

EXECUTIVE BRIEF

ENABLING MASSIVE INVESTMENT IN CLEAN HYDROGEN TO DELIVER ON GLOBAL CLIMATE GOALS

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Executive Summary

- OPSWF members signal readiness to step up global efforts to finance and accelerate the mass scale-up of clean hydrogen solutions both in terms of new investments and transition assets.
- Clean hydrogen is a key lever to achieving the goals of the Paris Agreement. In-line with the OPSWF Framework, investing in clean hydrogen can help solve the energy trilemma of sustainable, secure, and affordable energy, decarbonize global economies, foster new sectors, and technologies, and drive growth while providing socio-economic benefits.
- Many investors have demonstrated an early interest in clean hydrogen and investment can be significantly accelerated in the coming five years, provided the appropriate enablers are in place.
- OPSWF members highlight three such priority enablers: (1) demand-side stimuli such as public private partnerships, (2) actions to facilitate international trade in clean hydrogen, and (3) in its nascency and

where such pricing policies exist, public institutions and development banks to establish sectoral contracts-for-difference in clean hydrogen and its derivatives to stimulate demand, offset price differentials and make projects bankable.

- In addition, establishing a global industry standard on the definition of clean hydrogen to qualify hydrogen as a commodity and specific asset class will be critical to accelerating investment by overcoming regional differences.
- Members of OPSWF collectively have the capital and ambition to invest at scale into clean hydrogen solutions. Successfully addressing the priority enablers would open up further investment opportunities to OPSWF members.
- In this context, OPSWF members anticipate that sharing their insights and recommendations will help to transform clean hydrogen into a standalone asset class, in the same way as was done with renewable energy sources such as wind and solar.

1. Mobilizing Investors to Unlock and Scale-Up Development of Clean Hydrogen

The One Planet Sovereign Wealth Funds (OPSWF) group was set up to accelerate efforts to integrate climate action considerations and climate risk in the investment and management of large, long-term asset pools, and thereby make a decisive contribution to achieving the goals of the Paris Agreement.

Given both their influence and long-term investment horizons, Sovereign Wealth Funds (SWFs) have a **unique role to play** when it comes to accelerating the energy transition, including unleashing the potential of new energy vectors such as clean hydrogen¹. SWFs can help unlock private funds by making initial enabling capital investments, considering policies aiming to foster additional investment, and generate financial returns while driving positive societal impact (“double bottom line”).

At their 2021 Summit, the CEOs of OPSWF member organizations specifically recognized the **critical importance of continued actions to unlock massive investment in clean hydrogen** in the context of the ongoing global energy transition.

As a leading coalition of 43 members - sovereign wealth funds, asset managers, and private investment firms - with over USD 36 trillion in assets under management, **OPSWF’s perspectives on investment in clean technologies carry significant weight** in terms of signaling opportunities to the market.

To deliver on their CEO’s vision, OPSWF launched a dedicated Clean Hydrogen Workstream with the objective to identify **key enablers to foster the development and acceleration of clean hydrogen** by

¹ In the absence of a single universally recognized global standard on carbon emissions across the value chain of hydrogen production, all hydrogen production pathways that contribute to the global goal of decarbonization will be referred to as “clean” or “low carbon” hydrogen for the purpose of this document. These pathways may include, but are not limited to, natural gas with carbon capture (often referred to as “blue”), electrolysis with nuclear energy (“pink”) or electrolysis with renewable energy (“green”).

leveraging - among other - members' experience with the technology, markets as well as their collective insights into existing regional frameworks.

In this context, an OPSWF member survey² conducted as part of this Workstream in mid-2022 confirmed that **clean hydrogen is important to OPSWF members' long-term investment strategies**, and many OPSWF members are either already actively engaged in investing in clean hydrogen today or expecting to enter this space in the near future.

Barriers remain - especially when it comes to technology cost and perceived maturity – however, if these are appropriately addressed, **OPSWF members indicate readiness to increase their engagement**. Government action is seen as key to fostering further progress in clean hydrogen deployment at scale.

Building on expert work by leading international organizations as well as OPSWF members' first-hand experience in the hydrogen space, OPSWF have identified **three system-level enablers** that can have a **transformational impact** on the global investment environment and produce a multiplier effect for accelerated hydrogen investment across the global economy.

These key enablers include: (1) **demand side stimuli** such as incentives and other measures to spur demand or public-private partnerships, (2) **measures to facilitate global trade** and (3) in its nascency and where such pricing policies exist, public institutions and development banks to **establish sectoral contracts-for-difference in clean hydrogen** and its derivatives to stimulate demand, offset price differentials and make projects bankable.. In addition, establishing a global industry standard on the definition of clean hydrogen to qualify hydrogen as a commodity and specific asset class will be critical to accelerating investment by overcoming regional differences.

This document provides further context on the hydrogen investment opportunity, details OPSWF members' perspectives on clean hydrogen, and further explains the rationale behind the choice of these key enabling actions.

2. A Key Component of the Economic and Energy Transition

Clean hydrogen has become widely recognized as **a key component of the energy transition**, essential to **decarbonize the global economy**. It can be used as a low/zero-emission fuel, a versatile energy carrier, clean chemicals, or a flexible storage solution with multiple applications across the entire economy.

As such, clean hydrogen has a **critical role to play** in complementing and amplifying direct electrification and other emission-reducing technologies, transforming entire industries and thereby delivering not only **significant climate benefits** but simultaneously also helping **address other critical challenges** such as energy security, system efficiency, energy access/affordability and the societal and economic implications of the global energy transition.

By 2050, the International Energy Agency (IEA) expects that clean hydrogen could meet up to **13% of the world's final energy demand**³. The Hydrogen Council expects that hydrogen can become a **\$2.5trn+ economy**, provided significant investment can be made.⁴ Per research by Bloomberg New Energy Finance (BNEF), this new market is, in turn, expected to foster sustainable growth and jobs in participating countries and regions - an estimated **5+ million jobs by 2050**⁵, both critical in the context of recovery from the global COVID crisis.

The Energy Transitions Commission (ETC) estimates that implementing the global use of clean hydrogen at scale will require a total of **USD 15 trillion in investment between now and 2050**, peaking in the late 2030s at around \$800 billion per year.⁶ According to the same source, around 85% of the required investment would be in electricity generation and 15% in electrolyzers, hydrogen production facilities, and transport and storage infrastructure.

A dedicated survey⁷ conducted among OPSWF members points to the **significance of clean hydrogen within members' investment portfolios and the potential for growth** in clean hydrogen investments over the next ten years. Below are presented key insights from the survey:

- A substantial majority (87%) of the members surveyed consider investment in clean hydrogen to be an important factor in their long-term investment strategy. The significance of clean hydrogen investment is echoed in the strong support (91%) among members surveyed for the view that *“all new hydrogen investments shall be pursuing the objective of low carbon emission exposure to achieve the long-term global warming objectives of the Paris Agreement.”* 72% of the members surveyed say that investment in decarbonizing existing “grey” (unabated) hydrogen assets factor as important or very important in their long-term investment strategy.

³ IEA: Net Zero by 2050 (2021) – Other estimates are even higher, such as ~20% by the Hydrogen Council

⁴ Hydrogen Council (2018)

⁵ BNEF (2020)

⁶ ETC (2021)

⁷ The OPSWF Clean Hydrogen Workstream Survey was conducted to explore members' activities and experience with clean hydrogen. The survey was sent to all OPSWF members via secure online link in an email from the OPSWF Secretariat. Data was collected from the 51% of OPSWF members that completed the survey between June 30 and September 5, 2022

- Nearly a third of the members surveyed (32%) are already investing in clean hydrogen and all of them (100%) are planning to increase that investment in the next 5-10 years. Among members surveyed who currently hold investments in clean hydrogen, 86% say they will increase their investment in the next 2 years. These results indicate that members holding clean hydrogen investments anticipate positive benefits from growing their investment in clean hydrogen in the near future.
- Amongst OPSWF members surveyed currently investing in clean hydrogen, most (50%) plan to increase investments up to 50%, and a further 22% plan to increase investments by 300% or more, with project sizes ranging up to USD 500 million+.

3. The Need for Global, Regional, and National Strategies

To capitalize on this opportunity, already more than 30 leading governments, from developed as well as emerging economies, have adopted dedicated strategies to provide funding and policy support as well as other incentives to enable mass scale-up of clean hydrogen. For example:

- The European Union’s Hydrogen strategy sets a target of 6GW installed renewable hydrogen production capacity by 2024 and 40GW by 2030. The REPowerEU Plan published in 2022 includes a target of 10 million tons of domestic renewable hydrogen production and 10 million tons of imports by 2030, to replace natural gas, coal, and oil in hard-to-decarbonize industries and transport sectors.
- The U.S. federal government has announced a goal of USD 1/kg renewable (“green”) hydrogen cost within a decade and a USD 9.5 billion financing package for “clean hydrogen hubs” including a diversity of hydrogen production pathways - and related R&D and manufacturing priorities. In addition, the landmark 2022 Inflation Reduction Act introduced and/or expanded various types of tax credits (incl. raising the support for “green” hydrogen production to up to USD 3/kg), that are expected to further spur hydrogen investment and deployment in the market and ultimately contribute to a broader positive global dynamic as well.
- Considering the APAC region, for example, the Chinese national hydrogen strategy foresees a national network of 1,000 hydrogen refueling stations between 2025 and 2030.
- In Saudi Arabia, a USD 5 billion green hydrogen plant, the world’s largest to date, has been announced alongside other large-scale projects in the Middle-East focused on leveraging the region’s rich renewable sources.

According to the International Energy Agency⁸, **countries with hydrogen strategies have already committed at least USD 37 billion; an additional USD 300 billion has been announced by the private sector.** Per the Hydrogen Council and McKinsey & Company, more than 520 projects were announced in 2021, up 100% compared to the prior year. The number of giga-scale projects has more than doubled from 17 to 43 in the past year with announcements spanning all regions. Across regions, Europe accounts for

the largest share of announced projects (261), followed by Asia and North America.⁹ The first dedicated hydrogen infrastructure investment platform worth USD 1+ billion, Hy24, launched in 2021 to fund large-scale clean hydrogen infrastructure projects worldwide. Since then, multiple hydrogen-focused technology funds have been launched and commenced investing, thus further contributing to the acceleration of technology development and cost reduction.

This scale of investment speaks to **tremendous momentum** in the hydrogen sector as well as the broader industry energy transition process and is expected to continue to further drive down costs. However, **further acceleration is needed** to capitalize on clean hydrogen's full potential and deliver on global objectives set forth in the Paris Agreement. Per the IEA, putting the hydrogen sector on track for net zero emissions by 2050 requires USD 1,200 billion of investment in low-carbon hydrogen supply and use through to 2030.¹⁰

This is in line with the UN Climate Change Conference in Glasgow (COP26), which called for further strengthening of national climate plans - both in terms of adaptation and mitigation - and **stepping up worldwide efforts on mobilizing climate finance**. In addition, hydrogen, as such, was heavily featured during COP26. The Breakthrough Agenda, a key outcome of the proceedings capturing commitments by key players, includes a hydrogen-dedicated "Glasgow Breakthrough" goal, the aim of which is to ensure affordable clean hydrogen is globally available by 2030.

In May 2022, the G7 Summit launched a new **Hydrogen Action Pact** (G7-HAP) to accelerate the development of clean hydrogen and its derivative in hard-to-abate sectors, speeding up enabling frameworks and common standards on hydrogen, and identifying and closing existing hydrogen rampup "gaps" in the G7 nations and elsewhere. This international dialogue is expected to be further advanced at the next Climate Conference in Sharm El-Sheikh (COP27) in November 2022.

⁹ Hydrogen Council and McKinsey: Hydrogen For Net Zero (2021)

¹⁰ The IIGCC (2022) has published a Climate Investment Roadmap based on the IEA's Net Zero pathway which states that "CCUS and hydrogen are expected to face investment needs of around \$1.2 trillion (14%) and \$1.4 trillion (16%) respectively, most of which is expected to occur after 2030."

4. Better Integration of Risk Factors and Building a Global Asset Class for Long-Term Investments

To seize these opportunities, it is critical to identify remaining barriers and pursue concrete actions that will lift remaining blockers and help **create an investable market** with large-scale projects making a significant contribution to decarbonization and related global objectives. Such actions may range from structured dialogue and sectoral partnerships to efforts towards global standards and policy framework to specific commitments, either defined as financial or focused on deployment capacity.

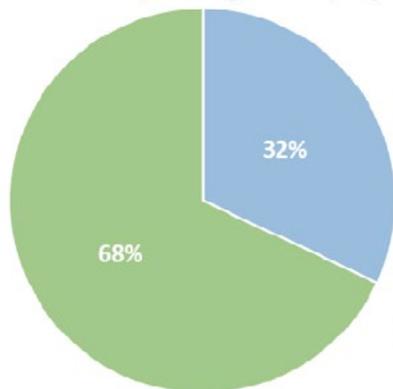
- Members surveyed who are not currently investing in clean hydrogen (68%) are likely to **plan for clean hydrogen investment in the coming years**. Members surveyed say they plan to invest in the next 2 years (20%), 5 years (60%), and 10 years (80%).

Figure 1: Members’ Current and Future Investment in Clean hydrogen

Source: OPSWF, 2022

Members’ Current Investment in Clean Hydrogen

- Currently investing in clean hydrogen
- Not currently investing in clean hydrogen

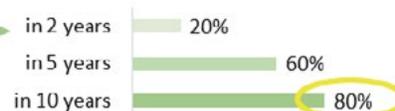


Members’ Future Investment in Clean Hydrogen

Planning to *increase investment* in clean hydrogen



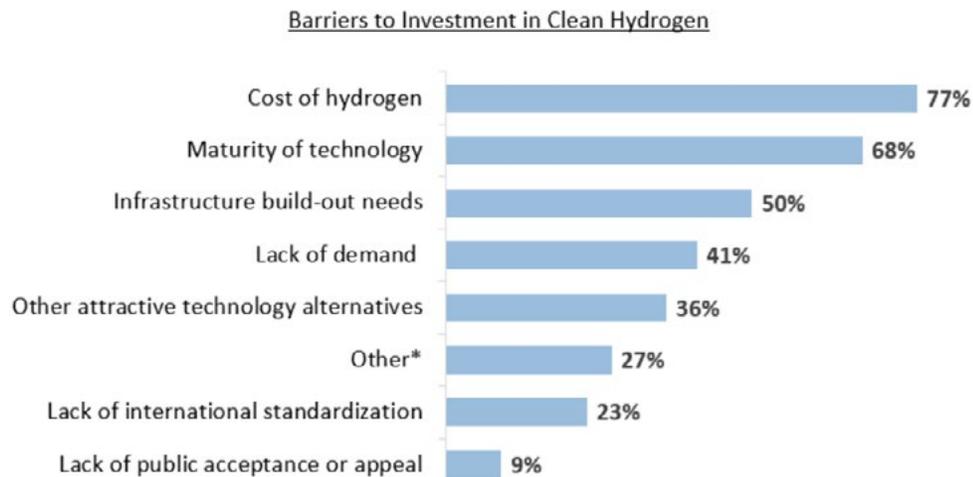
Planning to *begin investment* in clean hydrogen



- A majority of the members surveyed perceive the cost of hydrogen (77%) and the maturity of the technology (68%) as the top barriers that discourage allocation or investment to clean hydrogen.

Figure 2: Barriers to Investment in Clean Hydrogen

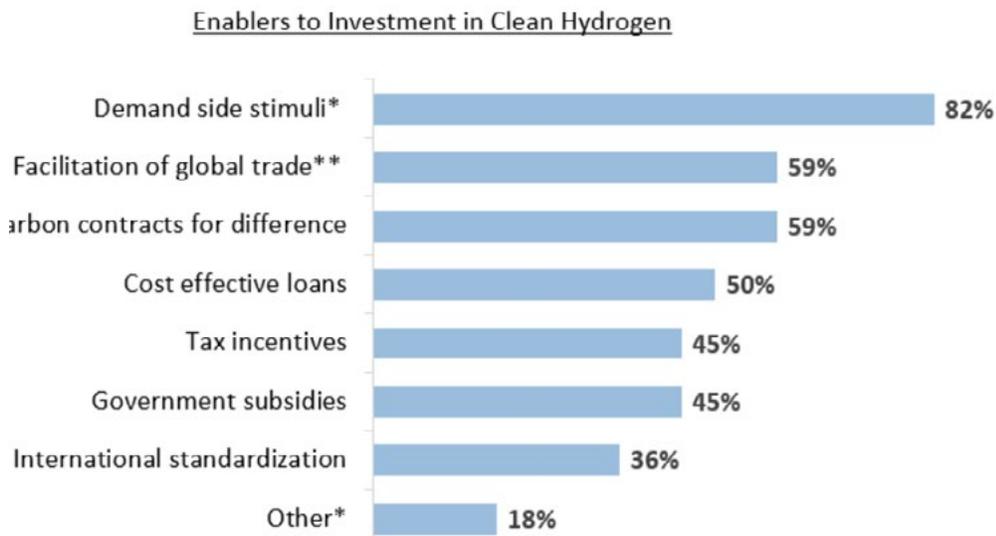
Source: OPSWF, 2022



- On the other hand, members surveyed indicated that the strongest enablers to mitigate barriers and encourage investment in clean hydrogen are demand side stimuli such as incentives or measures or public-private partnerships (82%); facilitation of global trade and other mechanisms (59%); and contracts for difference (where they exist) (59%) and cost-effective loans (50%).

Figure 3: Enablers of Investment in Clean hydrogen

Source: OPSWF, 2022



These results from the OPSWF network survey on Clean Hydrogen thus demonstrate not only the importance of clean hydrogen in members' investment strategies over the next ten years but also the **massive potential to unlock further investment** through addressing key barriers.

In reducing these investment risks, barriers can be alleviated through **effective project structuring**, which encourages risk sharing. The application of established PPP models or similar incentive schemes will be critical to support greater greenfield investment where the typical risk profile of such projects is higher at the outset of project development. They also exist within the application of clean hydrogen to transition assets, where there are significant capital expenditure requirements to support the use of alternative cleaner fuels in the energy network.

Indeed, the **risk-return profile is the principal determinant** for sovereign wealth funds' portfolio allocation. Clean hydrogen investment sits within a broader alternatives asset class, and whilst investment in the private markets has universally increased since the global financial crisis, portfolio allocation to such illiquid assets still makes up a comparatively small component of overall investment. For clean hydrogen to scale into a mainstream institutional allocation, sovereign wealth funds will either need to adapt to an ordinarily higher risk profile or consider further portfolio diversification to manage for this dynamic, at least in the very near future. Additionally, as SWFs investment is increasingly shaped by ESG criteria, investing in clean hydrogen can play an important role in achieving these targets.

Sovereign wealth funds recognize that they can **trigger a productive 'waterfall' effect** in the market, where frontier investment in clean hydrogen production and utilization technologies and associated projects at scale will **encourage crowding in other types of long-term, patient institutional capital**. Where this is the case, there is a real opportunity for a partnership approach to both alleviate the risk sharing by public sector-backed entities (over time) and benefit from the wider industrial expertise some independently managed investors continue to build. This will support the maturity of the asset class as the market has undertaken in other complementary clean technologies such as renewables.

5. Key Enablers Recommended to Lift Barriers to Massive Investments

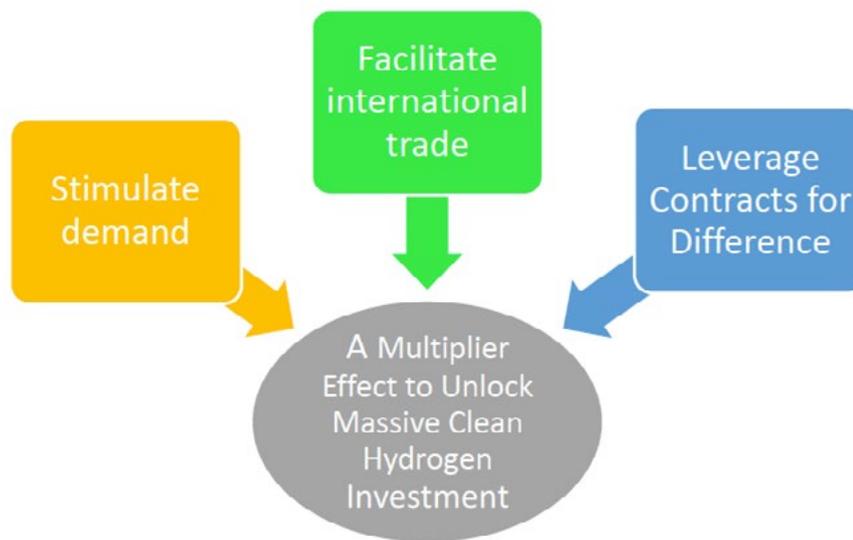
While hydrogen technology as such is broadly considered mature, clean hydrogen solutions are facing **typical growing pains of new technologies** on their way to a sustainable, competitive mass-market – not dissimilar from challenges encountered by solar and wind power just decades earlier.

The industry is hard at work on multiple fronts - from physical infrastructure build-out to further investment in technologies, restructuring global supply chains, putting in place appropriate policies, standards incentives and other measures, and forging new business partnerships and entrepreneurial ventures while engaging with communities and securing societal acceptance. All of these are **complex, multifaceted, multi-stakeholder processes** that require significant resources.

Against this dynamic, SWFs – like other investors – need standardized frameworks to enable investment, such as standardization and certification to drive consistency and certainty and alignment with government entities to ensure inclusivity. Benefits thereof include project and supply chain design to meet standards, bankability, and commoditization of the market.

OPSWF have therefore identified three **system-level enablers** that can have a transformational impact on the global investment environment and produce a snowball effect for increased clarity, predictability, and stability and therefore accelerated hydrogen investment across the global economy.

These key enablers include: (1) **demand side stimuli** such as incentives and other measures to spur demand or public-private partnerships, (2) **measures to facilitate global trade** and (3) in its nascency and where such pricing policies exist, public institutions and development banks to establish sectoral **contracts-for-difference** in clean hydrogen and its derivatives to stimulate demand, offset price differentials and make projects bankable.



Enabler #1 - Demand side stimuli

Hydrogen is well suited to play an important role in **decarbonizing a variety of end-uses**, especially in hard-to-abate sectors such as heavy industry, including steel, chemicals and refineries (tbd.), and heavyduty transport sectors including logistics, road trucking, long-distance busses, shipping, and aviation.

While different approaches exist across global markets, from specific targets and mandates to tax and other incentives, ensuring **sufficient commercial off-take at scale**, well aligned with clean hydrogen production and distribution, is paramount to success.

In its 2021 Global Hydrogen Review, the IEA recommends a **robust enabling framework to stimulate**

demand, which can, in turn, prompt further investment in production, infrastructure, utilization, and manufacturing capacity. The IEA notes that “a step change in demand creation” is required. While governments are “starting to announce a wide variety of policy instruments, including carbon prices, auctions, quotas, mandates, and requirements in public procurement”, most of these measures “have not yet entered into force”. The IEA emphasizes that their “quick and widespread enactment” could unlock more projects to scale up hydrogen demand and identifies “tailor-made support to selected shovel-ready flagship projects” and adequate infrastructure planning among actions without which the scale-up process may not happen “at the necessary pace to meet climate goals”.

On the infrastructure side, industry research shows that a **large-scale hydrogen refueling station network deployed/operated by a public-private partnership** would benefit investors, governments, and society.

- The Hydrogen Council has modeled such a project based on a public-private partnership to deploy and operate a large-scale hydrogen refueling station network, enabling hydrogen mobility for cars, buses, and trucks.¹¹
- It shows that while initial hydrogen infrastructure deployment is expensive, marginal costs decrease rapidly as vehicle penetration increases. Interoperable refueling infrastructure is required for optimal utilization of network and upstream distribution infrastructure.
- Furthermore, strategic placement of stations for a sufficient level of access, with scale-up of network capacity as vehicle fleet grows, ensures economic viability. Additional structuring options for the hydrogen utility operator could increase attractiveness for private sector lenders.

In September 2022, the European Commission announced the creation of the European Hydrogen Bank aimed at bridging the investment gap and connecting future supply and demand. The Bank will guarantee the purchase of hydrogen by using resources from the EU’s Innovation Fund up to a total of €3 billion to help build the future market for hydrogen.

Enabler #2 – Actions to facilitate global trade

Many of the world’s leading economies (e.g., China, Japan, Korea, European Union and Saudi Arabia) have adopted net-zero emissions targets, creating an urgent domestic need for decarbonized energy. However, those with constrained domestic energy resources will **require clean energy imports and/or technology advancement** - including in the form of clean hydrogen and its carriers such as ammonia - to reach their targets.

According to the International Renewable Energy Agency (IRENA),¹² countries with abundant natural resources (e.g. Australia, Chile, Saudi Arabia, Morocco, United Arab Emirates, etc.) could become largescale commercial producers of clean hydrogen. Producing and exporting clean hydrogen could be an **attractive avenue to diversify energy sources and develop new export opportunities**.

Per IRENA, these new dynamics in global trade and investment flows will “spawn new patterns of interdependence and bring shifts in bilateral relations around the world”, eventually positioning clean **hydrogen (and its carriers) as a new vector for energy transfers between continents** and thereby not only boosting trade and delivering on climate objectives but also enhancing the security of energy supply.

- For example, Japan aims to become a hydrogen society, yet faces the high cost of hydrogen production and the limitation of national resources. To satisfy its hydrogen demand, Japan could import clean hydrogen from Australia and the Middle East, produced using multiple pathways.

As of 2021, the World Energy Council counts 41 **import-export partnerships** for clean hydrogen established around the world since 2017, with the majority emerging in the past two years. Germany and Japan have established the largest number of partnerships, with 13 and nine, respectively.¹³ For example, in August 2022, Canada and Germany announce a new Hydrogen Alliance that will commit the two countries to enabling investment in hydrogen projects through policy harmonization, supporting the development of secure hydrogen supply chains, establishing a transatlantic Canada–Germany supply corridor, and exporting clean Canadian hydrogen by 2025.¹⁴

To build on this emerging foundation and facilitate international trade globally, **relevant mechanisms and policies, where applied, must recognize and incorporate the low-emissions potential of clean hydrogen.** These policies and mechanisms may include all instrument that ensure a level playing field between local and imported low carbon solutions consistent with regional approaches, complemented by a set of robust international standards for clean hydrogen and its derivatives, and dedicated import/export agencies that will foster the build-up of off-takers and facilitate international trade of all vectors.¹⁵

- For example, a project model developed by the Hydrogen Council – based on regional hydrogen production and an intercontinental supply chain to supply hydrogen at a landed cost of USD 3/kg, in which a hydrogen utility operator owns and operates infrastructure in the origin and destination country, controlling the production and export end-to-end - shows that such case is economically viable with existing Japanese feed-in tariffs, although different hydrogen production routes or demand segments would impact return on investment.
- It shows that existing energy resources and infrastructure can be monetized through exports, offering hydrogen at a cost significantly below what could be achieved locally. However, an initiative from both governments and investors is required to manage and mitigate the most important risks that could impact the large-scale global demand creation.

When it comes to standardization, the IEA¹⁶ makes it clear that establishing appropriate certification, standardization, and policy regimes will play a fundamental role in developing a global hydrogen market. Because the adoption of hydrogen will give rise to new value chains, modification of current enabling frameworks and defining new standards and certification schemes to remove barriers preventing widespread adoption will be required. Finally, the IEA points out that an “international agreement on methodology to calculate the carbon footprint of hydrogen production is particularly important to ensure that hydrogen production is truly low-carbon.”

¹³ World Energy Council (2021)

¹⁴ Natural Resources Canada: Canada and Germany Sign Agreement to Enhance German Energy Security with Clean Canadian Hydrogen (2022)

¹⁵ Content based on Hydrogen Council Archetype Project #1 - Hydrogen export and demand creation

¹⁶ IEA: Global Hydrogen Review (2021)

Enabler #3 - Contracts for Difference

Contracts for Difference (CfD) are project-based financial instruments that guarantee a fixed price over a given period (e.g. hydrogen price in case of Hydrogen Contracts for Difference), and thereby **manage risk of price volatility and reduce cost of deployment** where applicable. Depending on national Carbon pricing policies, Carbon Contracts for Difference (CCfD) may be applied to clean hydrogen projects to stimulate production where such policies are in place.

A recent Climate Friendly Materials (CFM) Platform report¹⁷ argues that that CfD are among “the best tool to **provide certain revenue streams** to decarbonized technologies, which investors could then capitalize over the lifetime of the project.”

- For example, per a study published in the Climate Policy Journal¹⁸: “a steel-production facility may be interested in investing in a new, carbon-free technology such as “green” hydrogen production. But this will require a significant investment, which has to be recovered in part by selling in the market the emissions reduced.
- If the carbon market price is uncertain, this flow of revenue may not be able to support the investment. However, that facility might sign a CfD with the government at a (in this case: carbon) price sufficient to make the investment feasible.
- When the carbon market price is lower, the government would pay the facility the difference for every ton of carbon reduced. When the carbon market price is higher, the facility would reimburse the government.
- The fact that the carbon price is stable under the contract means that the equivalent carbon price required to make the investment competitive could be reduced by 35%.”

Recognizing the potential of this tool to foster the deployment of low-carbon industrial technologies, building on this logic and expanding to clean hydrogen and its derivatives, the **European Commission has recently chosen to leverage CfDs as part of its REPowerEU plans**¹⁹ to switch existing hydrogen production in industrial processes to “green” hydrogen and transition to clean hydrogen-based production processes in new industrial sectors such as steelmaking.

Annex. Examples of OPSWF Members' Hydrogen Activities

OPSWF members are among the leaders in hydrogen investment. For example:

- **Allianz Global Investors (AllianzGI)** through Allianz Capital Partners (ACP) is one of the leading European financial investors in renewable generation with assets under management of more than EUR 5 billion in over 150 solar and wind park investments. Overall, ACP manages more than €25 billion assets under management in infrastructure equity with a substantial share in the energy sector. ACP is member of the European Clean Hydrogen Alliance and actively pursues hydrogen investment opportunities both directly as well as through its portfolio companies.

Examples for hydrogen initiatives of our portfolio companies' include the HyNet project, a widely praised decarbonisation blueprint for the benefit of key industries in the North-West of England as well as heating 2 million local homes with the intention of hydrogen production using carbon capture, UK's first hydrogen powered train, fitted with hydrogen fuel tanks and a battery pack to provide independent traction on non-electric routes, as well as several hydrogen production projects in Iberia, among them the first green hydrogen injection project into a gas network in Portugal. Furthermore, AllianzGI is part of the Allianz Group which is one of the world's leading insurers and asset managers and among the leaders in the insurance industry in the Dow Jones Sustainability Index. Allianz is a founding member of the Net Zero Asset Owner Alliance.

- **Ardian** is a prominent player of the energy transition. It started investing in renewables in 2006 and now has a global renewable asset base portfolio of 7.5 GW, which enables significant avoided emissions at the portfolio level. Ardian has also been active on battery transactions, transitioning CO₂-exposed companies as well as hydrogen through its portfolio companies since 2019. In 2021, Ardian & FiveT Hydrogen created a 50/50 Management Company, Hy24, which combines the two partners' respective infrastructure fund management record and hydrogen expertise to establish the world's first clean hydrogen infrastructure investment platform with a unique 50/50 combination of Industrial and financial investors. The fund has reached its €1,8 billion hard cap and has already started to deploy capital in three deals and several geographies.
- **GIP:** Energy continues to be a focus sector for GIP investments. GIP has honed its focus on the energy sector with a commitment to continue to invest in renewable energy as part of its investment strategy. As a proponent of energy transition, GIP pivoted towards renewables, and approximately \$18bn of equity capital has been invested or committed since GIP's inception representing approximately a third of GIP's investments to date. GIP is exploring investments in traditional renewable energy businesses such as wind and solar, and also assessing opportunities in innovative renewable energy sectors and technologies such as carbon capture and storage, hydrogen and bio-fuels through its portfolio companies. For example: (i) Vena Energy, Naturgy, Skyborn Renewables, all with plans for green hydrogen production, while Scotia Gas, a GIP investment held through one of GIP's separately managed accounts, is planning to utilize its grid for future hydrogen delivery; (ii) EnLink is developing the leading carbon capture hub in Louisiana and North Texas; (iii) Signature is selling SAF to customers; and (iv)

Edinburgh Airport is exploring SAF storage on-site. GIP feels strongly that it can meet its commitment to energy transition and the climate while continuing to meet its fiduciary obligations to its investors. During 2021, GIP portfolio companies generated 36 TWh of renewable energy (12% more than 2020) and avoided 26.4mm metric tons of CO₂ through renewable energy (16% better than 2020).

- **Macquarie Asset Management** recognises that technology will be key to mitigating climate change and is supporting its portfolio companies, such as the UK's largest gas distribution network operator Cadent, to explore the development of low carbon solutions. Macquarie Asset Management is supporting Cadent as it invests to increase the role of greener low-carbon gases in its network, which supplies more than 11 million homes and businesses with gas. Through innovative trials involving hydrogen and biomethane, Cadent is ensuring its long-term role in the UK's energy landscape whilst helping to secure zero carbon energy networks that are safe, reliable, flexible and convenient for customers.
- **Masdar** has been progressing "green" hydrogen projects in the UAE, such as their collaboration with Engie and Fertigllobe to explore as a 1st step a 200MW production of Green Ammonia. It has been expanding its partnerships internationally with several GW projects that include Egypt and Azerbaijan.
- **Mubadala** Investment Company (Mubadala) entered into binding agreements with TAQA and ADNOC in June 2022 for the purchase of stakes in Abu Dhabi Future Energy Company (Masdar – a Mubadala wholly owned portfolio company). The partnership sets out to create a global clean energy powerhouse that consolidates the renewable energy and "green" hydrogen efforts of Mubadala, TAQA and ADNOC under the Masdar brand. This strategic partnership will help to boost Masdar's renewable energy capacity to 100 GW by 2030.
- **Saudi Public Investment Fund's** giga-projects, NEOM, ACWA Power and Air Products have initiated construction of the world's biggest hydrogen-based ammonia production facility worth US\$ 5 bn, powered by renewable energy. The 4GW 'green' hydrogen project, will be located in NEOM, a new model for sustainable living, and will produce green ammonia for export to global markets. Air Products will be the exclusive off-taker of the green ammonia and will transport it around the world to produce "green" hydrogen for the transportation sector. The Green Hydrogen Project will supply 650 tons per day of Clean Carbon-Free hydrogen and save three million tons per year of CO₂. The project is on track to deliver clean hydrogen by 2026.

Annex. Statement Clean Hydrogen Workstream

ENABLING MASSIVE INVESTMENT IN CLEAN HYDROGEN TO DELIVER ON GLOBAL CLIMATE GOALS

Thursday, October 6th, 2022, Abu Dhabi, United Arab Emirates – One Planet Sovereign Wealth Funds’ and its companion asset manager and private equity fund initiative members’ (Network) 46 CEO members representing the world’s leading sovereign wealth funds, asset managers and private investment firms signal their readiness to step-up global efforts to finance and accelerate the mass scale-up of clean hydrogen solutions both in terms of new investments and transition assets.

Clean hydrogen, produced with no or low-carbon footprint, is a key lever to achieving the goals of the Paris Agreement. In line with the One Planet Sovereign Wealth Funds (OPSWF) Framework, investing in clean hydrogen can help solve the energy trilemma of sustainable, secure, and affordable energy and help decarbonize global economies, contributing especially to the hard-to-abate industries. Hydrogen also fosters new and innovative sectors and technologies, driving growth and providing socio-economic benefits.

Alongside industry and governments, many investors have demonstrated an early interest in financing clean hydrogen projects and solutions across the value chain globally. Investment in clean hydrogen can be significantly accelerated over the coming five years, provided the appropriate enablers are in place.

In an executive briefing released today, Network members highlight three such priority enablers: (1) demand-side stimuli such as incentives and other measures to spur demand or public-private partnerships, (2) measures to facilitate international trade in clean hydrogen and (3) in its nascency and where such pricing policies exist, public institutions and development banks to establish sectoral contracts-for-difference in clean hydrogen and its derivatives, to stimulate demand, offset price differentials and make projects bankable. In addition, establishing a global industry standard on the definition of clean hydrogen to qualify hydrogen as a commodity and specific asset class will be critical to accelerating investment by overcoming regional differences.

Members of OPSWF collectively have the capital and ambition to invest at scale into clean hydrogen solutions. Successfully addressing the priority enablers would open up further investment opportunities to OPSWF members.

In this context, Network members anticipate that sharing their insights and recommendations will help transform clean hydrogen into a viable asset class, in the same way this was done with renewable energy sources such as wind or solar. OPSWF will therefore continue their contributions to the scaling of clean hydrogen efforts and the group’s members stand ready to further strengthen their dialogue with key stakeholders including at the upcoming COP27 in Egypt and COP28 in the United Arab Emirates.

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