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CONFERENCE PROCEEDINGS

Understanding global hydrogen strategies: Strengthening clean hydrogen opportunities

A EXPERT OUTLOOK ON COLLABORATIVE EFFORTS TO DEVELOP A GLOBAL HYDROGEN ECOSYSTEM

August 10 and October 02, 2022 | Webinar | Soham Kshirsagar, Shubham Mishra, Anuraag Nallapaneni, Anindita Bhattacharjee, and Pawan Mulukutla

BACKGROUND

Hydrogen's potential contribution to a sustainable energy transition has never been more evident. Along with renewable energy (RE), hydrogen will play an important role in the transition to net zero, especially for hard-to-abate sectors such as steel, refineries, and fertilizers, where direct electrification is not technically viable or commercially feasible. A growing number of countries are announcing targets to achieve net zero status and are also transitioning to sustainable economic development models over the next couple of decades.

Hydrogen, which is commonly used as a feedstock in the chemicals and refining industry, has potential applications across multiple other sectors, both as a fuel and as a feedstock. Although existing applications will still account for a major share of the total hydrogen demand, recent progress across the hydrogen ecosystem is expected to drive hydrogen adoption in other niche applications.

The focus of most government policies for developing hydrogen ecosystems is through mechanisms to catalyze low-carbon hydrogen demand, drive adoption in new applications, scale manufacturing, and reduce costs. These mechanisms are being tested through various direct and indirect incentives and interventions. Globally, an array of policy mechanisms are being announced, like carbon taxes and pricing, auctions for low-carbon hydrogen and its derivatives, consumption mandates, and low-carbon requirements within public procurement.

CONTENTS

Quick and widespread enactment of these hydrogen strategies and roadmaps through decisive and robust legislations could unlock the future potential of clean hydrogen supply and demand. Hence, the announcement and implementation of a long-term national hydrogen strategy is the first critical step toward achieving a country's clean hydrogen ambitions.

WRI India's webinars on understanding global hydrogen strategies aim to facilitate an understanding of the various routes taken by countries to develop a robust clean hydrogen ecosystem.

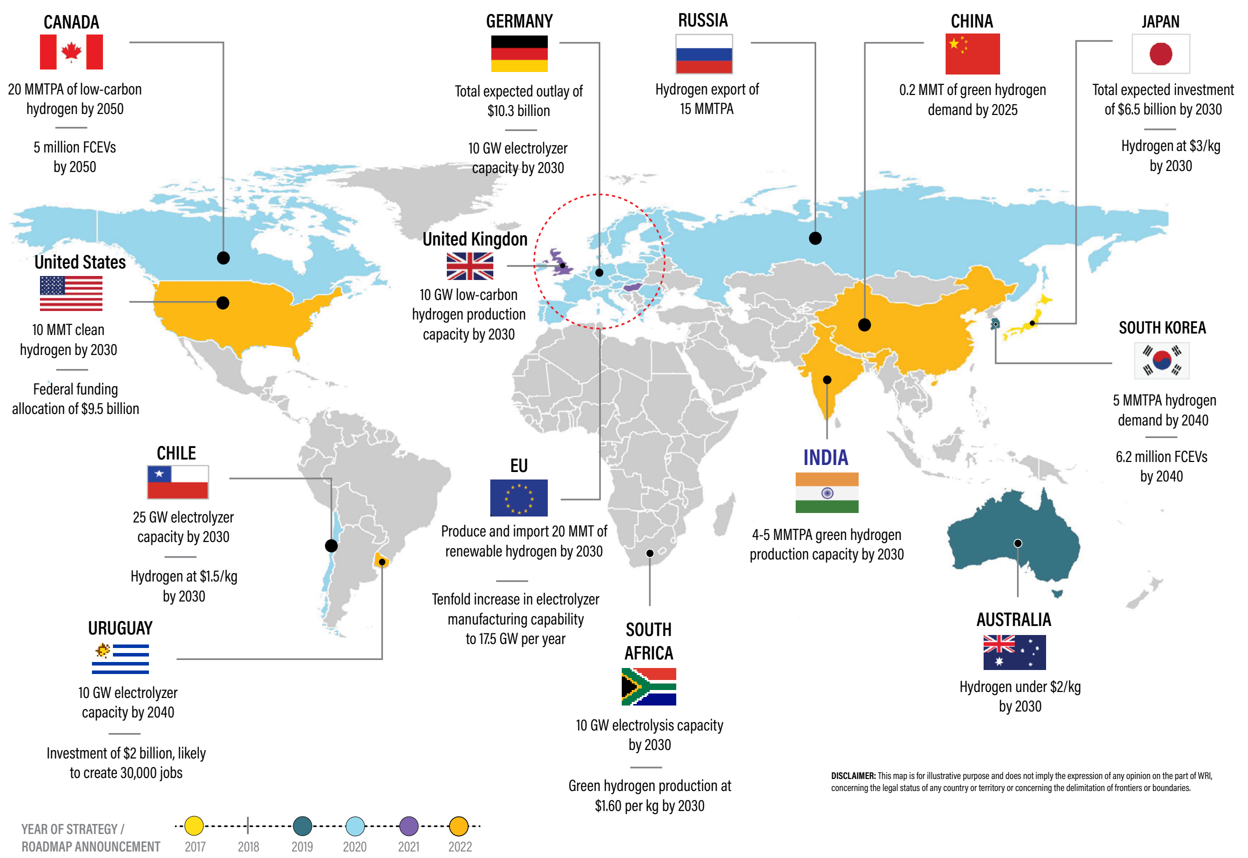
INTRODUCTION

Global hydrogen outlook

More than 20 countries have announced their official national hydrogen strategies, with several others announcing roadmaps and other official statements supporting an array of hydrogen programs.

The announcement of hydrogen strategies and roadmaps by countries across the globe is a pivotal step toward achieving their emission reduction targets and supporting long-term energy security by enabling the deployment of clean hydrogen across sectors. The precedent for a national hydrogen strategy was set by Japan in 2017, followed by other countries in the Asia-Pacific region. This has prompted the initiation of a hydrogen ecosystem leading to the formation of several trade partnerships and bilateral agreements in

FIGURE 1 | Global hydrogen outlook



Notes: FCEV - fuel cell electric vehicles; GW -gigawatts; MMT - million metric tons; MMTPA - million metric tons per annum.

Source: Compiled from hydrogen strategies by different countries.

the region. Although the initial focus of the announced hydrogen strategies was on specific sectors such as transport and power applications, especially in Japan, other countries are also focusing on hydrogen's potential in sectors such as industry, heating, and power generation.

By 2020, several countries across the European Union (EU) had announced their strategies, with Germany being the first. The EU's hydrogen strategy was launched a month after Germany's, after which several EU member states announced their domestic strategies in alignment with the EU's hydrogen strategy.

The rising global consensus to decarbonize hard-to-electrify sectors has further prompted hydrogen strategy developments in Canada and other countries in Latin America. Countries such as Chile and Gulf Cooperation Council (GCC) countries, which have strong RE potential for green hydrogen production, have also come forward with their export-oriented hydrogen strategies.

The United Kingdom and South Africa launched their strategies in 2021, with China and Uruguay launching their strategies and roadmaps in 2022 (see Figure 1). India announced its ambitious National Green Hydrogen Mission in January 2023.

India's National Green Hydrogen Mission

With a financial outlay of Rs. 1,97,440 million ($2.3 billion), the Mission is crucial for India's decarbonization journey. It targets the following by 2030:

- Production capacity of 5 million metric tons (MMT) of green hydrogen
- Electrolyzer installations with a capacity of 60–100 gigawatts (GW)
- Capacity addition of 125 GW of RE
- Creation of 0.6 million new jobs
- Abatement of 50 MMT of greenhouse gas (GHG) emissions per annum

Given the sector's infancy and the rapidly changing profile of the industry, the Mission is proposed to be implemented in two phases, beginning with the deployment of green hydrogen in sectors that already use hydrogen supported by an evolving ecosystem for R&D, regulations, and pilot projects. The Mission's subsequent phases will build on these foundational activities and launch green hydrogen initiatives in new sectors of the economy.

Key lessons and entry points of action

Factors influencing the development of global clean hydrogen ecosystem

For countries that have announced national hydrogen strategies, it is imperative that the governments follow through with legislative commitments and regulatory frameworks to enable the transition to low-carbon hydrogen and translate strategy announcements into concrete actions. In addition to legislative commitments, trends have been observed in critical areas such as the hydrogen color conundrum, sectoral preferences for the deployment of hydrogen, bilateral and trade agreements between countries, and financial allocations for the development of a hydrogen ecosystem.

Legislative commitments

The announcement of a hydrogen strategy is one of the key ways to demonstrate a commitment to the adoption of low-carbon hydrogen pathways. It has been observed that embedding and aligning these commitments within existing or new legislation and regulatory frameworks can ensure that these strategies are implemented effectively. Such strategies supported through legislative commitments can ensure that objectives and targets for medium- and long-term low-carbon hydrogen adoption are met.

Countries are developing a range of regulatory frameworks to catalyze clean hydrogen adoption. For example, South Korea has legeslatively supported the government's promotion of clean hydrogen and the implementation of safety standards for facilities through the Korean National Assembly and passed the Hydrogen Economy Promotion and Hydrogen Safety Management Law ("the Hydrogen Law") in January 2020. This Hydrogen Law or Act is the central legislation ensuring that the Korean hydrogen strategy is supported with incentives, as promised. Korea's Hydrogen Act is also supported by its Renewable Energy Act, which covers all other aspects that do not come under the purview of the Hydrogen Act.

Other countries such as the United States have an existing legislation (Energy Policy Act, 2005) and are also developing new legislation (Hydrogen for Ports Act of 2021) to support their clean hydrogen programs, further strengthening the role and scope of adoption of clean hydrogen. As of 2022, the United States has also announced, within the Infrastructure Investment and Jobs Act & Inflation Reduction Act, provisions to enable and accelerate clean hydrogen adoption. Such legislative commitments have also been made by other countries, as highlighted in blue in Figure 2.

Entry points of action: Countries that are in the process of drafting hydrogen strategies and roadmaps must also consider aligning their strategic commitments with existing legislations and regulatory frameworks to prevent the development of future bottlenecks in the supply and demand of clean hydrogen and its derivatives.

FIGURE 2 | Dedicated strategies for hydrogen

COUNTRIES	STRATEGY UNDER DEVELOPMENT	STRATEGY PRESENT
India		✓
European Union		✓
Australia		✓
Germany		✓
South Korea		✓
New Zealand		✓
Netherlands		✓
Chile		✓
France		✓
China		✓
Japan		✓
Uraguay		✓
South Africa		✓
Russia		✓
United States		✓
Saudi Arabia	✓	

Source: Hydrogen strategies of different countries.

The hydrogen color conundrum

Most countries want to use low-carbon hydrogen as a tool to drive decarbonization of hard-to-abate sectors, with some aiming to further explore hydrogen's export capabilities over the coming decades as the global market for low-carbon hydrogen and its derivatives grows.

Depending on the domestic availability of resources (fossil fuels, renewable energy, nuclear) and the economic capabilities of countries, hydrogen strategies target specific hydrogen production pathways. The color conundrum around clean/green/low-carbon hydrogen currently exists globally, and the color focus of countries depends on factors like carbon intensity thresholds, domestic demand, and the availability of resources and technology. Figure 3 shows the hydrogen color spectrum.

FIGURE 3 | The hydrogen colour spectrum

COLOR	FEEDSTOCK DESCRIPTION
	Gray - Natural gas reforming without CCUS
	Brown - Brown coal or Lignite
	Blue - Natural gas reforming with CCUS
	Green - Electrolysis powered through renewable energy
	Pink - Electrolysis powered through nuclear energy
	Turquoise - Methane pyrolsis
	Yellow - Electrolysis powered through electricity from solar
	Orange - Electrolysis powered through electricity from wind

Source: Compiled from different sources by WRI India.
Notes: CCUS- Carbon Capture Utilization and Storage.

Although there is a lack of consensus on the assigned color codes, some countries have a strategic focus/preference for adopting clean/low-carbon hydrogen. As the market evolves, countries are looking torwards transitioning to low-carbon hydrogen production pathways, leading to the development of a clean hydrogen economy. For example, countries such as Japan are more concerned about the cost and carbon intensity of hydrogen production based on the feedstock rather than on the assigned color code.

The blue hydrogen pathway on the other hand, has been observed to also have policy relevance in countries such as Canada, which has an existing natural gas (NG) infrastructure. Norway and nations from the Middle East are focusing on transitioning to blue hydrogen to capitalize on their existing resource availability and operations.

Countries with abundant RE potential such as Australia, India, Uruguay, and Chile want to directly transition to green hydrogen because of their low-cost and efficient RE network. The Uruguayan hydrogen policy aims for a direct transition to green hydrogen because more than 90 percent of its electricity generation comes from renewables such as wind, solar, hydro, and biomass.

Countries with limited NG and RE potential are also exploring brown hydrogen with carbon capture utilization and storage (CCUS) in an effort to meet the projected hydrogen demand for domestic applications, as shown in Figure 4.

The currently high prices of NG,coupled with higher costs and efficiency concerns around CCUS-based technolgoies, are making countries shift their strategic focus from blue hydrogen making the case for green hydrogen stronger.

However, Norway is aiming to pursue blue hydrogen (due to its high NG reserves) and plans to export both blue and green hydrogen in the coming years.

FIGURE 4 | Transition across hydrogen production pathways

GEOGRAPHY	HYDROGEN PRODUCTION PATHWAYS				
Japan	● (gray)	→	● (green)	● (blue)	● (brown)
South Korea	● (gray)	→	● (green)	● (blue)	
Australia	● (gray)	→	● (green)	● (blue)	● (brown)
New Zealand	● (gray)	→	● (green)	● (blue)	
Norway	● (gray)	→	● (green)	● (blue)	● (brown)
Germany	● (gray)	→	● (green)		
Portugal	● (gray)	→	● (green)		
Netherlands	● (gray)	→	● (green)	● (blue)	
Canada	● (gray)	→	● (green)	● (blue)	
India	● (gray)	→	● (green)		
China	● (gray)	→	● (green)	● (blue)	● (brown)
United Kingdom	● (gray)	→	● (green)	● (blue)	
United States	● (gray)	→	● (green)	● (blue)	● (brown)
France	● (gray)	→	● (green)		
European Union	● (gray)	→	● (green)	● (blue)	
Chile	● (gray)	→	● (green)		

COLOR	FEEDSTOCK
● (gray)	Gray : Natural gas reforming without Carbon Capture Utilization and Storage (CCUS)
● (green)	Green : Electrolysis powered through renewable electricity
● (blue)	Blue : Natural gas reforming with CCUS
● (brown)	Brown : Brown coal (lignite) as feedstock

Source: Hydrogen strategies of different countries.

A lack of consensus on feedstock-associated hydrogen production pathways is currently a major impediment to the development of a global hydrogen economy. It can also act as a barrier to international trade in hydrogen and its derivatives.

Entry points of action: Instead of focusing on the color, one possible solution would be to measure hydrogen's carbon intensity or carbon footprint across its production process. This approach is already taking shape in Australia, the EU, and the United States through their hydrogen certification schemes. Hydrogen classification based on this carbon intensity approach is a benchmarking tool to measure (in metric tons) the carbon dioxide equivalent emitted per metric ton of hydrogen produced.

A technology-neutral/agnostic criterion is currently being adopted by a few countries, and a global consensus on this certification mechanism will be critical to enable global tradability of hydrogen. Global agreement on a mechanism to measure the carbon intensity of hydrogen production pathways can create opportunities for competitiveness and drive cost reduction across low-carbon hydrogen production processes.

Sectoral preferences

Hydrogen's decarbonization capabilities across various sectors as a fuel for energy and feedstock make it a versatile vector for application in many areas, including industrial decarbonization, power, heating, and mobility. Global demand for hydrogen is currently 94 MMT, with refineries (40 MMT) and ammonia production (34 MMT) accounting for the majority of this demand, which is projected to increase in the coming years. As almost all this demand is met by fossil-based hydrogen, it is critical that the upcoming demand from these bulk consuming sectors be met through low-carbon/green hydrogen to limit emissions.. For example, in India, the demand for hydrogen in the refinery and fertilizer sector is currently 5.2 MMT and is expected to reach 11.7 MMT by 2030.

Hence, replacing this gray hydrogen with green hydrogen is critical for these sectors to drive deeper sectoral decarbonization in the initial stages of clean hydrogen adoption. India's National Green Hydrogen Mission focuses on decarbonizing its fertilizer sector using green ammonia. This would be followed by sectors such as transport (heavy trucking, long-distance vehicles, and shipping), steel, and power (where green hydrogen can be used as an energy storage medium).

Published hydrogen strategies reveal the following key drivers that determine the sectoral preferences:

- RE integration
- Cost and ease of adoption
- Need for diversification of energy systems
- Sectoral decarbonization targets

Based on the above factors, it is observed that sectoral adoption varies significantly across countries. For instance, industry focuses on clean hydrogen deployment due to its ease of adoption. Similarly, many countries are interested in hydrogen's applications due to the decarbonization opportunities clean hydrogen enables in long-haul mobility. Using clean hydrogen and replacing NG and other fossil fuels also improves national energy security. These are a few of the factors driving countries to align their policy and investment focus with clean hydrogen applications.

In most countries, green hydrogen adoption across refining, fertilizers, steel, chemicals, and heavy mobility applications (trucks and buses) has an aggressive policy outlook, whereas energy storage, heating, and aviation have a more long-term focus. Short- and medium-term hydrogen applications have a strong commercial investment priority, whereas long-term applications have a strong R&D investment focus, both from public and private investors.

In India, pilot projects to test the technological readiness and project viabilities of green hydrogen before its large-scale deployment have been planned for sectors such as refinery and fertilizers, which are currently the biggest consumers of gray hydrogen, alongside new applications such as long-haul mobility and power generation. With the goal of shifting from existing fossil-based hydrogen applications in refineries and fertilizers, India aims to target these two sectors for green hydrogen adoption in the initial stages. This will stimulate demand, aiding green hydrogen cost reduction as economies of scale are attained and the offtake increases. The plummeting cost of green hydrogen will further encourage adoption in niche applications where demand does not currently exist.

Depending on the technological readiness, the urgency to decarbonize, and the cost economics associated with hydrogen adoption, sectoral adoption varies globally. The adoption strategy can either be aggressive, mild, or focused on long-term policy and investments, as shown in Figure 5.

Entry points of action: Depending on their decarbonization goals, countries must actively include clean/green/low-carbon hydrogen in their clean energy mix and decarbonization strategies so that the associated policy, regulatory, and financial support can be well aligned. Identification of the most feasible sectors for cost-effective and timely adoption of clean hydrogen will be critical to boost both supply and demand in the early years of adoption. The pace of transition to a clean hydrogen-based economy will be based on two key parameters: cost and ease of adoption.

Understanding these two parameters and further identifying the sectors where they make the strongest financial and environmental impact will be pivotal to driving initial demand creation. The initial demand creation will be the key cost reduction driver for the adoption of clean hydrogen in newer applications.

FIGURE 5 | Sectoral adoption preference

COUNTRY	POWER GENERATION	HEATING APPLICATION	INDUSTRY			TRANSPORT					
			IRON & STEEL	CHEMICAL FEEDSTOCK	REFINING	CARS	TRUCKS	BUSES	RAIL	MARITIME	AVIATION
European Union	Slow	Slow	Long term	Aggressive	Aggressive	Slow	Aggressive	Aggressive	Aggressive	Long term	Long term
Australia	Slow	Aggressive	Long term	Aggressive	Absent	Slow	Aggressive	Aggressive	Aggressive	Long term	Slow
Germany	Absent	Slow	Aggressive	Aggressive	Aggressive	Slow	Aggressive	Aggressive	Slow	Long term	Long term
Japan	Aggressive	Aggressive	Slow	Slow	Slow	Aggressive	Aggressive	Long term	Slow	Slow	Slow
South Korea	Aggressive	Slow	Slow	Absent	Absent	Aggressive	Aggressive	Aggressive	Slow	Slow	Absent
Canada	Slow	Aggressive	Aggressive	Aggressive	Aggressive	Long term	Aggressive	Aggressive	Long term	Long term	Long term
Norway	Absent	Slow	Aggressive	Aggressive	Slow	Slow	Slow	Slow	Absent	Aggressive	Slow
Portugal	Slow	Aggressive	Aggressive	Aggressive	Aggressive	Long term	Aggressive	Aggressive	Aggressive	Long term	Long term
Netherlands	Slow	Aggressive	Aggressive	Aggressive	Aggressive	Long term	Aggressive	Aggressive	Aggressive	Slow	Slow
Chile	Absent	Aggressive	Aggressive	Aggressive	Aggressive	Absent	Aggressive	Aggressive	Absent	Long term	Long term
France	Absent	Slow	Aggressive	Aggressive	Aggressive	Long term	Aggressive	Aggressive	Slow	Slow	Slow

Absent | Aggressive | Long term | Slow

Source: Compiled from hydrogen strategies by different countries.

Bilateral agreements

For a globally competitive market advantage, it is critical to leverage existing bilateral relationships and form new ones, which will provide an impetus to the global clean hydrogen ecosystem. Some of the crucial areas of common interest are the following:

- Partnerships across R&D activities
- Low-cost technology transfer
- Joint demonstration projects
- Open raw material trade agreements
- Harmonization of standards and regulations

Currently, most partnerships seek to work on common projects to develop the supply chain and initiate joint R&D efforts to leverage each other's knowledge economies. Such bilateral agreements will enable cross-border collaborative climate action. Figure 6 shows the current bilateral agreements among various countries.

Experts from the EU believe that public private partnerships (PPPs) will play a pivotal role in aligning the strategic interests of industries, academia, and governments across the EU member states. PPPs can enable the EU to implement its hydrogen roadmap by developing such bilateral partnerships. Business-to-business partnerships have been observed to be critical in bringing private stakeholders together. Some successful examples of PPPs in the EU include a partnership between Toyota and Air Liquide to deploy hydrogen taxis in Paris in collaboration with the French government.

Another example is the electrolyzer partnership ITM Linde Electrolysis GmbH, a joint venture between Linde and ITM Power that enables electrolyzer manufacturers and green hydrogen producers to collaborate. Rotterdam Port is an example of a PPP mode of development of hydrogen infrastructure. The Rotterdam Port Authority, which is supported by other port-based operators, has collaborated with industrial groups

FIGURE 6 | International bilateral agreements

Source: Ministry of New and Renewable Energy Government of India, Clean Hydrogen Partnership EU, Ministry of Foreign Affairs of Japan.

from the Middle East (such as Aramco and AD Ports Group), electrolyzer manufacturers (such as Shell, BP, and Air Liquide) African energy leaders such as the Republic of Namibia. It is in the process of developing a hydrogen port at Rotterdam that will supply Europe with 4.6 million tonnes (Mt) of hydrogen annually by 2030, which is 40 percent of the European Commission's target.

Similar to the EU, the Indian government's focus is also on bilateral agreements, with Europe and countries such as Japan and South Korea as these countries will also create an export market for green hydrogen. Bilateral and multilateral agreements will be the key to success, given the huge investments requirements, for the development of this ecosystem.

Bilateral agreements will also be critical for countries such as South Africa, which is richly endowed with platinum group metals (PGMs) and accounts for over 75 percent of the global PGM reserves. PGMs will play a critical role in meeting global electrolyzer capacity and hydrogen production targets.

Entry points of action: Bilateral partnerships will enable countries to collaborate on various aspects of the value chain and leverage each other's development potential. These partnerships should include R&D, raw material trade, technology transfer, and joint demonstration projects. Countries can also leverage multi-lateral forums such as the G7, the G20, and the QUAD (Quadrilateral Security Dialogue) to further their cooperation across the hydrogen value chain. Some countries are already working in this direction and incorporating hydrogen into their existing energy agreements (Japan and Saudi Arabia), and others are exploring new hydrogen-specific partnerships (India and France). Countries such as South Africa intend to capitalize on the availability of its PGMs to build robust domestic manufacturing/supply chain capabilities.

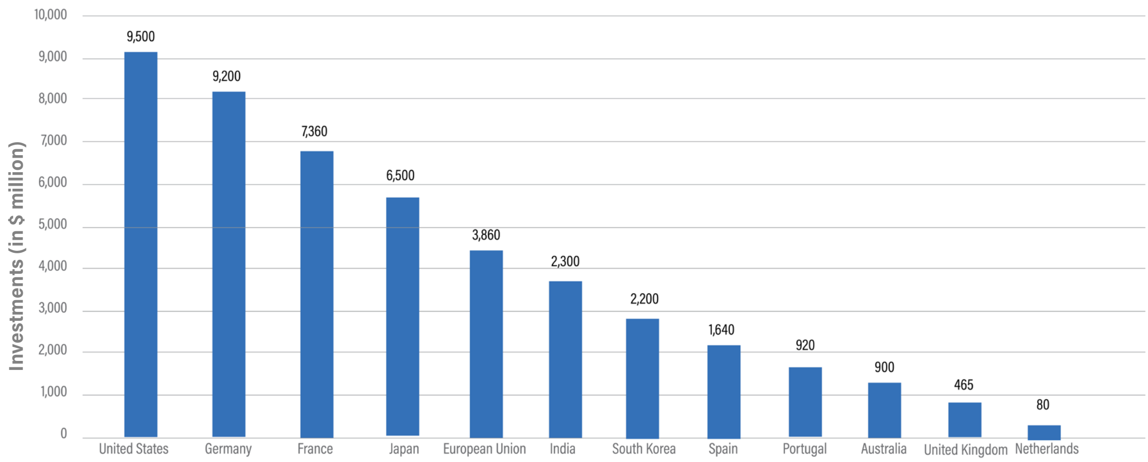
Funding

Announcements of investments across the hydrogen ecosystem have never been higher. Compared to the trajectory solar and wind have seen in terms of capital expenditure (CAPEX) costs, and capacity installations, hydrogen is still in its infancy. However, the investment pipeline is expected to grow as decarbonization strategies crystallize. Governments are now stimulating interest in the sector, with private players further stepping up their investments. Globally, governments, in tandem with private stakeholders, are aiming to develop production facilities, industrial clusters, hydrogen hubs, and refueling and pipeline infrastructure, thus laying a solid foundation for a clean hydrogen economy. It is important that the initial projects focus on sectors and applications where the cost of adoption is lower but the ease of adoption is higher. The recently announced draft national hydrogen strategy in the United States has a public federal funding of $9.5 billion, apart from several value-chain-specific program fundings.

To aggregate production and applications, some countries are also planning to develop integrated hydrogen hubs. Australia, for example, has launched a Federal Hydrogen Hubs program, with a funding of $310 million, to support the development of seven hydrogen hubs with $47 million each. Like Australia, the United States has also announced $7 billion to establish 6 to 10 clean hydrogen hubs under The Regional Clean Hydrogen Hubs or H2Hubs Program. Aggregated hydrogen supply and demand are critical enablers in the concept of co-location, which will eventually help bring down the cost of clean hydrogen. Such aggregated supply and demand can be achieved by developing hydrogen hubs at critical locations, where the cross-sectoral demand and export potential can be leveraged.

Figure 7 shows the public investment commitments that countries have made toward developing their domestic clean hydrogen ecosystem.

FIGURE 7 | Global public investment in clean hydrogen



Source: IEA, Global Hydrogen Review 2021.

Import-focused countries such as Japan and South Korea are planning to tie up with regions where low-carbon hydrogen can be produced most cost-effectively. Their focus for investments is correspondingly linked to countries that have announced the development of international supply chains for the production and export of hydrogen.

Feasibility studies are being conducted to further understand the best source of hydrogen as the global supply chain develops. For example, Germany's Federal Ministry of Economic Affairs and Climate Protection (BMWi) has approved $955 million for the innovative funding instrument called the H2Global to cost-effectively import green hydrogen into the EU. The program aims to meet EU's demand for renewable hydrogen, which is expected to significantly increase in the coming years, by supporting the development of unexploited renewable resource potential. The program will use a novel double auction procedure to cost-effectively import green hydrogen via a competitive process and long-term contracts.

Public funding for developing a low carbon, hydrogen ecosystem must thus address the economic viability of the initial projects. Robust financing frameworks must be developed to balance risk-sharing mechanisms among stakeholders. This public funding should be channelized toward ensuring risk mitigation in the initial projects, enabling early adoption of clean hydrogen technologies and further aiming to drive cost reductions to attain commercial parity with fossil-based hydrogen applications.

Initially, the technology development, demand, and financial risks will have to be borne by the public sector; over time, this can shift toward the private sector as the understanding of both project economics and technology evolves. As the sector matures with initial public funding, PPIs and investment models will be critical given the size of the investment requirements and other competing socioeconomic priorities in some countries. Such a cohesive public-private model will also ensure that the unique features of each sector are addressed.

Entry points of action: Technological readiness and technical complexity across hydrogen's value and supply chains, coupled with an urgent demand for clean hydrogen from a decarbonization perspective across countries, point toward a large funding requirement from an array of sources, including PPIs, clean energy funds, sovereign climate bonds, and institutional debt financing.

Allocation of public funding for procuring low-carbon hydrogen can act as an initial demand driver and establish a market by stimulating private investments in the sector. Committed public investments will also play a key role in driving confidence and investments from stakeholders such as oil and gas, automobile and fuel cell manufacturers, RE manufacturers and system integrators, and electrolyzer manufacturers. Public investments should clearly specify priority areas of investments across the value and supply chains and allocate funds explicitly to niche and key segments including hydrogen pipelines, refueling infrastructure, R&D (hydrogen storage and distribution), hydrogen hub development, and knowledge economy dissemination. A targeted funding outlook will also attract foreign direct investment and clean energy funds across the globe.

NEXT STEPS

- PPP frameworks and consortiums will be critical for overarching hydrogen value chain development (Sara Shah Mohammadi).
- Clean hydrogen's rising demand across countries is projected to require import and export of hydrogen, highlighting the need for bilateral and multilateral agreements and a definition of low-carbon/clean/green hydrogen (Mr. Pawan Mulukutla, Dr. Nicholas Musyoka, Dr. Perminderjit Kaur).
- Hydrogen hubs will act, a critical integration infrastructure for the supply and demand of clean hydrogen, enabling cost reduction and guaranteed offtake (Dr. Fiona Simon).
- Countries with vast RE potential are looking at hydrogen as both a decarbonization vector and as a fuel to export, aiming to align these two priorities through their strategies (Dr. Fiona Simon).
- The implementation of R&D and demonstration projects was identified to be the key enablers to the evolution of domestic hydrogen ecosystems (Manoj Upadhyay).
- To enable the development of resilient hydrogen supply chains, policies to promote development of domestic electrolyzer manufacturing capabilities and demand generation catalysts would play a critical role (Manoj Upadhyay, Sara Shah Mohammadi).
- Legislative commitments aligning with the national hydrogen strategies will be critical to drive on-ground implementation.
- Cost reduction across the entire value chain would be the game changer in hydrogen adoption (Sara Shah Mohammadi).
- National policies combined with subnational policies and product-linked incentives will enable easy adoption of hydrogen (Maria Jose Gonzalez, Dr. Perminderjit Kaur).

- Public policies should incentivize early suppliers and off-takers of clean hydrogen to enable quicker and wider adoption of hydrogen at scale and further drive private investments into the sector (Maria Jose Gonzalez).
- Sending marker signals through clear policy directions to the private stakeholders will be critical to stimulate investments. Markets should also avoid reinventing the wheel within the technology space and should leverage technology transfer as an when required.
- Harmonized global safety codes and standards will make the clean hydrogen value chain more robust and promote global trade. Retrofitting the existing infrastructure for the transportation of hydrogen will also help build economies of scale at a global level (Pawan Mulukutla, Dr. Nicholas Musyoka).
- Green jobs will be created with the adoption of green hydrogen, and a just transition is critical to minimize job losses (Pawan Mulukutla, Dr. Nicholas Musyoka, Dr. Perminderjit Kaur).

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Webinar 1 - August 10, 2022

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ABOUT WRI INDIA

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Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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