

# **HYDROGEN AND FINANCE – THE INTERPLAY TOWARDS SUSTAINABLE ENERGY**

## **Abstract**

Ahead of UN COP26 climate conference an emergency summit was convened by UK Prime Minister Boris Johnson, with aim to press for more actions on Climate Finance and other measures. In this conference UN Secretary-General, Antonio Guterres called on world leaders for “Decisive action now to avert climate catastrophe” [1] As per the Full National determined Contribution Synthesis reports of United National Framework Convention on Climate Change unless actions are not taken immediately with current emissions worldwide the temperature rise will be 2.7 degrees centigrade by the end of the century.[2] Hydrogen offers significant promise to help meet global energy demand while contribution to climate action goals. Green Hydrogen is also recognized as a key investment for the energy transition, needed to combat climate challenge. And with these developments green hydrogen technologies have received a renewed wave of Interest – for its applicability is expanding across sectors including, fertilizers, power generation, steel making, fuel cells, refrigeration, electricity grid, cleaning products and heavy transport. With this understanding of the estimated hydrogen needed by 2050 is 500-600 million metric tons. And to produce 500 million tons of green hydrogen per year, 22,000 TWh of renewable energy is required, and to hydrogen value chain including upstream, midstream and downstream elements), green hydrogen industry needs huge investment. [3] In this chapter authors bring forth the peculiar project finance risks that a green hydrogen presents for the financial intermediaries and expects will encourage the professionals to develop the

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skills and expertise needed to bridge the investment gaps with better understanding of multidisciplinary practices of specific Industry.

## I. INTRODUCTION

Hydrogen is the most abundant element in the Universe. Each atom of hydrogen has 1 proton [1]. Hydrogen is naturally found on earth in various compound forms like hydrogen combined with oxygen is water (H<sub>2</sub>O) and if combined with Carbon forms hydrocarbon [2]. In these various compounds Hydrogen is present in all three states i.e., liquid, solid, gases [2]. Hydrogen is the lightest element and has the highest energy density per unit mass [3]. The Sun and stars are giant balls of hydrogen gas undergoing fusion into helium gas [3]. Hydrogen burns clean, when combined with oxygen in a fuel cell, it produces heat and electricity producing only water as by-products [4]. For this reason, hydrogen is considered as the most suitable fuel to replace fossil fuels [4]. As hydrogen doesn't exist freely in nature, it is produced, either from water or other compounds [5]. It takes more energy to produce Hydrogen by splitting it from other elements than it is recovered by burning it [2]. Hence there are considerable difficulties associated with hydrogen production, transmission and end usage [6].

In a general context of Climate change, Governments, researchers, NGOs, financial institutions and all other parties around the world are working towards accelerating the ongoing energy transition efforts to reach Net Zero [7]. And hydrogen is being considered critical for the carbon neutrality of various industries. It is forecasted that by 2050 hydrogen to supply up to 20% of global energy demand and will be a driving force towards a net-zero emission economy [6, 8]. Demand for clean hydrogen can grow to 660 million metric tons annually by 2050 [6, 8]. Initially the demand is expected to build for the decarbonization of existing industrial uses of hydrogen. For example, 95 million metric tons of hydrogen would be demanded for fertilizer production [9]. Hydrogen also has potential to lead to significant emissions saving in hard to abate sector such as chemical industries, cement, steel and heavy transport as aviation and shipping [10]. By 2050, 42% of total clean hydrogen demand can be from heavy industry like high-temperature heating, cement, chemicals, iron and steel. 36% of total clean hydrogen demand can be in the transport industry i.e., aviation, heavy road transport and shipping [11].

Despite growing demand for clean hydrogen, a sizable investment gap remains for it to fully contribute to Net zero [12]. Governments around the globe have committed USD 37 billion in public funding for hydrogen development and USD 300 billion of additional investments are announced by the private sector [12]. According to IEA estimates, USD 10 trillion of cumulative private investment is needed in clean hydrogen projects by 2050 [13]. This may seem like a large sum of amount, however, is less than USD 417 billion spent in 2022 on oil and gas production. So, this is a doable endeavor if governments and private sector can redirect the oil and gas spending to Hydrogen [14]. The aim of this chapter is to explore the current state of the hydrogen market, to understand how finance is contributing to the landscape creation, to identify the funding gaps and synthesize the future trend [15].

## II. FINANCIAL BACKGROUND

As observed with the emergence of other renewable asset classes such as solar and wind, until technological advancements drop the hydrogen prices to competitive levels. Hydrogen projects must be supported exclusively through equity or with the assistance of grants or concessional funding [16].

Because when it comes to private funding, one question is evitable – this has also been seen when the renewable energy revolution started a few decades ago, the question was ‘would the electricity generated by renewable sources be cheaper to compete with coal or gas generated electricity?’ [6]. Hence Government support is envisioned unless green hydrogen reaches break even in terms of costs (including production, transmission, storage and end-use) [17]. Hydrogen price can benefit with tightening of CO<sub>2</sub> pricing and economies of scale [18].

To reach break-even projects rely on public funding and there are major government programs announced in recent years, such as in Sep 2022 European commission agrees to establish a USD 3 billion Hydrogen Bank to bridge the investment gap and connect future supply and demand [19-21]. Previously in Aug 2021, the European Commission expanded its Hydrogen Strategy through its Fit for 55 Package [22]. It also has Important Projects of Common European Interest (IPCEI) funding program [12, 19, 21, 22].

The United States Inflation Reduction Act is arguably the only legislation that is signed in law in the world [16, 23, 24]. US president Joe Biden later invoked Defense Production Act granting the Department of Energy access to USD 545 million to build US manufacturing capacity in key clean-energy sectors including electrolyzer manufacturing [16, 23, 24]. Cash via Defense Production Emergency Fund can be used to stimulate manufacturing via direct purchases or government procurement or as subsidies for capital investments to improve manufacturing of clean-energy systems [25, 26].

The UK government also launched its Hydrogen Strategy in Aug 2021 [27], this includes proposals to use a subsidy mechanism (called as (CfD) i.e., Contracts for difference”. As per the Hydrogen Strategy, the Government undertakes a review to support development of transport and storage infrastructure [27]. Safety, technical feasibility and cost effectiveness of mixing hydrogen into the existing gas supply will also be assessed by the Government [8]. The UK government also set the Net Zero Hydrogen Fund (NZHF), worth up to GBP 240 million [27]. The fund is designed to support the development and deployment of new low carbon hydrogen production. The fund aims to de-risk investment and reduce the cost of lifecycle of the projects [16].

Japanese government has demand side research and development (R&D) support programs [28]. On behalf of Australian Government, the Australian Renewable Energy Agency (ARENA) has AUD 70 million [28]. Renewable Hydrogen Deployment funding to fast track the development of renewable hydrogen in Australia [28]. The clean Energy Finance corporation an Australian government owned green bank aims to invest AUD 300 million to support the growth of a clean, innovative, safe and competitive hydrogen industry in Australia via its Advancing Hydrogen Fund [26, 28, 29].

More such funding examples includes EUR 40 million which the German Federal Ministry of Economic Cooperation and Development (BMZ) committed via grant funding for the promotion of South Africa’s Green Hydrogen Economy [26, 28, 29]. The German Development Bank (KfW) also provided EUR 200 million concessional loan for public and private sector green hydrogen projects in the South Africa [30]. Germany also committed EUR 550 million to help developing economies establish Green Hydrogen Projects and the ministry of economy created a EUR 300 million fund for German and European Companies

to be project partners [30]. KfW has launched the PtX Development Fund and the PtX Growth Fund. These are the world's first promotional platforms for financing Green Hydrogen [30].

Chilean Government is enabling Hydrogen economy in multiple ways, including financial structures and support for pre-feasibility phases, as well as tax and regulatory support for investments [22]. The International Finance Corporation (IFC) is working with its clients in emerging markets on green hydrogen Initiatives and is growing its investments to 35% of its own long-term commitment volume between 2021 and 2025 [22]. The European bank for reconstruction and development has not only supported the Egyptian government in developing a low carbon hydrogen strategy but will also provide USD 80 million loan to Egypt Green and hence assist in development of the first hydrogen facility in Egypt [26].

Sustainable Energy Fund for Africa (SEFA) is a multi-donor special fund established to unlock private sector investments into energy efficiency and renewable energy [31]. It is an effort of African Development Bank to provide catalytic funding for hydrogen projects based in Africa [31]. In line with the New Deal on Energy for Africa, SEFA would provide funding for hydrogen projects that demonstrate domestic benefits [30]. SEFA also provides technical assistance with concessional finance instruments for the development of ancillary renewable energy supply or grid infrastructure, or to remove market barriers, to build a more robust pipeline of projects, or for project that would export green ammonia to other African jurisdictions with market demand, or to improve the risk return on investments [31].

The SDG Namibia One Fund is an innovative blended finance fund created through a partnership between the Environmental Investment Fund of Namibia of Namibian Government, Climate Fund Managers and the Dutch Invest International [30, 32]. The aim of the fund is to facilitate and accelerate the development of a Green Hydrogen economy in Namibia. The European Investment Bank (EIB) also signed a pact with Namibian Government for EUR 500 million potential loan for renewable energy investment or financing of renewable hydrogen [30, 32].

The world bank has also launched the Hydrogen for Development Partnership (H4D) to raise and allocate blended finance for low-carbon hydrogen production and distribution projects [30, 32]. The aim for the Partnership is to boost the deployment of low-carbon hydrogen in developing countries. Hence the Partnership will also foster capacity building, regulatory solutions, business models and technologies that will accelerate the roll out of low carbon hydrogen in developing countries [30, 32].

Private philanthropic funders such as the Rockefeller Foundation's environment program, the African Climate Foundation and the Microsoft Climate Innovation Fund alongside other private climate funds and organizations are playing a key role on research and development of low carbon hydrogen [22]. Thus far however banks are not providing Debt financing for Hydrogen Projects. While the commercial banks are interested in financing the hydrogen projects to fulfill their own sustainability goals and to support their clients in their transition to Net Zero [22]. They hold back from scaling up this technology because of the perceived risks involved. Banks provide non-recourse debt finance to projects that meet their project-finance risk criteria [33]. As the government funding also has limits, Private funding is a must for Hydrogen projects. This will boost economies of scale, increase the demand for green hydrogen and demonstrate the viability of hydrogen projects to other private investors

[33]. Let's dive deeper into the Project finance criteria and the perceived risks of commercial banks in regards with Hydrogen Projects [24].

- 1. Project- Finance and Perceived Risks:** Project finance is a long-term non-recourse debt financing of a specific, capital-intensive project [34]. Non-recourse debt is a debt issued by the commercial bank, in which the bank doesn't hold the borrower personally liable for the amount loaned. Hence in case of default, banks can seize the property/collateral to recover the debt amount. And if the full debt amount is not recovered by the collateral, the bank can't reach out to the borrower for further compensation [35]. Project finance is contingent to a project capability to generate future cashflows equivalent to its outflows i.e., operating expenses, capital expenditures and debt repayments [35].

Project finance is attractive to private sector companies as it allows them to fund projects off balance Sheet. Hence the company is free to use its existing debt or debt capacity for other investments [36]. Usually, Project Finance for projects creates a special purpose vehicle (SPV) with its sole activity to carry out the project by subcontracting the operations and construction phases [32]. Hence the Sponsor of the project doesn't have impact of project cost to be accounted on his cost of shareholders' existing debt [37]. At this moment there are a few Hydrogen Projects around the globe being funded by Project finance and this is an issue – for equity funding has impact on balance sheet and can go only this far [37]. Project finance is a matter of scope and growth potential, as this helps government and corporates to do investments off-balance sheet and takes less fiscal space [30]. As the extra-revenue generated from the economic growth-sub-contracts results in more people working and paying/earning more money and allows profit when inflow and outflow is equated, which can again be accumulated and invested further [21]. Hence Project finance is attractive for investors, as by leveraging a project with project finance enhances equity returns, provides an attractive risk allocation, reduces sponsor's initial equity commitment (much below the project's cost) and attract tax-benefits through interest-cost deduction [30]. Project finance has also been instrumental in developing a scalable market for solar and wind power technology [30].

Hydrogen projects are factored in the medium-term lending plans of banks and are expected to be 10% of the energy-related portfolio of banks by 2030 [20]. However, 80% of announced Hydrogen projects are still in the planning stage and as banks are not prepared to relax their project finance criteria and this is the reason many projects are not going ahead [9]. We will explore the project finance risk criteria to explore how this can be managed specifically for Hydrogen Projects. As financing low carbon hydrogen projects require risk allocation and cataloguing in a fashion familiar to financiers [12].

- 2. Project Finance Risk:** As the lenders have limited recourse or no recourse on a Project finance, before committing to finance a hydrogen project the lender would like to ensure its viability [12]. Financial institutions have set process and policies in place for this and an in depth-due diligence will be conducted to validate that the project complies with applicable credit and policy requirements [38]. The scope of due diligence differs for each project factoring in the institution that is the borrowing party. The level of scrutiny for hydrogen projects during its due-diligence process will vary not only on the institution but it will also include an assessment of construction risk, operating risk, shipping risk, technology risk, legal risk, offtake/market risk, environmental risk, social risk and

insurance cover if there is any [12, 33, 38]. [11] Here is a short brief about each of these risks:

- **Offtake/Market risk:** Project finance relies on predictable revenue streams. So that the lender can expect to have a long-term take/pay offtake contract with credit worthy customers [39]. At present there is no merchant market for hydrogen i.e., Hydrogen is not traded as a commodity in future or spot market and hence is not liquid [15]. Revenue contracts that support the bankability of the project will be key for hydrogen projects to be financeable. Offtake contracts can be structured in several different ways, for example – a company that owns a hydrogen production facility i.e., the project developer may get into a contract with its customer, where the customer will pay a tolling fee to the Project developer to produce the hydrogen [29]. As part of such a contract called as Tolling arrangement the customer will also be liable for the supply of the inputs like electricity and water. Hence the Project Developer will have a predictable revenue stream that would make the project bankable and Project developer will not have to bear the variable supply cost [19, 40].

Alternatively, the project developer may opt to purchase the electricity and water that is needed for the production and may sell the hydrogen produced to the customers/off takers [31]. In such cases the financier would like to understand the potential markets for the hydrogen that is produced, as that would help determine the medium/long term demand for the product [19, 40].

Electricity projects financing is often backed by long-term agreements between independent power producers and strong buyers [36]. These are commonly known as PPA or Power Purchase agreements and provide a long-term price certainty as the agreement includes a fixed unit price or a floor price for the purchased electricity for a long time [28, 39]. Electricity generated by solar, and wind is easily sold into grid or is purchased by large corporates with individual electricity need as the production from solar and wind is highly subsidized and incentivized by government regulation [28, 39]. This creates a customer base that is willing to involve in long term PPA for electricity production by solar or wind energy. That customer base is not present at this moment for Hydrogen [5].

- **Policy Risk:** Decisive policy support can help to scale up the clean hydrogen economy as it did for solar and wind energy [27]. Between 2002 and 2017 in the UK substantial support was provided for large scale renewable energy projects by the UK Renewables Obligations program [41]. Program mandated a proportion of energy supply to be from renewable sources for the electricity suppliers. It also provided accreditation certificates called ROCs were issued to renewable energy generating stations as part of this program [27]. These ROCs were tradeable between operators and delivered to suppliers to evidence the sourcing from renewable projects. If energy suppliers didn't meet the RO mandates, they faced a payment obligation [27].

Also in Great Britain, smaller scale generation of electricity was supported by Feed-in Tariffs [42]. FITs was introduced in 2012, it provided long-term guaranteed above market prices for smaller levels of energy produced [27]. This long-term guaranteed price supported renewable energy productions in early stage of

development, as it provided payment to anyone producing electricity from renewable sources, including homeowners producing their electricity through solar energy [41]. Such targeted policy support is crucial for clean hydrogen to ensure the early-stage pilot projects compete on a level-playing field. This would expedite the entry of hydrogen to the market and would trigger economies of scale [43]. [8]

- **Technological Risks:** Low-Carbon Hydrogen decarbonization potential requires clean technologies consistent with net-zero emission targets [8]. Right now, electrolysis is considered as the most promising and sustainable technological solution for producing green hydrogen [8]. The largest cost for on-site production of green hydrogen is the cost of renewable power needed to run the electrolyzer unit and is followed by the cost of electrolyzer themselves [44]. Low-cost electricity is a must for producing competitive green hydrogen and this incentivize the project developers to produce hydrogen at locations with optimal renewable resources [8]. Financiers would assess the technology being applied to produce Green Hydrogen at each interface. The emergence of a clean hydrogen is met with opportunities and challenges at each junction of the value chain [33]. There is still huge uncertainties around the global value chain pathway that will be followed. This pathway is dependent on production and consumption locations, resulting energy trade routes, choice of supply technologies, associated leadership and improved hydrogen applications [45]. Selection of the variable will have a bearing on each stakeholder involved in the hydrogen economy, such as the energy suppliers and utilities, government that determines the industry and energy policies, consumers, equipment manufacturers, shipping companies and port facilities' managers [46]. Lenders require independent verification on the technical feasibility of the application at commercial level to assess the technological risks associated with the project throughout the value chain that could jeopardize the monetization of hydrogen produced [46].
- **Legal Risk:** The regulatory framework for hydrogen is still at its nascent stage and is subject to extensive change [37]. It is worth mentioning that not a single country has put policies in place that would make clean hydrogen cost-competitive against grey Hydrogen. Despite all the announcements and with all published hydrogen strategy key decisions are pushed to an undetermined future date [30]. Tax implications in the respective jurisdictions will also determine the allocation of projects works between separate offshore and onshore locations. Therefore, the legal advisers of financiers will opine on the legal risk faced by the project [21]. Changes in tax legislation, policies, and industry standards may transform the project cost as those are reflected in the financial model assumptions. And the lenders may seek to mitigate the risk by procuring assurance letters by relevant government authorities [21]. Governments across the globe shall collaborate with industry to develop standards to give assurance to the producers and users that the Hydrogen production is consistent with Net-Zero ambitions [27], Government shall aim to strike international cooperation to frame development polices [7] that would promote strong regional integration to strengthen synergies between energy and climate [7]. National strategies shall aim for diversification all along the value chain from raw materials suppliers to trade partners to equipment. These would help avoid costly bottlenecks and would ensure market resilience in the long term [47].



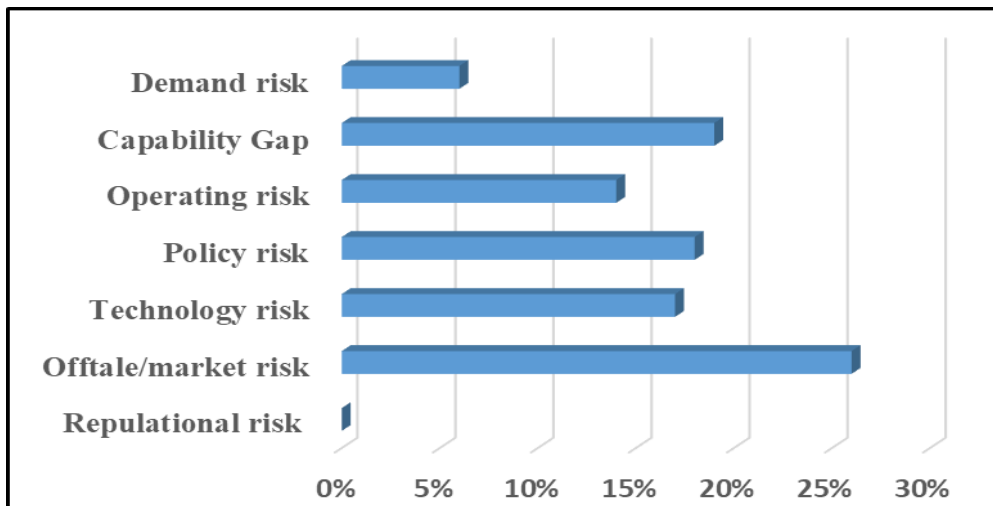
- **Construction risk:** Technical advisors of the financing team will need to validate the project's construction and installation strategy [47]. Green hydrogen value chain is comprising of various segments and each segment presents risks that are specific and interdependent like the renewable energy provided by the renewable energy plant and hydrogen production plant [48]. And depending on the contract structure that is presented in the proposal for financing, the lenders will need to be comfortable with integration and interface risk at each stage. They may want to assess the from where the constituting equipment is being supplied and if is installed by one supplier or have multiple contracts [32].
- **Shipping risk:** Hydrogen can be transported in several forms such as a liquid, gas or solid. Each form carries its own associated financial, technical feasibility and safety risks. At this moment it is also unclear which of the safety or technical standards will be widely accepted [49]. Lenders would make a distinction between a 'captive' hydrogen project, where the hydrogen will be produced and sold to one or more local industrial facilities [31]. This is also called as integrated model of hydrogen production and there has been a significant increase in the development of hydrogen hubs and export facilities for specific end users. In these cases, Hydrogen producers will be most probably located near the end user like a refinery, green steel production unit or a mining facility. Hydrogen producers will also use existing infrastructure for producing hydrogen and will supply it to neighboring facilities [50]. And a 'split' green hydrogen project that are reliant on a downstream hydrogen market and is not located close to the production facilities. For these projects lenders need to understand how the gas/produced hydrogen is supplied to the end users [50]. Would it be shipped or transported via a pipeline like LNG where there is third parties providing distribution and storage services [50]. However gas pipelines where applicable would need to either be adapted or replaced for hydrogen supply at scale, similarly, ships must be built to transport the liquid hydrogen or green ammonia safely [49]. Unlike renewable power generated electricity which can be sold to existing grid or network, for hydrogen projects the infrastructure network and end-user products are not sufficiently mature yet to assist 'plug and play' mechanisms for delivery of hydrogen in most geographies [49].

So, lenders will require assurance regarding all necessary infrastructure is in place to ensure both the delivery inputs required to produce hydrogen, storage and transportation of the produced hydrogen to end users [49]. Lenders will expect to have long-term arrangements in place that lock in the pricing and availability of transportation, storage, shipping with customized terms that is acceptable to guarantee financing [31].

- **Operating, Environment and Social risk:** With increasing awareness on Environmental, social and governance issues. Lenders would like to ensure that the proposed project follow international best practices and operate in a framework that is based on sound environmental and social management policies [30, 31, 43, 49].

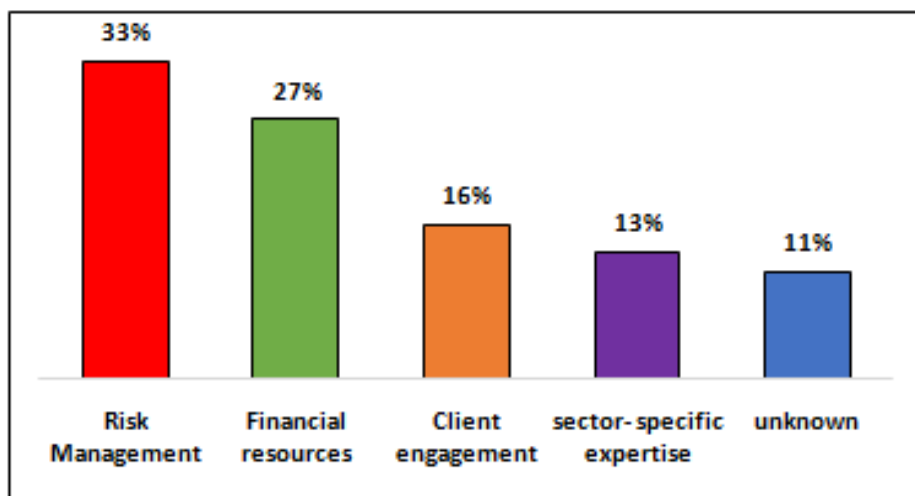
### III. CURRENT LANDSCAPE

An in-depth due diligence of all these risks involved in a hydrogen project is not an easy task. Lender might engage independent expert consultants to prepare a detailed due diligence report and to answer their questions/concerns for each risk area [13]. This exercise may allow the lender to confirm if the risks involved in the project have been managed adequately or not.[21] As per BCG survey offtake/market risk is of biggest concern to the banks around hydrogen projects (see Figure 1).



**Figure 1:** Challenges Impacting Hydrogen Financing.  
**Source:** BCG Analysis [21]

One interesting observation in the above chart is 19% of Capability Gap. BCG has further broken down the determinants of the capability gap in their survey [21]. During this research BCG found that risk management is the leading capability that is stopping commercial banks from financing [18] these projects as shown in Figure 2.



**Figure 2:** Top Capability Gap Impeding Hydrogen Project-Financing.  
**Source:** BCG Analysis [21]

Despite the necessary understanding of risk tools for renewable energy projects for two decades, the banks lack models and data for gauging the risk for Hydrogen Projects [11]. Banks need to have strong risk assessment and management capabilities to service Hydrogen projects and to have a competitive advantage among their peers [21]. Developing a knowledge base and in-house expertise is critical for managing risks and originating deals. Hydrogen is a new environment for banks, but one where they are well positioned to succeed given the breadth of their customer base [39]. The financial advisers are good at structuring partnerships and attracting the right partners is key capability for becoming a pioneer in hydrogen space and to act as ecosystem enabler [29].

Existing cases of hydrogen financing show that banks have adopted an enabling mindset, innovative funding approach to invest in capabilities building for Hydrogen Projects. For example, Barclays has adopted an innovative funding approach for Hydrogen Business [30]. Through its Sustainable Impact Portfolio, it has invested equity in Protium. This portfolio is run by Barclay's principal investment team and Protium is using green hydrogen to develop energy solutions in the UK. On the other hand, HSBC has invested as an anchor partner in Breakthrough Energy Catalyst, by using public-private investment initiative [51]. Breakthrough Energy Catalyst is investing in sustainable aviation fuel, direct air capture, long duration energy storage and clean hydrogen [35].

Also, energy players are actively partnering with financial institutions in these areas, an example of this H2 Energy. Investors in H2 Energy can gain exposure to emerging hydrogen energy sector and can still rely on the company's expertise as it has been working on renewable hydrogen projects since 2014 [30]. H2 is based in Switzerland and has extensive network of strategic partners and co-investors across Europe. This approach helps institutional investors to develop internal capabilities to take up more complex projects in future, while tapping in the exposure from existing scale up and Pre-IPO companies extracting their expertise to the nascent sector [30]. Traditional energy companies and industrial players with strong balance sheets, as well as new market entrants and start-ups are also attracted to invest in Green Hydrogen market by leveraging their financial intermediaries' network [51].

Similarly, Project developers can proactively leverage grants and partner with development banks, export credit agencies or relevant government departments to give greater assurance to lending to commercial banks [24]. Long-term offtake contracts, or agreements of stable revenue with reputable counterparties can also be utilized to secure financing contracts [24]. NEOM green hydrogen project an under-construction hydrogen project of Saudi Arabia has benefitted from a 25-year offtake agreement with Air Product [52]. Air Product is a US chemical and Gas company, and it has a stake in the project and has taken the responsibility to transport, store and manage the end user application of the green ammonia produced from NEOM plant. Taking up the commercial risk of transportation and distribution of green ammonia also presents an opportunity to become a market leader for Air Products [30].

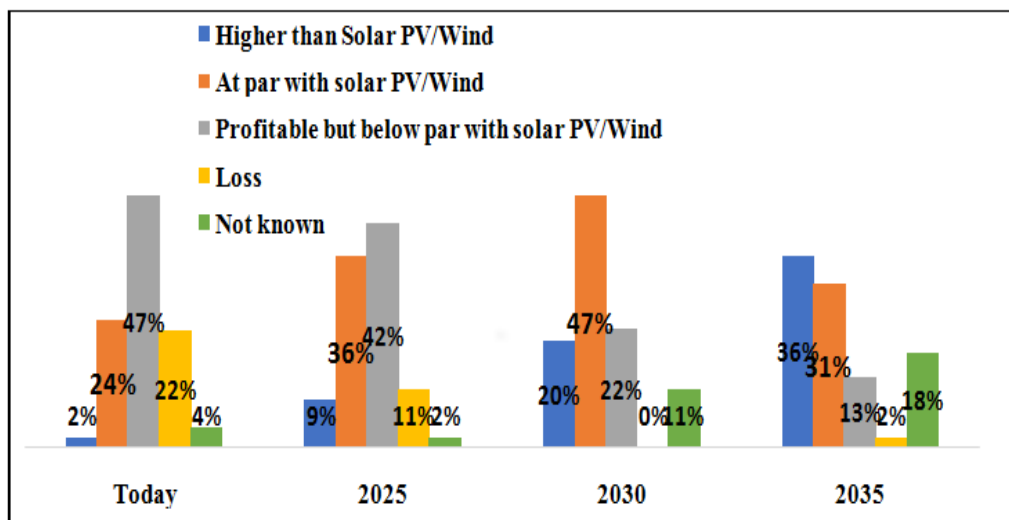
The developer of a green hydrogen power project Centrale Electrique de l'Ouest Guyanais in French Guinea has a 25-year PPA with France's state-owned utility, EDF and it has a contract with Germany based established firm Siemens for EPC element of the Project

[53]. These contracts have mitigated the risks involved and got the financiers on board with the project [53].

#### IV. FUTURE TRENDS

Banks can also gain competitive advantage by utilizing the Sustainable Finance instruments like Green Bond and Green Loan. As shown in Figure 3 below, banks expect that the number of commercially attractive projects are few today, but this will increase over time because of the policies and momentum around Hydrogen. 67% of the banks anticipate that the risk adjusted returns of hydrogen projects will be better or equivalent of the solar and wind projects by 2035 [16]. Financier and project finance advisers can take a multi-disciplinary approach by drawing on their financing experience in power [51], oil and gas, transport, mining and infrastructure projects to analyze the hydrogen projects and structuring investments by harnessing the green and ESG-linked liquidity into heavy transport and industrial production sectors [51].

Hydrogen Projects committing long-term contributions to the economic well-being, through additional renewable energy capacity, water supply, improved infrastructure, employment and other tangible benefits to the local communities will comply with Green Loan Principles and hence will enable financial advisers to market the financing of the project as a ‘Green Loan’ [22]. Announcements of qualitative and quantitative KPIs of the impact of projects will help financial advisors to link it to the financial covenants and provide access of sustainability-linked-instruments to Hydrogen Projects [11]. The exact content of these covenants will vary naturally between the transactions depending on the geography, project structure, offtake arrangements etc. Financiers shall utilize the GLP guidance to determine if these are relevant to be eligible as green projects [11].



**Figure 3:** Expected Risk Adjusted Returns of Hydrogen Projects Over Time in Comparison With Solar PV and Wind Projects.

**Source:** BCG Analysis [21]

As noted above, these transactions involve several risks. Lenders may also propose the Project Company certain hedging arrangements to mitigate the associated interest rate risk

or currency risk [43]. For example, in absence of a PPA for the end products – to mitigate the risk lenders would expect to hedge the electricity price for at least part of the electricity required to produce Hydrogen [54], these sorts of commodity hedge will mitigate the exposure to raw material price fluctuations and hence will impact the price of its products [55]. Finally, banks should also design the KPIs of the team working in emerging hydrogen markets – as the potential of immediate returns is limited on these deals, bonuses of employees shall also be properly managed [56].

## V. CONCLUSION

The few pioneering commercially viable projects that have transitioned from planning to operations have tested the financing parameters and established starting points for other projects. The government and industries should focus on the following points:

1. The Project structures and documentation packages of these projects can be utilized by various under preparation projects around the world. We also learnt about the various government initiatives to accelerate hydrogen projects from pilot stage to industrial scale.
2. To incentivize private investments, banks need to prioritize development of technical capabilities to build innovative financing solutions by integrating risk mitigation and credit enhancement instruments that catalyzes concessional and climate finance resources.
3. Governments shall develop mechanisms to certify green hydrogen along the value chain and establish internationally cooperated carbon pricing, as these changes would increase competitiveness, create local green opportunities, open new markets – that would result in even more private sector investments.
4. These concerted efforts from all the market participants will contribute to credibility and resilience to the hydrogen market.

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