragraph 4 below); and
- if this arrangement is workable in the context of the producer's third-party contractual arrangements (including its funding agreements), which may set strict requirements with respect to the required specification and green origin of the hydrogen.

See further our comments at section 4.4 below in this regard.

[124] See section 4.4 of this paper in relation to certifying the 'greenness' of hydrogen under guarantee of origin schemes.

4. Guarantee of origin schemes

4.1. Overview

A buyer's motivation for signing a green hydrogen offtake agreement (or its related derivatives) will likely be driven by a desire to decarbonise its operations – for example, to displace natural gas consumption in its operations with 'green' or low-emission alternatives.

As such, offtakers to green hydrogen projects will be especially keen to:

- certify the 'greenness' of the hydrogen they are purchasing; and
- ensure the relevant certification regime is independent and has credibility with, and is well-recognised by, market participants and the general public.[125]

These considerations will be increasingly relevant to offtakers intending to use green hydrogen to market products they manufacture or produce as 'green' – for example, 'green' steel or 'green' cement. In addition, given the increasing levels of scrutiny on alleged 'greenwashing' activities, providing confidence in green certification schemes will be an important consideration for parties from a reporting perspective. This includes ESG reporting to both internal and external stakeholders (such as regulators), particularly where a party could face financial consequences for wrongful claims regarding the green elements of a product.

In light of these considerations, there has been much discussion at all levels of the market regarding the establishment of 'guarantee of origin' (**GO**) schemes for hydrogen. These schemes are intended to provide a measure for the carbon intensity of a unit of hydrogen (from the point of production to the point of consumption) and provide guarantees to hydrogen customers of the 'greenness' of the hydrogen they are purchasing.

The parties to hydrogen offtake agreements will therefore need to agree on the level of detail and disaggregation in the certification of the hydrogen being traded. There are a great deal of factors to be considered in this regard. At one end, parties may consider that it is sufficient for a hydrogen project to be certified as "green", and thereafter to treat all hydrogen produced as 'green' hydrogen. On the other hand, such an approach would not account for changes in the hydrogen production process over time (especially where the electricity source varies). Accordingly, the parties will need to agree upon the certification mechanics in the offtake agreements they negotiate. As is the case with approaches to hydrogen volume regulation (see section 3 above), what is most suitable to the parties will be influenced by several factors such as project characteristics, the offtaker's requirements and any regulatory reporting requirements.

[125] See section 8 (Social licence and transparency) of this paper regarding the importance of social licensing considerations.

This section sets out some of the relevant considerations regarding GO schemes when negotiating green hydrogen offtake agreements. It also provides an overview of some of the GO schemes that have been introduced across the market.

4.2. Chain of custody models

One method that parties can use to establish confidence in the green certification of the hydrogen being traded is to agree upon a chain of custody model which provides for the required level of protections in their hydrogen supply chain.

In this respect, there are four common models which may be relevant to parties in the context of green hydrogen offtake agreements. These models provide for varying degrees of trustworthiness, complexity, detail and cost,[126] and parties should therefore take care to adopt the most suitable and credible chain of custody for their offtake arrangements.

An overview of each model is as follows:[127]

1. **‘Identity preservation’ model:**

   This model prohibits a certified product from a certified site from mixing with other certified sources. It requires a tracking of the actual molecules of the materials as they move through the supply chain.

   In the context of a green hydrogen project, this would require any ‘green’ hydrogen to be kept separate from other, potentially non-green, products (such as ‘grey’ or ‘blue’ hydrogen) as it moves through the supply chain. This includes during production (including to ensure the power used for electrolysis is from renewable sources) and during storage, shipping and delivery.

   This model offers the highest level of credibility in the end-product (in this case, green hydrogen) and as a result will attract a pricing premium. However, the complex, logistical and strict processes involved in ensuring physical separation, which would require the development of dedicated storage and transport infrastructure, and will require higher costs compared to the other models available.

   The parties to an offtake agreement will need to consider whether this increased level of credibility is a valuable trade-off for the additional capital cost (particularly given the chemical make-up of green hydrogen is indistinguishable from gray or blue hydrogen).

[126] Tian Daphne, ‘Four chain of custody models explained’, *Circularise* (Blog Post, 17 November 2022) <https://www.circularise.com/blogs/four-chain-of-custody-models-explained>.
[127] Ibid.

2. **‘Segregation’ model**

   The segregation model also offers a high level of credibility regarding the green origin of a product, with the requirements being slightly less stringent than the identity preservation model.

   Under this model, a certified product from a certified site must be kept separate from non-certified sources. However, unlike the identity presentation model, products from different certified sources can be mixed provided they share the same defined standard. For a hydrogen project this may potentially allow green hydrogen to be mixed with blue or gray hydrogen (provided the specific characteristics of the hydrogen are maintained, and it is not mixed with hydrogen with different characteristics or grades).

   Similar considerations apply to this model as in relation to the identity preservation model. However, given the potential for mixing green hydrogen with other non-green forms, the parties will need to consider whether the additional investment required to comply with this model is worthwhile given the ‘greenness’ cannot be assured.

3. **‘Mass balance’ model**

   The mass balance model is used in areas of the energy sector involving mass production and scale, such as petrochemicals. It is designed to track the total amount of sustainable content in a production process and allocate this as an appropriate value relative to the finished product. It does this, for example, by using auditable bookkeeping methods to assign a ratio of the sustainable content used in the production process to the end product.

   Mixing of sustainable and non-sustainable materials is permitted under this model. As such, in the context of hydrogen, green hydrogen can be mixed with other non-green variants. It is likely that this would not provide clear guidance on the source of electricity used in hydrogen electrolysis (for example, through a directly connected renewable energy generator or through a grid-connection).

   As such, although providing for lower cost and greater flexibility, parties negotiating green hydrogen offtake agreements may also want to consider that:

   - the lack of physical traceability in the hydrogen delivered may provide little certainty to buyers who are keen to ensure that the hydrogen they receive, and use, is green; and
   - there is a greater risk of double-counting and greenwashing, as companies can make claims regarding the ‘greenness’ of hydrogen even where the production method of the actual hydrogen delivered cannot be verified with certainty.

4. **<u>'Book and claim' model</u>**

   Finally, under the book and claim model companies can obtain sustainability certificates for the volume of certified sustainable materials they generate or create. This model offers the most flexibility and the lowest cost barrier to entry, and therefore may be an attractive option for parties negotiating a hydrogen offtake agreement.

   With that said, under a book and claim model both certified and non-certified materials are permitted to flow freely through the supply chain without traceability. As such, there is greater potential for the certification under this model to be manipulated and abused. This will need to be carefully considered by the parties to determine whether this model provides the level of assurance required.

Noting the differing considerations under these supply chain models, it is relevant to keep in mind that for many of the GO schemes and hydrogen standards published to date (some of which are considered in sections 4.3 and 5.2 respectively), the preferred chain of custody model is the mass balance and book-and-claim models.[128]

See further our comments at section 4.4 below in this regard.

4.3. GO schemes

A number of different approaches have been considered by regional and national actors as part of the GO schemes currently being developed. This includes differing approaches in relation to the:

- suggested supply chain model; and
- the relevant steps in the hydrogen supply chain (or 'system boundaries') to which the relevant GO scheme applies. For example, some GO schemes focus on a:
  - 'well-to-gate' system, which focuses on the supply of fuels used in the hydrogen production process;
  - 'well-to-point of delivery' or 'well-to-tank' system, which extends to also include the transport and possible conversion and reconversion of hydrogen into other carriers (e.g. ammonia); and
  - 'well-to-wheel' system, which extends further to include emissions associated with the use of the hydrogen produced.[129]

[128] International Energy Agency, 'Towards hydrogen definitions based on their emissions intensity' (Report, April 2023) 62-66 (table 3.1) <https://iea.blob.core.windows.net/assets/acc7a642-e42b-4972-8893-2f03bf0bfa03/Towardshydrogendefinitionsbasedontheiremissionsintensity.pdf> ('*Hydrogen definitions based on emissions intensity*').

[129] For a useful overview of the different supply chain models and 'system boundaries' being considered in various planned GO schemes (as well as other hydrogen certification systems), refer to *Hydrogen definitions based on emissions intensity* (n 128) 36 (table 3.1).

This section provides a brief overview of some of the hydrogen GO schemes announced at a regional and national level.

At a regional level, a registry for hydrogen certificates across Europe called 'CertifHy' (a non-governmental certification scheme) has been established, which facilitates the issue and trade of hydrogen GO certificates.[130]

At a national level:[131]

1. **Australia**

   In September 2023, the Australian DCCEEW released Australia's Guarantee of Origin scheme design paper. This describes an end-to-end participation model to measure, track and verify the production technology, carbon emissions, location and other factors such as water consumption in the certification process. [132] The 'Clean Energy Regulator' in Australia will be responsible for administering the scheme, including to undertake compliance monitoring and validating certificate creation claims.

   The paper outlines how 'Product GO Certificates', which are associated with a product-based emissions accounting framework, will cover hydrogen and hydrogen energy carriers. These certificates will rely on a mass balance chain of custody approach (see section 4.2(c) above).

   As part of the initiative, DCCEEW also released an Emissions Accounting Approach methodology paper.[133] This provides details on how emissions will be estimated for Product GOs. The framework has been designed to meet the requirements of the IPHE Methodology (see section 5.2(b) below).

[130] Gaby Hornby, 'Bureau Veritas announced as certification body for CertifHy scheme', *Independent Commodity Intelligence Services* (Blog Post, 28 July 2023) <https://www.icis.com/explore/resources/news/2023/07/28/10910218/bureau-veritas-announced-as-certification-body-for-certifhy-scheme/>.

[131] These listed examples are provided for reference only. In addition to these announcements, regulatory frameworks and certification systems have also been announced by several other countries, including Canada, EU, France, Japan, Korea, India, Italy, Spain, UK and US. See International Energy Agency, 'Global Hydrogen Review 2023' (Review Paper, September 2023) 165-166 (table 6.4) <https://www.iea.org/reports/global-hydrogen-review-2023>.

[132] Department of Climate Change, Energy, the Environment and Water, 'Australia's Guarantee of Origin Scheme Design', (Policy Paper, 20 September 2023) <https://storage.googleapis.com/files-au-climate/climate-au/p/prj291cc9979281a4ffc59d8/public_assets/Guarantee%20of%20Origin%20Scheme%20design%20paper.pdf>.

[133] Department of Climate Change, Energy, the Environment and Water, 'Emissions Accounting Approach', (Attachment Paper, 20 September 2023) <https://storage.googleapis.com/files-au-climate/climate-au/p/prj291cc9979281a4ffc59d8/public_assets/Guarantee%20of%20Origin%20-%20Emissions%20Accounting%20Approach%20paper.pdf>.

2. **South Africa**

In December 2022, South Africa also published a draft of its *Green Hydrogen Commercialisation Strategy*.[134] According to the draft, South Africa plans to implement a system which mirrors the requirements of the European Energy Certificate System (EECS) in order to appeal to European green hydrogen investors.[135] By aligning a possible South African green hydrogen GO system with the requirements of foreign registry systems, the country seeks to ensure that South Africa is able to compete in the export market.

3. **Denmark**

Denmark also launched a GO scheme for green hydrogen and derivatives (including ammonia and methanol) in July 2023.[136] The hydrogen GO scheme is an extension of Denmark's existing regime which previously only applied to renewable electricity, gas and heat.[137] The regime allows participants in Denmark's Power-to-X (PtX) industry, which is the term used in Denmark to refer to hydrogen produced via electrolysis, to market and trade green hydrogen. It will also allow GO certificates to be issued for hydrogen produced via grid-connected projects where the producer can provide GOs for renewable electricity that satisfy the relevant criteria.[138]

4.4. Green hydrogen specific challenges

One of the key challenges in guaranteeing the 'green' aspects of low carbon hydrogen arises where hydrogen will be produced by electrolysers which are connected to the electricity grid.

Given it will not be possible to certify whether electricity drawn from the grid is from a renewable source (such that the resulting hydrogen produced can be considered 'green'), except where a country's power grid is fully renewable, this presents a unique challenge for grid-connected projects. This may be addressed in part by the proposed legislative definition of 'qualified clean hydrogen' in the IRA legislation (discussed further in section 5.2(d)(2)), noting this regime is yet to come into effect as at the date of this paper.[139]

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[134] Published in South Africa, *Government Gazette*, No 47698, 9 December 2022.

[135] The EECS (European Energy Certificate System) is a standardization system for the European GOs.

[136] Rachel Parkes, 'Denmark launches green hydrogen Guarantee of Origin scheme — but where is the EU's?', *Hydrogen Insight* (Blog Post, 6 July 2023) <https://www.hydrogeninsight.com/production/denmark-launches-green-hydrogen-guarantee-of-origin-scheme-but-where-is-the-eus-/2-1-1481667>.

[137] Ibid.

[138] Ibid.

[139] Internal Revenue Service, 'Section 45V Credit for Production of Clean Hydrogen; Section 48(a)(15) Election To Treat Clean Hydrogen Production Facilities as Energy Property' (Proposed Rule, 26 December 2023) A(2)(B) <https://www.federalregister.gov/documents/2023/12/26/2023-28359/section-45v-credit-for-production-of-clean-hydrogen-section-48a15-election-to-treat-clean-hydrogen> ('*IRS Proposed Rule*').

As noted in section 5.2(a) below (in the context of the GH2 Standard), one potential option to address this challenge is for producers to sign PPAs with renewable electricity generators for volumes of electricity that are at least equivalent to the volumes used in the electrolysis process. This is similar to the approach taken under Denmark's proposed GO scheme discussed above. Whether this is appropriate for a project or will be permitted under the relevant green certification scheme should be carefully considered by the parties when negotiating a hydrogen offtake agreement.

4.5. Digital certification

In recognition of the need to harmonise certification standards, especially given the long-term desire to create an international export market for hydrogen, key players in the market are looking to the potential for digital green hydrogen certification tools to create greater traceability, transparency and interoperability across the hydrogen supply chain.[140]

In this respect, H2Global released a policy brief in September 2023 highlighting the potential applications of the blockchain in this area. As transactions are recorded chronologically and in the public domain, blockchain has the potential to provide an accurate public record of hydrogen units and their associated production emissions.[141]

Two initiatives are currently exploring this technology – Siemens Energy's 'Clean Energy Certification as a service' (**CEC**) and SAP's 'GreenToken'. CEC offers accreditation for a range of renewable energy carriers, including green hydrogen, by bundling the final unit of electricity (or product) with its production method to guarantee that it originates from a renewable source.[142]

[140] H2Global Foundation, 'Standardizing Hydrogen Certification: Enhance Traceability, Transparency, and Market Access' (Policy Brief, May 2023) 3 <https://files.h2-global.de/H2Global-Stiftung-Policy-Brief-05_2023-EN.pdf>.

[141] Ibid 15-16.

[142] Petra Michalke, 'Green or greenwash? Why we need clean energy certification', *Modern Power Systems* (Blog Post, 2 August 2023) <https://www.modernpowersystems.com/features/featuregreen-or-greenwash-why-we-need-clean-energy-certification-11050273/>.

5. Required technical specifications and standards for hydrogen

An offtaker's required technical specifications for the hydrogen traded will be another key consideration when negotiating hydrogen offtake agreements (green or otherwise).[143]

5.1. Considerations regarding hydrogen specifications

There are existing international standards that parties can draw upon when agreeing the required technical standards (and associated monitoring and verification requirements for the hydrogen being traded under an offtake agreement). Some of these standards are considered in section 5.2 below.

The required specifications and quality requirements for hydrogen will vary depending on several factors, including the offtaker's intended end use of the hydrogen, the mode of delivery and the regulatory reporting requirements in the market(s) where the hydrogen will be used. Parties will also need to consider the technical specifications and quality requirements for the proposed state of hydrogen at each of the shipping point and delivery point. By way of example, green hydrogen being delivered for injection into gas pipeline infrastructure will need to comply with stringent technical specifications set by the relevant gas network operator (including factors such as hydrogen purity and pressure). These requirements may be different to the requirements for other delivery pathways for hydrogen – for example, for direct delivery to industrial customers, or export to overseas markets.

Similar considerations equally apply where hydrogen is being converted into other chemical compounds such as ammonia, 'safe aviation fuel', synthetic methane or methanol. As with hydrogen, where these ancillary compounds will be traded, parties should take care to consider the relevant existing and future technical specifications for these compounds.

In the context of gas and LNG supply arrangements, offtakers will typically have a right to reject 'off-spec' gas that is delivered to the relevant delivery point. Such rejected gas may be deemed to be 'shortfall gas' for the purposes of determining whether the producer has complied with its minimum supply obligations or not (see sections 3.1 and 3.2 above). The producer may also be liable to indemnify the offtaker for losses it incurs for unknowingly accepting 'off-spec' gas – for example, for property damage caused to the offtaker's infrastructure by shipping the off-spec gas. The scope of this indemnity may include costs related to the cleaning or clearing of the offtaker's facilities and rectification costs for any damage, and may also trigger an insurable event.

As such, when negotiating green hydrogen offtake agreements, producers should be careful to ensure the hydrogen it intends to produce can comply with the offtaker's required specifications, and that there is a clear contractual regime governing the treatment of any 'off-spec' hydrogen. Similarly, if producers are eligible for government support, it will be equally important to ensure the producer can comply with any technical specifications

[143] See also GH2 Green Hydrogen Organisation, 'The GH2 Green Hydrogen Standard 2.0' (Standard, December 2023) <https://www.greenhydrogenstandard.org/sites/default/files/2023-12/GH2_Standard_A5_Nov%202023_DIGITAL.pdf> ('*The GH2 Green Hydrogen Standard 2.0*').

required as a condition to receiving that support. This is apparent in the H2Global framework agreements (see section 2.2(a)(2) above) where the product must comply with three different sets of specifications to be eligible for the scheme. This includes specifications relating to the technical components of the product, specifications regarding emissions, as well as sustainability requirements relating to the environmental impact of production of the product.[144]

5.2. Published hydrogen standards

Parties will need to consider whether to adopt an industry standard for hydrogen (see below) and, if so, which standard should be adopted. This will need to account for whether there are national or international standards relevant to a project, and to the extent there is any overlap between these standards, how any conflict between standards will be addressed.

Some examples of global and national hydrogen standards which have recently been published are as follows:

1. **GH2 Standard**

   The Green Hydrogen Organisation (**GH2**) first published its 'Green Hydrogen Standard' (the **Standard**) in May 2022.

   The Standard and was updated in January 2023 (version 1.1) to include a 'green ammonia protocol', and the second edition (version 2.0) was published in December 2023.[145]

   This second edition provides a global definition of green hydrogen and a mechanism for projects to be accredited and certified by GH2 against this Standard. In this respect, green hydrogen is defined as:

   > *Hydrogen produced through the electrolysis of water with 100% or near 100% renewable energy with close to zero greenhouse gas emissions (<=1 kg CO_2e per kg H2 taken as an average over a 12-month period).*[146]

   In addition to green hydrogen, the Standard also includes definitions which provides guidance to developers of green hydrogen projects in measuring greenhouse gas emissions associated with the production of green ammonia, green methanol and synthetic methane. These definitions are as follows:

   - Green ammonia: *ammonia produced using green hydrogen (as defined above) with 100% or near 100% renewable energy with close to zero greenhouse gas emissions (<=.3kg CO_2e per kg NH3 taken as an average over a 12-month period).*[147]

[144] *Hintco Hydrogen Sales Framework Agreement* (n 62); *The GH2 Green Hydrogen Standard 2.0* (n 143).
[145] *The GH2 Green Hydrogen Standard 2.0* (n 143)
[146] Ibid 5.
[147] Ibid 25.

- Green methanol: *methanol produced using green hydrogen (as defined in the green hydrogen standard) and an eligible source of CO_2 with well-to-gate greenhouse gas emissions of <=.3 kg CO_2e per kg CH3OH taken as an average over a 12-month period. Eligible sources of CO_2 include CO_2 sourced from biomass, biomass waste and or bioenergy (as defined in the Green Hydrogen Standard), direct air capture, unavoidable industrial emissions or emissions that have paid compensation through a credible carbon price mechanism.*[148]

- Synthetic methane: *methane produced using green hydrogen (as defined in the green hydrogen standard) and an eligible source of CO_2 with well-to-gate greenhouse gas emissions of <=0.85 kg CO_2e per kg CH4 taken as an average over a 12-month period. Eligible sources of CO_2 include CO_2 sourced from biomass, biomass waste and or bioenergy (as defined in the Green Hydrogen Standard), direct air capture, unavoidable industrial emissions or emissions that have paid comprehensive compensation through a credible carbon price mechanism.*[149]

In addition to satisfying the relevant definitions above, to receive accreditation by GH2, a project must meet several additional principles including compliance with international human rights standards, local work, health and safety requirements and ensuring key stakeholders and local communities have been engaged with.

The Standard also provides that, for grid-connected green hydrogen projects, producers may count electricity taken from the grid as 'fully-renewable' where a producer signs a PPA with a renewable electricity generator for a volume of electricity at least equivalent to the amount of electricity that is claimed as fully renewable in the electrolysis process.[150] Where possible, the Standard recommends that PPAs utilise credible guarantee of origin certification schemes (see section 4.3 above) and requires that the project operator undertakes an evaluation of the project's utilisation of electricity and the impact on the energy market.[151]

A pre-qualification phase pursuant to which early-stage green hydrogen projects can become qualified early under the Standard was launched in October 2023.[152]

[148] Ibid 28.
[149] Ibid 30.
[150] Ibid 15.
[151] Ibid.
[152] 'Pre-qualification launches under the Green Hydrogen Standard', *GH2 Green Hydrogen Standard* (Web Page, 6 October 2023) <https://www.greenhydrogenstandard.org/news/pre-qualification-launches-under-green-hydrogen-standard>.

2. **International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) methodology**

The IPHE is currently working to develop a methodology for determining the greenhouse gas emissions associated with hydrogen production (**IPHE Methodology**).[153]

The IPHE Methodology, which incorporates the standards of the International Standards Organisation (**ISO**), aims to facilitate international trade in 'clean' hydrogen. In December 2023, the ISO published a 'Methodology for determining the greenhouse gas emissions associated with the production, conditioning and transport of hydrogen to consumption gate' (ISO/TS 19870:2023) based on earlier work undertaken by the IPHE.[154] The ISO methodology provides a framework for assessing the carbon emissions of hydrogen production from well through to delivery gate.

3. **United Nations Economic Commission for Europe (UNECE) hydrogen classification system**

At a regional level, the UNECE Committee in 2022 announced its intention to develop a "comprehensive and science-based terminology, classification and taxonomy for hydrogen".[155] It is intended that this approach, once finalised, will provide for a taxonomy for the UNECE Committee which includes economic, social, and environmental considerations as set forth in the 'United Nations Framework Classification for Resources' (**UNFC**).[156]

The UNECE Committee is currently establishing a Task Force on Hydrogen under the Group of Experts on Gas, which is intended to catalyse the UNECE Committee's efforts on its hydrogen initiative.[157] Some of the recommendations being considered include whether to (i) extend the UNFC to all hydrogen projects and production technologies; (ii) agree and adopt European hydrogen specifications; and/or (iii) establish a hydrogen guarantee of origin scheme.

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[153] International Partnership for Hydrogen and Fuel Cells in the Economy, 'Methodology for Determining the Greenhouse Gas Emissions Associated with the Production of Hydrogen' (Working Paper Version 3, July 2023) <https://www.iphe.net/_files/ugd/45185a_8f9608847cbe46c88c319a75bb85f436.pdf>.

[154] International Standards Organisation, 'Methodology for determining the greenhouse gas emissions associated with the production, conditioning and transport of hydrogen to consumption gate' (Standard ISO/TS 19870:2023, 2023) <https://www.iso.org/standard/65628.html>. This standard will be replaced by International Standards Organisation, 'Methodology for determining the greenhouse gas emissions' (Standard ISO/AWI 19870-1) which is currently under development (see <https://www.iso.org/standard/88686.html>).

[155] United Nations Economic and Social Council, *A Comprehensive and Science-Based Terminology, Classification and Taxonomy for Hydrogen*, 35th sess, Agenda Item 6, ECE/Energy/2022/8 (23 September 2022) 2 <https://unece.org/sites/default/files/2022-08/ECE_ENERGY_2022_8e.pdf>.

[156] 'United Nations Framework Classification for Resources (UNFC)', *United Nations Economic Commission for Europe* (Web Page) <https://unece.org/sustainable-energy/sustainable-resource-management/united-nations-framework-classification>.

[157] 'Hydrogen', *United Nations Economic Commission for Europe* (Web Page) <https://unece.org/hydrogen#:~:text=In%202022%2C%20the%20ECE%20Committee,in%20the%20United%20Nations%20Framework>.

4. Regional and national standards

A number of regional institutions and individual countries have also recently introduced or announced plans to introduce national hydrogen standards, including specific standards required to be met to be eligible for certain government subsidies (particularly for grid-connected projects). Hydrogen project developers should consider if any such standards have been adopted in the jurisdiction where their project is located.

Some recent examples include:

4.a) EU RFNBO Rules[158]

The European Commission formally adopted two delegated acts in June 2023, one of which defines the conditions under which electricity used to produce hydrogen, hydrogen-based fuels or other energy carriers can be considered as 'renewable fuels of non-biological origin' (**RFNBOs**).[159]

The regulations (**EU RFNBO Regulation**) apply to both domestically produced hydrogen and hydrogen to be imported to EU,[160] and provide that hydrogen producers may consider electricity used from a grid-connected source as "renewable" if it complies with the conditions of: (i) additionality, (ii) geographical correlation, and (iii) temporal correlation:[161]

- **Additionality**:[162] Producers must demonstrate that the proportion of electricity used for hydrogen production is matched by renewable electricity generation. Producers can demonstrate this by showing that (i) in the same installation, the producer generates renewable electricity; or (ii) it has signed PPAs with operators generating renewable electricity, in each case for an amount at least equivalent to the amount of electricity that is being claimed as "renewable" for the purposes of hydrogen production. To meet this criterion the relevant renewable energy generator must not have been operational for more than 36 months before the electroylser comes into operation, and (subject to certain exceptions) must not have received any state aid.

- **Temporal correlation**:[163] Up until 31 December 2029, the production of hydrogen must occur within the same calendar month as the contracted generation source (e.g. PPA or electricity from a storage asset, which must be charged in the same calendar month). From 1 January 2030, hydrogen production must occur within the same one-hour period as the production of electricity from the contracted generation source.

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[158] Directorate-General for Energy, *Commission Delegated Regulation (EU) 2023/1184*, C/2023/1087, Document 32023R1184 (20 July 2023) <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32023R1184> ('*Commission Delegated Regulation*'). It should be noted that this is a European Union regulation.

[159] 'Renewable hydrogen production: new rules formally adopted', *European Commission* (Web Page, 20 June 2023) <https://energy.ec.europa.eu/news/renewable-hydrogen-production-new-rules-formally-adopted-2023-06-20_en>.

[160] *Commission Delegated Regulation* (n 158) recital (3), art 4.

[161] *Commission Delegated Regulation* (n 158) arts 4(4), 5, 6, and 7. See also Gregor Erbach and Sara Svensson, 'EU Rules for Renewable Hydrogen' (Parliament Briefing, April 2023) 7 <https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/747085/EPRS_BRI(2023)747085_EN.pdf>.

[162] *Commission Delegated Regulation* (n 158) art 5.

[163] Ibid art 6.

- **Geographical correlation**:[164] This requires hydrogen producers to demonstrate that the additional renewable electricity is located in an area where the hydrogen is produced. The renewable electricity generator must satisfy at least one of the following criteria. The renewable electricity generator must be:
    - in the same bidding zone as the electrolyser;
    - in an interconnected bidding zone with electricity prices in the day-ahead market equal or higher than the bidding zone where the hydrogen is produced; or
    - in an offshore zone interconnected with the electrolyser's bidding zone.[165]

4.b) US Production Tax Credit: Definition of 'qualified clean hydrogen'

The US IRA similarly published a proposed legislative definition of 'qualified clean hydrogen' relevant for producers seeking to receive PTCs.[166] The definition is similar to the EU Delegated Regulation, with notable differences such as:

- a relaxation on the requirement that a generator party to a PPA must not have received state aid; and
- stricter requirements for temporal correlation, with annual matching required up to 2027, with hourly matching required from 2028 onwards.[167]

4.c) UK Low Carbon Hydrogen Standard (LCHS)

The UK standard, known as the LCHS, was introduced in July 2022, with version two being published in April 2023 and version three following in December 2023. This most recent version sets out further details regarding the requirements for compliance with the emissions threshold and is focused on ensuring the LCHS can be effectively applied under the Hydrogen Production Business Model contract (see section 2.2(a)(1)(A)), and other future schemes.[168] The LCHS provides a definition of 'low carbon hydrogen' at the point of production.[169] To comply with the LCHS and meet the definition of 'low carbon hydrogen', producers must meet the following criteria:

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[164] Ibid art 7.

[165] Ibid.

[166] United States Department of Energy, 'Assessing Lifecycle Greenhouse Gas Emissions Associated with Electricity Use for the Section 45V Clean Hydrogen Production Tax Credit' (White Paper, 19 December 2023) 8 <https://www.energy.gov/sites/default/files/2023-12/Assessing_Lifecycle_Greenhouse_Gas_Emissions_Associated_with_Electricity_Use_for_the_Section_45V_Clean_Hydrogen_Production_Tax_Credit.pdfhttps://www.energy.gov/articles/clean-hydrogen-production-tax-credit-45v-resources>.

[167] *IRS Proposed Rule* (n 139).

[168] Department for Energy Security & Net Zero, 'UK Low Carbon Hydrogen Standard: Greenhouse Gas Emissions Methodology and Conditions of Standard Compliance' (Standard, December 2023) <https://assets.publishing.service.gov.uk/media/6584407fed3c3400133bfd47/uk-low-carbon-hydrogen-standard-v3-december-2023.pdf> ('*UK Low Carbon Hydrogen Standard*').

[169] 'UK Low Carbon Hydrogen Standard: Emissions Reporting and Sustainability Criteria', *UK Government* (Web Page, 18 May 2023) <https://www.gov.uk/government/publications/uk-low-carbon-hydrogen-standard-emissions-reporting-and-sustainability-criteria#:~:text=The%20standard%20requires%20hydrogen%20producers,to%20the%20%27point%20of%20production%27>.

- the carbon emissions released in the process of hydrogen production must be less than or equal to a threshold of $20gCO_2e/MJ_{LHV,}$[170] using 'lower heating values'.[171] In addition:
    - the hydrogen must be produced at a hydrogen production facility which satisfies a number of conditions, including use of an 'Eligible Hydrogen Production Pathway' (such as electrolysis and biogenic gas reforming, details of which are included in the LCHS);[172]
    - emissions must be calculated at the 'point of production' and account for input materials, feedstock, process, carbon capture and network entry, carbon sequestration and fossil waste/residue counterfactual, among other components; and
    - emissions associated with capture, compression, temporary storage and transport of carbon until entry into a carbon network must also be included in the emissions calculation;
- the use of electricity must be accounted for to demonstrate both that the production facility is operating at the same time as the electricity input source, and that the producer has exclusive ownership of the electricity;
- the producer must set out a risk mitigation plan for fugitive hydrogen emissions; and
- additional requirements must be met if biogenic inputs are used (e.g. compliance with land, soil carbon and forest criteria).

The third version of the LCHS contains updates and clarifications informed by industrial, technical and legal stakeholder feedback following the publication of the first and second versions of the LHCS. This includes the introduction of a materiality threshold aimed at easing the reporting and verification process and further details including a number of newly defined terms and updated terminology to ensure clarity of requirements set out in the standard.

4.d) Brazil international certification

Brazil's Electric Energy Commercialization Chamber created a working group in November 2022 intended to develop an international certification standard for hydrogen, focussed on quantifying carbon emissions intensity associated with electrolysis.[173]

The intention is to provide a set of guidelines by 2024 that can be incorporated into commercial agreements.[174]

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[170] *UK Low Carbon Hydrogen Standard* (n 168) 28.

[171] The LCHS defines 'Lower Heating Value' as "*A measure of the energy content of a substance, also known as the Net Calorific Value. Specifically, it is the amount of heat released in the combustion of a specified quantity of the substance. For the purposes of Consignment sizes and Step efficiencies, this LHV measure only takes into account the moisture content of the substance, whereas the latent heat of vaporisation of any moisture in the substance is also subtracted in the LHV measure for Co-Product Energy Allocation calculations*". See Ibid 20.

[172] *UK Low Carbon Hydrogen Standard* (n 168) 28, 31.

[173] See Electric Energy Commercialization Chamber, 'Group led by Brazil will establish requirements for certification of hydrogen at the international level' (Press Release, 29 November 2022) <https://www.bnamericas.com/en/news/group-led-by-brazil-will-establish-requirements-for-certification-of-hydrogen-at-the-international-level>.

[174] Ibid.

4.e) Green Hydrogen Standards for India

In August 2023, India's Ministry of New and Renewable Energy announced its 'Green Hydrogen Standards for India', which defines green hydrogen as hydrogen produced through electrolysis or conversion of biomass (provided that greenhouse gas emissions produced do not exceed 2kg of CO_2 per kilogram of hydrogen over a 12-month period).[175]

The standard was published as part of the Indian Government's National Green Hydrogen Mission,[176] which was released in January 2023.

Given the various standards being published by international, regional and national bodies outlined above, there is a need for harmonisation of these standards to facilitate a liquid hydrogen trading market across jurisdictions.[177]

In the absence of such agreed global standards, in the short term:

- countries looking to establish trade routes for green hydrogen will likely need to agree to bilateral trade agreements which specify the agreed standard to be adopted between those countries (which may also provide for mutual recognition of any 'green' products under those countries' respective green product schemes); and
- otherwise, parties will need to commercially agree the relevant standards and specifications by which they will define their contractual obligations on a project-by-project basis.

[175] Ministry of New and Renewable Energy, 'Green Hydrogen Standard for India' (Office Memorandum, 18 August 2023) <https://mnre.gov.in/notice/green-hydrogen-standard-for-india/>.

[176] 'National Green Hydrogen Mission', *Ministry of New and Renewable Energy* (Web Page, 29 November 2023) <https://mnre.gov.in/national-green-hydrogen-mission/>.

[177] *Hydrogen definitions based on emissions intensity* (n 128) 84.

6. Creditworthiness and credit support

6.1. Creditworthiness

To ensure the reliability of a project's revenue stream, as noted above, financiers will require long-term, fixed priced offtake arrangements with creditworthy offtakers as part of their bankability assessment for a project. The creditworthiness of the parties to hydrogen offtake agreements in the early years of the industry will be particularly important given the:

- lack of a widely adopted market price for hydrogen;
- challenge of finding a replacement offtaker if the offtake agreement is terminated, given the limited pool of potential offtakers while demand for hydrogen is still developing; and
- untested nature of the technology at a commercial scale.

Given the offtaker's payment obligations under a hydrogen offtake agreement will underwrite project revenues and a producer's ability to service its debt, project sponsors and their financiers will need to undertake detailed due diligence in relation to an offtaker's financial position. This will require a careful assessment of the balance sheet of the offtaker (and its broader corporate group).

6.2. Credit support

In this respect, in the absence of an 'investment grade' offtaker,[178] parties may wish to consider whether it is appropriate for an offtaker to provide credit support in support of its payment obligations under the offtake agreement.

Credit support may take various forms (for example, unconditional letters of credit, bank guarantees, parent company guarantees or retention monies) and will assist with the overall bankability assessment of the project. Reflecting the two-way payment flows under CfD-style arrangements, in some circumstances, offtakers will also require that producers provide credit support in support of the producer's payment obligations. This may be relevant particularly for early-stage hydrogen projects, where a producer may lack sufficient creditworthiness (but is contracting with a creditworthy buyer, such as a large European, Asian or North American utility company as offtaker – for example, under the H2 Global scheme).

[178] For a company to be considered 'investment grade', it must generally be rated at 'BBB-' or higher by Standard and Poor's or Moody's (or equivalent). Anything below this 'BBB-' rating is considered non-investment grade.

If relevant, the parties will need to carefully consider the following factors when negotiating green hydrogen offtake arrangements:

- will either the producer or offtaker be required to provide credit support?
- if so, will this credit support be provided at contract commencement or only following specified credit downgrade events (for example, a ratings downgrade from a recognised ratings agency or some other form of credit downgrade)?
- what form will the relevant credit support take, bearing in mind the creditworthiness of the parties (for example, is cash collateralisation an option where a party is unable to procure external credit support)?

6.3. Credit enhancement for non-investment grade participants

For projects involving non-investment grade offtakers seeking project financing, the parties will need to carefully consider their options to enhance the project's credit profile and improve its bankability assessment.

This may be relevant in developing countries which do not have an investment grade rating (for example, where a state-owned utility or company intends to enter into a hydrogen offtake agreement with a producer). In these circumstances, parties may consider whether funding or credit enhancement packages from development-finance institutions (**DFIs**) are available to the project. Such institutions include the World Bank at a global level, and institutions such as the African Development Bank, Asian Development Bank and European Bank for Reconstruction and Development at a regional level. There are also a number of bilateral DFIs at a national level which may be relevant depending on the project's location. This will need to be considered on a project-by-project basis.

6.4. Change of control restrictions

Given an offtaker's critical role in underwriting project revenues, both project sponsors and financiers will likely require restrictions on the following events (without the producer's prior written consent):

- change of control of the offtaker; or
- assignment or novation of the offtaker's interest in the relevant offtake agreement to a third party.

These restrictions are intended to preserve the credit profile of the offtake agreement, and ensure producers and financiers maintain control over the identity and creditworthiness of the offtaker.

7. Broader risk allocation: Force majeure and change of law or regulation

In addition to the other regimes considered throughout this paper, parties to a hydrogen offtake agreement will also need to carefully negotiate the broader risk allocation between the parties. If the project owner is seeking project financing, this risk allocation will need to align with international bankability requirements.

Some key risk allocation topics include force majeure and change in law or regulation. This section considers each of these items in turn.

7.1. Force majeure

Force majeure relief is a common feature in offtake agreements across the energy sector and will need to be considered by parties negotiating similar arrangements for green hydrogen projects.

Under an offtake agreement, a party will be relieved of its obligations to perform its obligations during the period such obligations are affected by a force majeure event. This will typically be defined broadly and include any event or circumstance that:

- is beyond the reasonable control of the party affected (**Affected Party**);
- the occurrence or effect of which the Affected Party could not have avoided through compliance with its obligations under the agreement or the exercise of good industry practice; and
- causes or results in the prevention or delay of the Affected Party from performing its obligations under the agreement.

The Affected Party's rights to claim relief will be subject to a limited list of express exclusions. These exceptions will be negotiated between the parties and will typically exclude events such as financial hardship and normal wear and tear of the facility.

The scope of the definition of force majeure events should be carefully considered between the parties in the context of the project's location and supply chain, including to take into account political risk factors. Producers should also take care to ensure its rights to claim force majeure relief under an offtaker agreement are sufficiently broad and mitigate the risk of any 'gaps' in its rights against the corresponding rights of its project contractors under project contracting arrangements.

7.2. Change of law or regulation

1. **Overview**

   A regime regulating how the parties will allocate the risk of changes to applicable laws or regulations under the offtake agreement will be a key focus during negotiations.

   As a general principle, a party's right to claim a change of law will typically be limited to (i) laws and regulations which have the force of law; and (ii) changes which occur after the date of the relevant agreement. Qualifying changes may include (depending on whether the offtake arrangements relate to a domestic or international transaction) changes to national and international laws, regulations, rules, standards, or codes which have the force of law, or any court orders which give rise to the relevant change.

   Events which may trigger a change of law regime could include, for example, amendments to:

   - a government support scheme which impacts a project's economics – for example, a repeal or reduction of a tax or a production credit available to a green hydrogen project after the offtake agreement has been signed; or

   - an applicable national certification regime (for example, the standards referred to in section 5.2 above) which impacts a hydrogen production facility's eligibility for 'green' certification – see section 7.2(c) below.

2. **General approaches following a change of law**

   There are a variety of approaches available to parties when considering how to allocate the risk of a change of law or regulation.

   Some of these include:

   - Upon the occurrence of a change of law, requiring the parties to:
     - use their best endeavours to mitigate the effect of the relevant change of law; and
     - negotiate in good faith any amendments to the offtake agreement to preserve (i) the intended operation and effect of the offtake agreement; and (ii) the relative commercial position of the parties as at the commencement of the agreement had the change not occurred.
   - Given the lack of a widely accepted market price for hydrogen, whether to include price review mechanics to the extent such an index is established during the offtake term.
   - The parties agreeing to monetary thresholds, whereby a party will only have a right to claim a change of law if the relevant change of law increases (or decreases) that party's costs of performing its obligations under the agreement beyond the agreed threshold. This may include a monetary threshold per event or in the aggregate over the offtake term.

- Whether:
  - the seller will be entitled to pass through the full value of the relevant change of law (above any agreed monetary thresholds, if applicable); and
  - the parties will share (i) the risk of any cost increases; and (ii) the benefit of any cost decreases, following a change in law (for example, on a 50/50 basis).

3. Approaches in relation to the risk of changes in certification requirements or standards

In addition, to mitigate the risk of changes to certification requirements or standards during the offtake term, the parties may negotiate bespoke arrangements to regulate how these changes will be dealt with. Some options in this regard include:

3.a) Agreeing a version of the standard at the signing date

The parties may agree that the seller's obligation regarding the standard of hydrogen to be produced are fixed by reference to a version of an agreed standard at the time the contract is signed.

Under this option, the offtaker effectively bears the risk of regulatory changes during the offtake term. The offtaker will need to satisfy itself that hydrogen which meets the agreed certification standard when the contract is signed will remain suitable for the offtaker's requirements for the term of the contract. This option also assumes that the relevant certifying body will continue to accredit the relevant facility (and the hydrogen produced by it) based on a legacy version of the rules.

Whether this is a viable option will need to be considered in the context of the relevant project. For projects being project financed, arrangements such as this (at least during the term of the debt) will help to improve bankability by mitigating the project's exposure to regulatory change. This will need to be balanced with (i) the offtaker's interests and whether they require the seller to comply with any updates to the standards; and (ii) whether the seller has the capabilities to comply with any such updates to the standards.

One option to mitigate against this risk is to provide for an initial period where the seller's obligations are defined by reference to a specified version of the standard, following which the seller will be required to implement any updates to the standard.

3.b) Agreeing a version of the standard at the signing date, with obligation on seller to consider if and how to implement updates

This is a similar option to the above, with the seller providing an additional commitment to the offtaker (and the relevant certification body) that it will consider if and how it can implement any updates to the agreed standard.

In this respect, the seller may be required to:

- use its best endeavours to implement the relevant updates over an agreed period; and/or
- submit a proposal to the offtaker outlining the required amendments to the offtake agreement to address the change in standard, and any associated cost implications to comply with these changes. The agreement will need to provide for a regime which permits the offtaker to comment on any such proposal and require the parties to negotiate in good faith over a specified period. Failing agreement, the parties may agree to permit termination of the offtake agreement.

Given the potential cost impact to the seller implementing changes to the relevant standard, the offtaker (and project lenders) may require the seller to provide credit support.

3.c) **Agreeing to the standard, and requiring seller to comply with all updates during offtake term**

A seller may agree to an obligation to comply with the agreed standard throughout the offtake term, including any relevant updates. Given the potential cost implications to the seller in taking this regulatory risk, this will need to be carefully considered from a bankability perspective (for project financed projects). Sellers for projects being funded on balance sheet may be more open to accepting this risk.

Similar to the first option above, one option to mitigate this risk is to provide for an agreed period where the seller's obligations will be defined by a specified version of the standard, following which the seller will be required to comply with any updates to that standard.

Noting the considerations above, change of law regimes will need to be negotiated carefully between the parties to take account factors such as the political risk, conflict and potential for corruption in the relevant jurisdictions.

8. Social licence and transparency[179]

Social licence and community engagement considerations are increasingly becoming critical to the success of individual projects, and working with and sharing the benefits of early-stage hydrogen projects with local communities will be key factors in the future success of the global hydrogen sector. This is especially true for initial projects developed in regions proximate to vulnerable communities.

Noting this presents a unique opportunity for a nascent industry to engage with local communities and stakeholders, a failure to adequately engage at an early stage (in relation to both the potential benefits and impacts of a project) can have a detrimental impact on the future success and pipeline of similar projects in the region. Parties looking to develop hydrogen production projects should be mindful of these considerations from early in the project development phase.

Some considerations for parties to account for in this regard are all follows:

- the need for transparency and information sharing with local communities, including in relation to supply chains. This may need to be balanced with confidentiality requirements to maintain a competitive market;
- education and engagement with local stakeholders and communities to the project, including in relation to the potential economic and social benefits and challenges presented by the project;
- ensuring the project has robust systems in place to facilitate compliance with modern slavery laws, labour conditions, workplace, health, safety, and environmental requirements relevant to the project;
- transparency in relation to sourcing and use of water and electricity as feedstock for electrolysis, particularly for communities where these commodities are scarce; and
- ensuring the project has obtained and complies with all regulatory approvals, accreditations and certifications (including in relation to low-carbon standards for green hydrogen).

The GH2 Green Hydrogen Standard provides guidance as to the steps which project developers may take to satisfy these requirements.

When negotiating hydrogen offtake agreements, parties should seek to obtain contractual obligations or warranties in relation to engagement with the local community and other similar stakeholders to ensure these requirements are always front of mind for the parties.

[179] See also 'Community engagement and transparency practices', *GH2 Green Hydrogen Organisation* (Web Page, February 2023) <https://gh2.org/community-engagement-and-transparency-practices>; 'Green hydrogen contracting – for people and planet', *GH2 Green Hydrogen Organisation* (Web Page) <https://gh2.org/our-initiatives/green-hydrogen-contracting-people-and-planet>.