



2023 Global Hydrogen Industrial Association Alliance

2023 GHIAA Annual Report

January 31, 2024

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Preface and Acknowledgment

This report is an annual report for 2023, published by the Secretariat of the Global Hydrogen Industrial Association Alliance (GHIAA), covering hydrogen trends by country over the year.

The contents of the report were made with contributions from GHIAA members, including representatives of hydrogen industrial associations from 21 countries.

The Secretariat would like to express sincere gratitude to

- H2KOREA
- Fuel Cell & Hydrogen Energy Association
- Hydrogen Europe
- Asociación Chilena de Hidrogeno
- Asociación Española de Hidrógeno
- Australian Hydrogen Council
- Canadian Hydrogen and Fuel Cell Association
- Consortium for the Development of the Hydrogen Economy in Argentina
- France Hydrogène
- Hydrogen and Fuel Cell Association of Singapore
- Hungarian Hydrogen and Fuel Cell Association
- Hydrogen Denmark
- Hydrogen Poland
- International Hydrogen Fuel Cell Association
- Japan Hydrogen Association
- La Asociación Colombiana de Hidrógeno
- Norwegian Hydrogen Forum
- Netherlands Hydrogen and Fuel Cell Association
- The German Hydrogen and Fuel Cell Association
- Hydrogen Energy Association
- Vetgas Sverige

for their dedicated support for the publication of this report.

Greetings from the Chair

It is my great pleasure to publish the 2023 GHIAA Annual Report, which introduces each country's hydrogen economy policy, industrial trends and relevant information. This publication, following the first 2022 Annual Report, includes meaningful updates in data and provides an overview of the political, socio-economical atmosphere of the world of hydrogen. I would like to express my deepest gratitude to the Members who shared their valuable data for this report, and to the Secretariat who showed the seamless efforts in its editing and publication under the outstanding devotion of InJoon Oh.

Now the world has entered a new era of implementing action plans based on the vision and strategy for the development of a hydrogen economy. Many countries are intensifying their policy efforts to establish an ecosystem centered on clean hydrogen. Indeed, clean hydrogen is widely considered as a game changer, even as a catalyst to replace fossil fuels to achieve net zero by 2050. As we expand our use of hydrogen, it will go far beyond its traditional role as a mere energy storage and carrier.

However, we are still facing several challenges which include price competitiveness of clean hydrogen production, barriers regarding technologies and infrastructure for transport, distribution and use of hydrogen. Public awareness could also act as an obstacle in realizing a hydrogen economy. In addition, soaring energy prices and government's financial deficits resulting from the COVID-19 aftermaths and geopolitical risks have significantly discouraged efforts to promote corporate investments.

Nonetheless, positive developments are evident in the global hydrogen market. There is growing consensus on the urgency to actively engage and invest in clean energy transition to decarbonize hard-to-abate sectors utilizing clean hydrogen, including long-haul transport, chemicals, steel, and more. At the same time, I would like to take note of the necessity of specific measures promoting mutual recognition of the clean hydrogen certification scheme and harmonization of technical regulations and standards which are implemented by each government.

As such, the GHIAA will cooperate and collaborate to collect information and share best practices among members by utilizing various means. I look forward to the collaborative efforts and actions of All members of the GHIAA to expedite hydrogen economy this year.



Jae-do Moon

Chair of H2KOREA and Chair of GHIAA

Greetings from the Vice-Chair

January 10, 2024

Dear Fellow Members of the Global Hydrogen Industry Association Alliance (GHIAA):

As I look back on 2023, I continue to be astonished by the immense progress of both our GHIAA member associations and the hydrogen industry at large. The support and momentum behind hydrogen is at a height we have never seen before and is a testament to the work of our associations as leading voices defining industry needs and advancing key policies in each of our countries.

Since GHIAA's founding just over two years ago, we are now twenty-one strong and each of us can take pride in accomplishments within our home countries and throughout the regions we represent from North and South America to Europe, Asia, and Oceania.

Though progress has been strong, there is still much to do. As our industry grows, we will face new forms of competition for our priorities and more than ever, the voices of national trade associations are a vital means of communication among industry and government. While new policies and the drive to decarbonize have led to new investments and announcements of activity, those policies will need improvement as our industry continues to scale. Our participation in GHIAA offers the opportunity to share the best ideas among our members and our respective regions, and to expand the inventory of these ideas globally. Cooperation and communication among our membership is at the heart of GHIAA.

The hydrogen industry could not have risen to this level of acceptance and momentum without all of your hard work and innovation.

I look forward to collaborating with you in 2024 to expand our ideas, grow GHIAA membership and continue the progress of hydrogen across the globe.

Sincerely,



Frank Wolak

President & CEO, Fuel Cell and Hydrogen Energy Association
Vice Chair GHIAA

I. Introduction of GHIAA

Faced with the global climate crisis, many countries are promoting decarbonization policies with hydrogen at the fore. Accordingly, the representative hydrogen industrial associations of 21 countries shared a deep understanding of the importance of private-sector cooperation for accelerating the implementation of the global hydrogen economy, and agreed to use GHIAA as the platform for communication.

GHIAA was officially launched on May 25, 2022 to strengthen international private cooperation within the hydrogen industry. Initiated by H2KOREA, a global consensus among hydrogen associations around the world was first established on the H2 Mobility+Energy Show by signing a LOI in September 2021.

After six months, laying the groundwork including the establishment of the Articles of Association and a website, GHIAA was officially inaugurated with a total of 18 Members. On the same day, the 1st General Meeting was held to issue the Articles of Association, which set the groundwork for GHIAA and its Secretariat. In addition, Jaedo Moon, the Chair of H2KOREA, was appointed as the first Chair, and Frank Wolak, the President & CEO of FCHEA, was appointed as the Vice-chair.

Jorgo Chatzimarkakis, the CEO of Hydrogen Europe, was appointed for the one vacant Vice-chair position at the 2nd General Meeting which was held in October 2022 in Belgium, fulfilling the three seats of the GHIAA Chairs. Meeting COP 27, a joint statement was issued to call for actions of the participating countries and related stakeholders to implement the hydrogen industry. In addition, in order to share recent information of international hydrogen industry, the members agreed to publish an annual report.

The 3rd General Meeting was held in California on February 2023, during Hydrogen & Fuel Cell Seminar, where Dolf Gielen, the Hydrogen Lead in the World Bank, participated as a special speaker and introduced the Hydrogen for Development Partnership(H4D), an initiative to boost the development of low-carbon hydrogen in developing countries. GHIAA also expanded to the total of 20 members.

The 4th General Meeting and the Forum was held during the H2MEET, Korea on September 2023. Each association from 8 different countries introduced its recent national hydrogen policy and projects. GHIAA released the joint declaration in Seoul to urge the global coordination and the financial support to realize the hydrogen economy in the near future. GHIAA was also expanded to the total of 21 members.

Members of GHIAA



Korea



USA



EU



Chile



Spain



Australia



Canada



Argentina



France



Singapore



Hungary



Denmark



Poland



China



Japan



Colombia



Norway



Netherlands



Germany



UK



Sweden

II. Introduction of GHIAA Members

H2KOREA
Republic of Korea



■ General Information

- Chair: Jaedo Moon
- H2KOREA, the private-government consultative organization, was established in 2017 to promote hydrogen production, storage, supply and utilization. The organization was designated as a designated hydrogen promotion organization on July 2020 under the Hydrogen Law to promote hydrogen economy in Korea.
- 158 partners, including public/private enterprises, research institutes, local governments, etc.



■ Business Area

- Revision of the law and government policy, including Hydrogen Law, National Roadmap and Strategy, certification scheme, etc.
- Foster and support hydrogen-specialized enterprises; matching domestic companies with abroad, supporting domestic companies to enter overseas markets etc.
- Research on hydrogen technology, mobility and energy infrastructure, standardization, etc.
- Plan and Investigate activities for FCEV-related Projects at domestic and abroad
- Provide statistics on hydrogen, hydrogen charging stations, hydrogen electric vehicles, and related information

■ Basic Information

- President & CEO: Frank Wolak
- Chairman: Andy Marsh, CEO, Plug Power
- The Fuel Cell and Hydrogen Energy Association (FCHEA) is the national hydrogen and fuel cell industry association in the United States representing more than one hundred leading organizations advancing production, distribution, and use of innovative, clean, safe, and reliable hydrogen energy.
- FCHEA originated in 1989 as the National Hydrogen Association, which later merged in 2010 with the U.S. Fuel Cell Council, which was formed in 1998, to become FCHEA.
- The mission of FCHEA is to advance the commercialization of and promote the markets for fuel cells and hydrogen energy.

■ FCHEA Activities Areas

- FCHEA is focused on achieving our mission through three primary activities:
 - Leading national advocacy to encourage all levels of government in the United States to support fuel cell and hydrogen technology research, development, and deployment.
 - Providing a unified voice in shaping regulations, codes, and standards to enable commercial growth, while ensuring the highest levels of consumer safety and satisfaction; and
 - Educating the public and key opinion and policy leaders on the economic and environmental benefits of fuel cell and hydrogen technologies.
- FCHEA's policy priorities focus on three main pathways to further drive the industry forward:
 - Tax Incentives to drive private investment and adoption;
 - Infrastructure programs to expand deployment of hydrogen and fuel cell technologies at scale; and
 - Securing appropriations funding to advance hydrogen and fuel cell research, development, demonstration, and deployment.
- To achieve these goals, FCHEA operates a number of technical Working Groups and Committees, collaborating with our members on specific initiatives and regulatory efforts to help the industry thrive.
- FCHEA runs two committees focused on advocacy and stakeholder outreach and education: the Government Affairs Committee and the Communications and Marketing Committee.
 - The Government Affairs Committee engages and educates U.S. federal and state decision makers and opinion leaders to provide support for federal and state hydrogen and fuel cell funding, policy initiatives, incentives, and regulations.
 - The Communications and Marketing Committee is focused on expanding awareness of fuel cell and hydrogen technologies to a range of audiences, including media, potential partners, and end users.

- FCHEA operates five market sector Working Groups, each covering a major area of the hydrogen and fuel cell industry. Two groups address hydrogen production and distribution three groups cover the use of hydrogen across power generation, transportation, and commercial applications.
 - Production: Reflecting the diversity of clean hydrogen production pathways, both from traditional and renewable feedstocks.
 - Distribution: Hydrogen distribution, compression, and storage.
 - Power: Confluence of hydrogen, fuel cells, and power markets both as a production vector and end-use market.
 - Transportation: All applications of hydrogen and fuel cell transportation across land, sea, and air.
 - Commercial: Intersection of hydrogen and emerging markets for commercial processes like steel and cement production, use of hydrogen as a chemical feedstock such as ammonia, hydrogen for heating, and others.
- Each of these Working Groups is focused on not only the technical codes and standards needs for each industry segment but also provides a forum for discussion of the range of other challenges and opportunities that these sectors face, including policy needs and stakeholder outreach development. Once issues are identified, they may be raised for further action either within the working group or for action by the Government Affairs Committee or Communications and Marketing Committee.

■ Basic Information

- CEO : Jorgo Chatzimarkakis
- Hydrogen Europe is the European association representing the interest of the hydrogen industry and its stakeholders and promoting hydrogen as an enabler of a zero-emission society. With more than 400+ members, including 25+ EU regions and 30+ national associations, we encompass the entire value chain of the European hydrogen and fuel cell ecosystem. Our vision is to propel global carbon neutrality by accelerating European hydrogen industry.
- 431 members, including private companies, government agencies and academic and research institutions

■ Mission

Hydrogen Europe's mission is to

- enable the adoption of clean hydrogen as an abundant and reliable energy carrier and feedstock which efficiently fuels Europe's net-zero economy;

- bring together diverse players, large enterprises and small and medium-sized enterprises, national hydrogen associations, non-governmental organisations, regional public authorities and other relevant organisations which support the delivery of clean hydrogen and fuel cells technologies;
- promote national, European and international policies and initiatives that strengthen market penetration of European hydrogen technologies domestically and globally;
- promote and coordinate research, development and innovation of reliable clean hydrogen technologies;
- be the trusted and united voice of the European hydrogen sector through the joint efforts of its Members at European level;
- be the driving force for the future direction of the hydrogen sector, creating sustainable jobs and growth.

H2Chile Chile



■ H2 Chile - Chilean Association of Hydrogen

Founded in 2018 as a non-profit association, it seeks to accelerate the energy transition by promoting the use of renewable hydrogen (H₂R) and its derivatives in industrial, commercial, residential, and mobility applications that enable the decarbonization of the economy.

Our vision is to be a promoter of zero-emission development in Chile and the world, and it aims to position Chile as one of the leading countries in the production and export of renewable hydrogen.

Our members come from the private, public, and academic sectors, with 40 professional partners and around 100 leading companies. With the current partners, H2 Chile can cover the entire value chain of renewable hydrogen.



Logo update
November 2023

■ Our strategic focuses

To achieve our mission, we work on five strategic focuses to strengthen the hydrogen ecosystem:

1. Collaborate in the creation of public policies
2. Facilitate the availability of financing
3. Stimulate the concretion of projects
4. People awareness and capacity building
5. National and international collaboration networks

- Our value proposal

- Support the coordination of a strategic agenda that allows the transition to a renewable hydrogen economy.
- Public-private collaboration with academia.
- Promote the production and use of renewable hydrogen in all its forms: storage, transportation, energy, and fuel.
- Be part of a network of companies and professionals linked to the value chain of renewable hydrogen.
- Provide networking opportunities among various key players in the national and international renewable hydrogen industry.
- Encourage and participate in instances that enable collaboration among various international actors.

The map of renewable hydrogen projects in Chile



■ Areas of action

The objectives of the AeH2 are to foster the development of hydrogen as an energy vector and its use in industrial and commercial applications. To that end, AeH2 works in these areas:

- Cluster: gathering the sector, bringing together companies, institutions, technology and research institutes, and universities, with activity in hydrogen and fuel cells.
- R&D: promoting research and innovation in hydrogen and fuel cells, as well as the promotion of startups and technological knowledge.
- Development: supporting the development, and promoting the production, storage, and distribution applications of hydrogen, and its use in fuel cells.
- Education: Offering professional education through specific courses already consolidated with various universities and training centres.
- Legislation: Promoting laws and rules for the regulation of hydrogen as an energy vector.
- Dissemination: making hydrogen is acknowledged as an energy vector by our society.

■ The AeH2 supports research and development, technology demonstration, and market introduction impulse of hydrogen energy. To reach its objectives, the AeH2 carries out different activities:

- Expertise and promotion.
- Organization and participation in conferences, seminars, and meetings.
- Boosting the national sector.
- Promotion and education.
- Lobbying for hydrogen and fuel cells.
- Facilitation of contacts with companies from Spain and abroad.
- Networking.

■ AeH2 is the leader of initiatives such as:

- The Spanish Technological Platform of Hydrogen (Pte H2), managed by the AeH2, is fostered by the Spanish Ministry of Science and Innovation. Its objective is to promote technological R&D in the hydrogen and fuel cell sector in Spain. The Platform is in contact with the Public Administration to convey the needs of the sector and the priority lines of action in R&D&I to promote the development and implementation of these technologies in our country. In 2022, a restructuring of the Platform took place for the Call for Platforms 2023-2024, in which it was agreed to reformulate its name, mission, objectives, and structure.
- The Hydrogen Industry Sector Agenda is a document that aims to be an agreed-upon document between the different stakeholders, including public organisms companies, financing entities, etc. The agenda is a public-private collaboration instrument that aims to reflect a shared and consensual vision of the state of the sector, its competitive keys, and the most important measures and lines of action to boost the sector. The document is currently under revision by the Ministry of Industry.

- The Technical Committee for Standardization CTN 181 on Hydrogen Technologies (Mirror Committee of the International Committee ISO TC 197) is the Committee responsible for standardizing all those aspects related to systems and devices for the production, storage, transport, distribution, measurement, and use of hydrogen. The AeH2 has held the Technical Secretariat of the CTN 181 since its launch in February 2005. Miguel A. Pea, Secretary of AeH2, has been the Committee's Chairman since June 2019.
- The AeH2 Regulatory Working Group worked to stimulate and promote the definition of a regulatory environment for projects incorporating hydrogen technology, in addition to aspects of financing, taxation and even contracting authorities and contracting entities in public procurement related to certain road transport vehicles. The final report is launched on the AeH2 website.
- The EHEC (European Hydrogen Energy Conference) is Europe's conference of reference in the field of hydrogen energy. Hosted every two years, EHEC is organized by the Spanish Hydrogen Association (AeH 2 and brings together experts, researchers, and industry leaders in the field of hydrogen, providing a platform for sharing the latest advances, innovations, and developments in hydrogen-based technologies. After the great success of the EHEC 2022 which saw over 1100 attendees and featured 200 speakers from across the entire hydrogen value chain, we are proud to announce the next edition of EHEC 2024, which will be held in Bilbao (Spain) on the 6th, 7th, and 8th of March 2024.
- The Hydrogen Project Census was one of the most important initiatives of hydrogen in Spain in 2023. Through this activity, the aim was to contribute to the dissemination of information at the national and international levels of the sector, to highlight the collaborative relationships between the different groups and/or partners, and to favour the sharing and contact of interested parties. Phase I consisted of the compilation of demonstration projects (TRL 7 or higher), which can contribute to the achievement of the objectives of green hydrogen implementation in the short to medium term set out in the Spanish Hydrogen Roadmap. This phase ended with an interactive map and a final report on the AeH2 website.
- The Association also participates in the project GREEN HYSLAND, which aims to deploy a fully functioning Hydrogen (H₂) ecosystem on the island of Mallorca, Spain, turning the island into Europe's first H₂ hub in Southern Europe. AeH2 mainly participates in the performance and elaboration of the communication, dissemination, and exploitation activities of the project: Work Package 7 (WP7), led by FEDARENE. International collaborations: AeH2 maintains collaboration and cooperation relations with international organizations, intending to know the state of development of hydrogen technologies in different parts of the world transmit good practices to our partners, and promote the implementation of these technologies in Spain. In addition, it seeks to promote opportunities for commercial cooperation in the hydrogen sector with other countries. In the picture below, some of the countries with which the AeH2 has a collaboration agreement:



Australian Hydrogen Council Australia



■ General Information

CEO: Dr Fiona Simon

The Australian Hydrogen Council, or AHC, is the peak body for the clean and green hydrogen industry in Australia. With over 100 members, we represent the emerging hydrogen industry, connecting its stakeholders to collectively create a clean and resilient energy future that has hydrogen as a key part of the energy mix. AHC members are companies from the energy, transport, technology, consulting, and financial sectors. We work closely with all levels of government to develop the policy, funding, and regulatory settings to enable the hydrogen industry.

Please see
<https://h2council.com.au/our-members/>
 for a full list of members.



■ Business Area

- Advancing Australia's development as a global hydrogen leader
- Promoting policies that fast-track the transition to clean and renewable hydrogen technologies
- Enhancing domestic and international collaboration across industry, government, academia, and the broader community
- Becoming the recognised and influential authority in the clean hydrogen sector.

Canadian Hydrogen and Fuel Cell Association Canada



■ Basic Information

- President and CEO: Ivette Vera-Perez

The Canadian Hydrogen and Fuel Cell Association (CHFCA) is a national association that supports industry, academia, government agencies, financial organizations, and other stakeholders focused on hydrogen and fuel cell technologies and products. As the collective voice of Canada's world-leading hydrogen and fuel cell sector, the CHFCA's mission is to strengthen Canadian leadership, raise awareness of the benefits of the technology, and accelerate the adoption of its members' products and services in Canada and abroad. The

CHFCA currently has 160+ members across Canada and regional affiliates in British Columbia, Alberta, Ontario and Quebec

160+ members, including industry companies, government agencies and academic and research institutions

■ Business areas

Our mission is to champion the Canadian hydrogen and fuel cell sector and accelerate the adoption of our members' products and services, in Canada and abroad, by:

Enhancing business opportunities for members through networking and market development opportunities;

Promoting the economic, environmental and societal benefits of hydrogen and fuel cell energy solutions with policy makers to create an enabling environment for their increased adoption;

Supporting the development of regulations, codes and standards to ensure the safe and widespread application of hydrogen and fuel cell products; and, Increasing the literacy of hydrogen and fuel cells through relevant communications channels so businesses, investors, media, the general public and other stakeholders understand their relevance and opportunities within the energy sector.

H2ar Consortium Argentina



■ Basic Information

- Leading company: Y-TEC
- H2ar Consortium is a collaborative workspace between companies that are interested in developing the hydrogen economy in Argentina. It was established in October 2020. It is organized in 8 working cells, led by Y-TEC.
- 60 companies, as well as 10 public entities acting as collaborators.

■ Our main goals are:

- To unify a medium- and long-term common view to align efforts and reduce uncertainty for new implementations and business opportunities
- Create techno-economical models to calculate costs related to hydrogen production, transport, and end use.
- To promote pilot projects to boost the early uptake of these new markets.
- To collaborate with public entities in terms of regulation, normative and new developments, leading the voice of the industry

CURRENT MEMBERS



Further information: <https://y-tec.com.ar/#/somos-y-tec/en/h2ar>

Point of contact: H2ar@ypftecnologia.com

France Hydrogène France



■ General Information

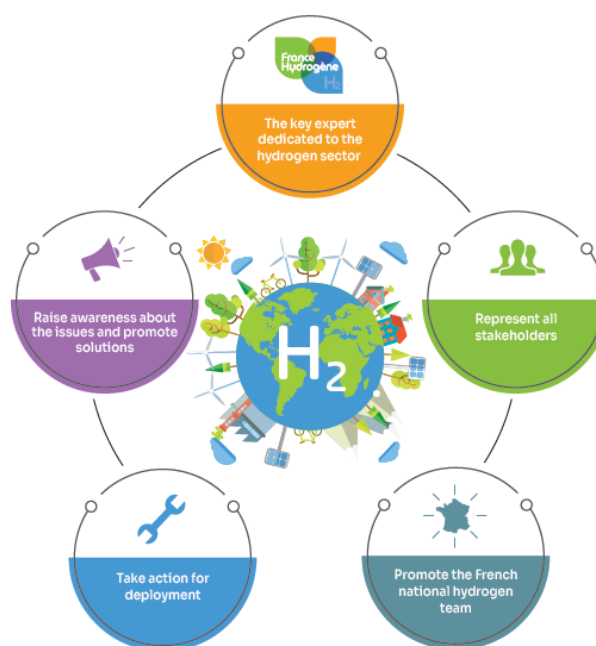
- President: Philippe Boucly

With around 460 members, France Hydrogène brings together the stakeholders of the French hydrogen sector across the entire value chain: major industrial groups developing large-scale projects, innovative SMEs and start-ups supported by laboratories and research centres of excellence, associations, competitiveness clusters and local authorities committed to the deployment of hydrogen solutions. France Hydrogène is working closely to French region and provinces. The association has 14 local delegations, in the 12 metropolitan region and 2 French overseas territories”.

■ Our mission

Acting together to develop all uses of hydrogen and making it a sustainable solution for the ecological transition.

■ Our main activities



■ Our objectives

France Hydrogène is working to:

- Structure an efficient, competitive and innovative French hydrogen sector,
- Share and promote the challenges of the sector,
- Communicate on the benefits and features of technologies,
- Facilitate societal consultation around national objectives and local initiatives,
- Develop the regulatory framework to support the deployment of hydrogen technologies in France.

Hydrogen and Fuel Cell Association of Singapore (HFCAS) Singapore



The Hydrogen and Fuel Cell Association of Singapore (HFCAS) was formed in Nov 2019 in response to Singapore's plan to decarbonize the energy sector through the introduction of a 4th switch focusing on low carbon alternative energy with green hydrogen as one of the options. HFCAS serves its members by providing a platform where they can explore networking and collaboration opportunities, both locally and overseas.

■ HFCAS has 6 strategic thrusts to guide our workplans.

First and foremost, there is a need to establish codes and standards for the import of green hydrogen and its downstream uses to support pilot trials and future deployment, regardless of the energy carrier. The scope will include the import of green hydrogen (in the form of ammonia, liquified hydrogen or liquid hydrogen organic carrier), off-loading and bunkering, processing, distribution and transportation and the various use cases such as fuel cell electric vehicles (FCEVs), power to gas, and stationary fuel cell systems.

Secondly, the green hydrogen economy will lead to many new jobs being created. Current jobs may be made redundant with the switch from internal combustion engines (ICE) vehicles to FCEVs for example, and new processes created with the gasification of liquified hydrogen and cracking of ammonia. It is therefore crucial for our workforce to acquire new skills to take on these new jobs. HFCAS will support this by developing courses either in partnership with 3rd party providers or by developing our own content that is relevant to Singapore context.

Furthermore, HFCAS will also engage the schools to explore the injection of hydrogen related content into the curriculum, partner with its members to provide internship opportunities to students from institutes of higher learning and support them in international events such as the Shell Eco-Marathon for greater exposure. HFCAS believes that for green hydrogen to be a critical factor in Singapore's decarbonization plans, it needs to be accepted by the public. We aim to create greater public awareness through events and roadshows to share about the properties of hydrogen, how it can be used safely and why is it important to Singapore, with the eventual goal of making hydrogen part of our daily lives. In preparation for a green hydrogen economy, there are opportunities for Singapore to identify and support R&D projects that could help to improve the efficiencies in the green hydrogen production processes leading to reduction in overall cost. This is essential to provide economic justification for the use of green hydrogen. HFCAS will be able to work with the industry members who are keen to test-bed these solutions once they are ready. Our industry members have benefited from our webinar series where experts have shared information about the latest trends and projects in hydrogen. We have also partnered and supported with various international hydrogen event organisers such as the Singapore International Energy Week (SIEW) to expand our network. HFCAS will be planning for our 1st flagship event to bring together international experts and established organisations to share on the latest trends and set up business opportunities with our local enterprises. Lastly, it is important for HFCAS to be plugged into the international network of hydrogen players. We have signed more than 10 MOUs with other hydrogen associations and organizations to establish opportunities for our industry members to work with overseas companies. With the launch of the Global Hydrogen Industrial Association Alliance (GHIAA) by H2 Korea, the various country hydrogen associations would come under one umbrella to discuss cross cutting issues and how we could collaborate on common themes.

Hungarian Hydrogen Association Hungary



In recent years it has become obvious that hydrogen - primarily green hydrogen (types of hydrogen produced in an environmentally-friendly way) - and hydrogen technologies will play a significant role in sustainable energy and transportation systems of the future. These technologies are

essential for reaching decarbonisation objectives, integrating renewable energy resources and they also count potential from aspects of industrial development and economic growth. Based on this recognition the National Hydrogen Technology Platform (a Hungarian project organisation active in 2020-2021) turned itself into an independent legal entity: the Hungarian Hydrogen Technology Association from the 3rd November, 2021 (following the official registration of the Court of Company Registration in Hungary).

Strategic goals of the Association are comprehensive: from providing professional framework to industrial, economic and scientific cooperation in favour of establishing a hydrogen economy in Hungary, through facilitating organized cooperation of institutions and companies in the Hungarian market to all of these efforts establishing and strengthening the national hydrogen sector.

■ Our main objectives include:

- active participation in implementing the National Hydrogen Strategy including coordination of implementing the Green Hydrogen Truck Programme, keeping contact with members of the Association in favour of assessing professional needs and recommendations through the process of spreading hydrogen technology,
- professional support of setting up the necessary regulatory systems and conditions to disseminate hydrogen and hydrogen technology in Hungary, proactive contribution to generating pilot projects in the industry,
- organising conferences and professional events,
- establishing world-wide professional connections with hydrogen associations and companies and at the same time supporting Hungarian companies in initiating cooperation with first of all regional and EU contacts in various hydrogen projects,
- spreading knowledge, technology and shaping people's attitude connected to hydrogen and hydrogen technologies in the society by featuring the advantages of hydrogen in aspects of environment, climate protection and economy development.

■ Further information: www.hh2.hu

Application for membership or any inquiries: office@hh2.hu

Registered address: 1117 Budapest, Magyar Tudósok krt. 2.

President: István Lepsényi,

Mobile: +3620/934-4400

Executive Director: dr. Attila Nyikos,

Mobile: +3630/529-4937

■ Basic Information

CEO: Tejs Laustsen Jensen

Hydrogen Denmark brings together all hydrogen and Power-to-X (PtX) stakeholders in Denmark. We are a business organization, and represent the entire value chain from research to business, and from the production of renewable energy and energy technology such as fuel cells and electrolysis, to the use of hydrogen, methanol, ammonia and other electrofuels in the transport sector.

Our members together form a network that spans all parts of the industry. Our members consist primarily of companies but also research institutions, public institutions and network organizations. They all work with hydrogen, electrolysis and fuel cells in connection with the transport, energy storage or production of green fuels.

As a member of Hydrogen Denmark, you become part of this network, you have an influence on the work of Hydrogen Denmark and can at the same time draw on the secretariat's expertise. You also get access to Hydrogen Denmark's weekly newsletter, which ensures insight into the latest initiatives, legislation, political development, technology and production — both in Denmark and internationally.



Hydrogen Poland Republic of Poland



■ General information:

- CEO: Paweł Piotrowicz
- Vice CEO: Krzysztof Kochanowski
- Board Member: Beata Superson — Polowiec
- Board Member: Tomoho Umeda

Hydrogen Poland, an industry organization established in 2021, unites enterprises in the hydrogen economy, prioritizing the representation of Polish business interests globally.

■ Business Area:

- **Advisory Services:**
Hydrogen Poland provides expert advisory services to enterprises involved in the hydrogen economy.
- **Investment Support:**
The organization actively supports and facilitates investments in hydrogen technologies to drive innovation.
- **Sector Synergy Identification:**
Hydrogen Poland identifies and fosters sector synergies to improve project efficiency and collaboration.
- **Legislative Engagement:**
Actively participates in the legislative process, contributing to the shaping of regulations for hydrogen and fuel cell technologies.
- **Expertise in Fund Acquisition:**
Excels in securing European investment funds to accelerate the implementation of hydrogen and fuel cell technologies in Poland.

■ Brief Introduction:

- In the face of unprecedented energy challenges, our association has tirelessly strived to contribute to the sustainable energy landscape and promote hydrogen as a key player in the global energy transition.
- Amidst the complexities of a changing energy paradigm and the geopolitical tensions arising from the conflict in Ukraine, Hydrogen Poland has remained steadfast in its commitment to innovation, collaboration, and a cleaner, more sustainable future.
- The organization's significant contributions, acknowledged by influential leaders in energy transition, climate action, and environmental improvement, highlight the impactful role played by its Board of Directors and dedicated employees. Notably, Hydrogen Poland's Board Members actively engage in shaping the industry landscape in Poland and Europe, offering expertise and counsel to Prof. Jerzy Buzek (former Prime Minister of Poland (1997-2001), the Member of European Parliament, rapporteur for the key regulation on the EU market for hydrogen, natural gas and renewable gases.
- Among many core competences performed by Hydrogen Poland's board members is to create more value to the hydrogen market by engaging in key industry events both in Poland and globally, leveraging their expertise to share valuable insights and contribute to constructive programs. From the European Economic Congress in Katowice to the Rotterdam World Hydrogen Congress, Connecting Green Hydrogen Europe 2023 in Madrid, and concluding with COP 28 in Dubai, these events serve as platforms for collaborative knowledge-sharing and strategic development within the hydrogen sector. Through their participation, Hydrogen Poland remains at the forefront of shaping industry discourse and fostering innovation.
- This brief report summarizes our most important efforts and the notable influence of our initiatives on the hydrogen sector in Poland and internationally.
- The year 2023 proved to be a time of increased work for Hydrogen Poland, starting at the beginning of the year with activities on regulatory and legal grounds.

■ Point of Contact:

Hydrogen Poland Association

Address: 40 Smolna Street, 00-375, Warsaw, Poland

Tax Identification Number (NIP): 6751745293

E-mail: biuro@h2pol.org

International Hydrogen Fuel Cell Association (IHFCA) People's Republic of China



■ Basic Information

Chairman: Ouyang Minggao

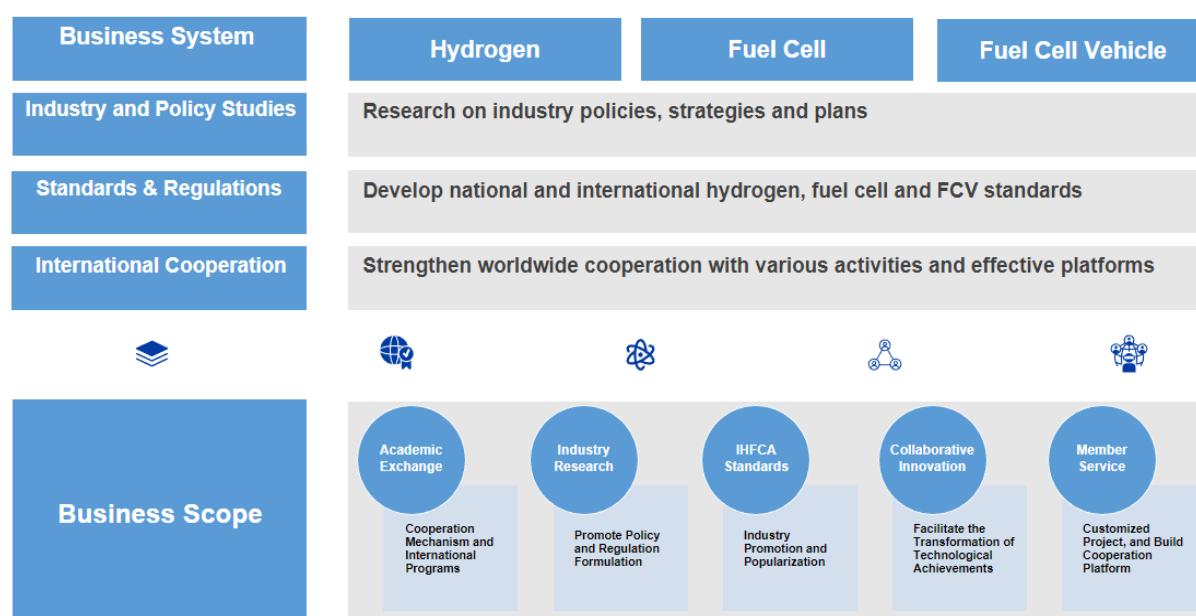
- Launched by China SAE, FORVIA, Toyota, Hyundai, SAIC, Sinopec, AngloAmerican & other leading companies and organisations, IHFCA is an international non-profit organization, promoting worldwide hydrogen collaboration and FCV rollout and commercialization.
- By the end of July 2023, the number of members has reached 86, covering 14 countries.
- Members cover the entire hydrogen and fuel cell industry chain.
- 78% enterprises, 22% research institutes, universities and NGOs.

■ Mission

- To promote exchanges and cooperation in the field of hydrogen energy and fuel cells
- To build an international exchange and cooperation platform covering the entire industry chain
- To optimize international technical standards and rules
- To promote information sharing and open science
- To promote global hydrogen energy and fuel cell technology progress and promotion
- To cultivate a market environment that promotes the large-scale application of hydrogen energy and fuel cells
- To promote the realization of carbon peaking and carbon neutrality goals



■ Business System and Scope



■ Point of Contact:

International Hydrogen Fuel Cell Association

Address: Level 2, Xingzhi Building, No.37 of Rongxing North 3rd Street, Beijing Economic and Technological Development Zone, Beijing.

Telephone: +86(0)10 5091 1068

Email: IHFCA@ihfca.net

■ Basic Information

Co-chairman :

- Takeshi Uchiyama, Executive Fellow, Toyota Motor Corp.
- Takeshi Kunibe, Chairman of the Board, Sumitomo Mitsui Financial Group
- Akiji Makino, Chairman and CEO, Iwatani Corporation

The Japan Hydrogen Association (JH2A), was established in December 2020 with 88 private companies. Our unique feature is that companies from wide range of industries are participating in this organization. JH2A became an incorporated organization in April 2022 with 19 secretarial members seconded from various companies..

JH2A has five committees, Commercialization, Regulatory, External Relations, CO2 Free H2, and Finance. We work through five committees to identify and resolve issues for the development of hydrogen value chain.

We now have 376 members, including 25 executive members.

Executive Board Members	25 companies 
Members	376 Companies/Organizations (as of July 2023)

Hydrogen Colombia The Republic of Colombia

Executive Director: Monica Gasca

POC : monica.gasca@hidrogenocolombia.com

The Colombian Hydrogen Association is the official representative of the Hydrogen industry in Colombia. Aimed at promoting a low-emission economy boosting the use of low-emission hydrogen and its derivatives as fuel, energy storage and industrial input. Founded in May 2021 and launched with the Colombian Hydrogen Roadmap, Hidrógeno Colombia promotes the development of the hydrogen ecosystem through public-private articulation, joining industry, non-profit entities, academic institutions, government entities, international cooperation, and professionals interested in materializing the national decarbonization.

Today we have more than 60 associates and strategic allies. The 60 members that compose Hidrógeno Colombia are:



Hydrogen Colombia will develop its activities to:

- Stimulate Networking: Among industry, the academic-scientific sector, and public authorities to direct collective efforts towards the development and effective implementation of sustainable hydrogen technologies and their derivatives.
- Spread knowledge: Promote good practices, benefits and disseminate a knowledge base among its members and for the public, allowing the development of technical capacities and human talent at the national level.
- Promote the creation of the Regulatory Framework: Support the adaptation of laws and stimulate the necessary regulations to develop and promote hydrogen as a key factor in the decarbonization of industrial processes.
- Development of international links: Generate links and associations with organizations at the regional and international level to share best practices and lessons learned that allow the correct development of the local market.
- Leverage investment in the sector: Stimulate the articulation between national and international entities that manage funds for the development of projects and implement sustainable hydrogen technologies.

Norwegian Hydrogen Forum (NHF) Kingdom of Norway



- General Secretary: Ingebjørg Telnes Wilhelmsen
- 100 members from industry, sub-contractors, the R&D sector, organisations and authorities.
- NHF is the national members' association for hydrogen and ammonia and was founded in 1996. Its members represent the entire hydrogen value chain, from producers, via distributors to end users, including both small and large energy companies, technology suppliers, research and authorities. NHF promotes the advantages of hydrogen and ammonia as energy carriers and seeks to establish a substantial home market for hydrogen and ammonia and to strengthen Norway's position as an international supplier of hydrogen, hydrogen technologies and competence.
- NHF works actively to disseminate key information in Norway on hydrogen and ammonia research and technology commercialization, market trends and international policy making.
- Actively promoting member's interests towards public authorities and decision makers in Norway and the EU.
- Fostering international collaboration by representing Norway hydrogen and ammonia industry abroad.
- Close collaboration since 2006 on knowledge sharing in the Nordic Hydrogen Partnership (NHP) to boost cross-sector implementation of hydrogen and fuel cell technologies with Nordic partner organisations Vetgass Sverige in Sweden, Brintbranchen in Denmark, VTT Technical Research Center of Finland and Icelandic New Energy on Iceland.
- Coordinating County Governor's Network: Sharing knowledge and exchanging information about regional plans and hydrogen strategies, cooperation on projects and public procurement.
- Email: post@hydrogen.no.

Dutch Hydrogen & Fuel Cell Association (NWBA) The Netherlands



■ Basic Information

- Chairman: Arjan van Ginkel
- 60 members in total

Our members:



■ Objective

- The aim of the NWBA is to promote the application of hydrogen and fuel cell technology in the Netherlands as far as possible in order to make society more sustainable.
 - COMBINING STRENGTHS: The NWBA helps to improve Dutch competitiveness in the field of hydrogen and fuel cell technology and supports the implementation of hydrogen and fuel cell applications in the Netherlands.
 - SHARING KNOWLEDGE: The NWBA promotes the collection and generation of relevant knowledge, the provision of information, education and training, the provision of expertise, the national and international dissemination of the Dutch vision and expertise in the field of hydrogen and fuel cell technology, the stimulation of the development of hydrogen and fuel cell technology and the provision of advice in the field of hydrogen and fuel cell technology.
 - REPRESENTING: Representing the Netherlands in European initiatives in the field of hydrogen and fuel cells

■ The team and its working groups

The NWBA is organized in 3 pillars and each pillar has its own working groups and activities

- Pillar Government and international contacts
The NWBA is currently in regular consultation with the government and thus represents its members towards the government.
- Human Capital Agenda
For the members, the human capital question is an important subject for the near future. The 'Young NWBA' has been launched. It is the first hydrogen related platform in The Netherlands focusing on students and Young Professionals. A specific student membership is introduced and being a success already. Additionally, there is being worked on NWBA certifications of trainings, courses and research programs.
- Innovation, knowledge exchange and promotion of end-use
This pillar focusses on organizing events for members providing interaction and contacts between the members.
This involves participation in exhibitions, organising activities, small conferences and networking drinks.

German Hydrogen and Fuel Cell Association (DWV) The Federal Republic of Germany



■ Basic Information

Chairman: Werner Diwald

The German Hydrogen and Fuel Cell Association (DWV) is the umbrella organisation in Germany for all concerned with the general application of hydrogen as an energy carrier. We also advocate that hydrogen be produced from renewable energies for a sustainable energy economy.

■ Our challenges and mission

Together our member firms employ more than 1.5 million people in Germany; the association therefore represents a considerable section of the German economy. These companies need a suitable economic and legal framework that enables them to continue developing as sustainably as possible under the changing environmental conditions.

As the leading lobby group for the special interest of reliable, affordable and emissions-free transportation fuels and energy supplies, we make our voice heard in politics as well as the media and we campaign for fair competition.

We formulate the justifiable interests of the branch in order to secure the business environment needed by our industry.

In regular contact with political decision-makers, by targeted lobbying activities we ensure that our positions and arguments are considered during the development of legislation.

We expound to the public the advantages of using hydrogen and fuel cells, and their relevance to the system in a sustainable energy economy, by targeted activities in the media and at national and international events.

Due to climate change, increasing competition for minerals and political upheavals in countries that supply them, the challenges for a secure and economic provision of energy for the mobility, stationary power and heating sectors will continually mount for the economies in Germany and Europe. The energy transformation will thus become a key factor in safeguarding our economic strength.

Our duties therefore include contributing towards a successful energy transformation in the interests of the German economy. Together we analyse the current situation and formulate proposals to further develop the legislative framework for an integrated energy concept. As an advocate group since 1996, the German Hydrogen and Fuel-Cell Association (DWW) has focused on the call for a rapid market introduction of hydrogen as an energy carrier and of fuel-cell technology. The aim is to prompt an objective debate on all aspects of hydrogen, its production and energy use — in particular an energy switch to fuel cells — the technology and prospects for a future supply infrastructure, as well as help in shaping the development of the market.

We provide an extensive network for the exchange of information and ideas. Providing a common link for all our members — from the smallest own-er-managed enterprise to the largest stock-market listed multinational. We offer the best preconditions for our members to establish and maintain contacts — for example at our general meetings and numerous parliamentary events. Over 20 volunteer experts from our member companies contribute their technical knowledge to the work of our committee. Not only does the industry profit from this. Above all our members obtain an advantage, because they receive vital industry information first hand.

In addition to regular industry information in our comprehensive DWW updates, members also have access to the results of the association's work in an exclusive password-protected section of the DWW website. Through our Expert Commission 'performing energy' we offer our member companies the possibility to participate actively in shaping the underlying legislative environment. We also offer special expert knowledge to member companies for example in the fields of: Vocational training, Business economics, Energy economics, European politics (FQD, RED), Sustainability, and Statistics & market research.

■ Basic information:

CEO & Founder : Celia Greaves

As the UK leader in advocating for and accelerating the transition to Net Zero through the deployment of hydrogen solutions, the HEA supports stakeholders across the entire value chain. Our work drives change at home and abroad, and positions the UK at the forefront of hydrogen globally. Our 100+ members represent over 200,000 employees worldwide with combined revenues of £400bn. We are a key focal point for national and international engagement on hydrogen and its activities for UK plc and UK businesses. As part of this activity, we convene the Hydrogen Coordination Forum, which brings together UK national and regional groupings with interests in hydrogen to build consensus and share good practice.



Mission:

Our Mission is to support the growth of our members and wider industry, and deliver policy outcomes that accelerate the progress of hydrogen in the UK and support UK business growth.

Areas of work:

Our policy work is shaped via our working groups which cover areas such as electrolytic hydrogen production, CCUS enabled hydrogen production, nuclear enabled hydrogen, hydrogen transportation and storage, hydrogen mobility, planning for hydrogen projects and hydrogen refueling infrastructure.

We work closely with Government to drive policy change, participating in a range of Government Advisory Groups and similar, as well as producing Action Plans and responses to consultations.

Our newly published UK projects map shows the depth and breadth of project in the UK – <https://ukhea.co.uk/uk-hydrogen-project-map/>



Chairman: Anders Lundell

Vätgas Sweden started as a national organization on January 1, 2007 with the aim of functioning as an initiator, coordinator and spreader of knowledge. The business is conducted in the form of a non-profit, politically unbound industry and membership organization. Our view of hydrogen's role as an energy carrier is balanced and long-term. On behalf of our roughly 120 members, we work to promote the role of hydrogen gas in Sweden and spread knowledge.

We are a committed and experienced organizer who spreads knowledge in various channels such as lectures, events, conferences and digital channels. We have extensive experience in running both national and international hydrogen projects with the aim of developing business models for part or the entire hydrogen value chain.

We have an exciting, diversified and active network with partners from the business world, authorities and academia both globally and nationally.

Vätgas Sweden's overall goals:

- Promote hydrogen as an energy carrier in Sweden to support the Swedish innovation system for hydrogen and contribute to a sustainable development in industry and society, with lower emissions and more renewable energy and increased resilience.
- To be the central hub for hydrogen issues in Sweden and to be a point of contact and Swedish coordinator in international contexts.
- Together with the members, with joint forces, convey the potential of hydrogen use and to be the voice of hydrogen use in society. The board and the office work in consultation to best promote these purposes in long-term strategies and action plans.

We are a constantly growing association and now consist of over 120 members. Our members are represented in small and large companies, academia, regions and municipalities.



III. Overview of Hydrogen Policy

Republic of Korea

■ Amendments to the Hydrogen Economy Promotion and Hydrogen Safety Management Act (May 2022)

An amendment to the Hydrogen Economy Promotion and Hydrogen Safety Management Act (“Hydrogen Act”) passed the National Assembly on May 29th, 2022. The Hydrogen Act was originally enacted in 2020 to promote the development of the hydrogen industry and, through this amendment, it aimed to invigorate the hydrogen business by introducing i) a clean hydrogen certification system, ii) obligations to sell and use clean hydrogen, and iii) obligations to purchase and supply electricity generated using hydrogen.

Production Diversification of hydrogen production methods and establishment of domestic and overseas production bases	• (Domestic) Developing and demonstrating water electrolysis technology in connection with renewable energy* and nuclear power**; Construction of a blue hydrogen plant using LNG and demonstration of CCS technology, Introduction of clean hydrogen certification system * Demonstrating renewable energy with scale of 10MW (2022-2026) and 100MW (Jeonbuk Saemangeum, 2023-2027) • Considering establishment of large-scale green hydrogen production base(energy island) infrastructure ** Reviewing demonstration based on a basic research of hydrogen production with nuclear power (2022-2024) • (Overseas) Promoting feasibility studies and pilot projects for overseas hydrogen production with domestic capital and technologyActivating international cooperation channels and strengthening private and public cooperation
Distribution Prepared infrastructure to seamlessly connect production and utilization sectors	• (Recieve/Storage) Build infrastructure such as ammonia/liquid hydrogen receiving bases and storage facilities by utilizing existing oil stockpiling bases and LNG receiving bases • (Piping) Promote commercialization so that the general public can use hydrogen on a daily basis by demonstrating the hydrogen blending into municipal gas pipelines (a target of 20%) • (Refueling stations) Expand deployment of fusion hydrogen refueling stations that operate distributed power generation such as solar and fuel cells and install hydrogen and electric charging stations by utilizing existing gas stations and LPG charing stations
Utilization Expand hydrogen mobility centered on commercial vehicles such as hydrogen buses and trucks, and hydrogen power generation such as ammonia co-fired in earnest	• (Transportation) Focus on deployment of hydrogen commercial vehicles and technology development for hydrogen vessels, drones, etc. * Produce 100,000 passenger vehicles and 2,000 commercial vehicles annually by 2025 • (Power Generation) Develop/demonstrate and improve regulation for hydrogen and ammonia power generation technologies, supply ditributed fuel cells, and establish bidding market for hydrogen power in connection with the restructuring of electric power market * Promote commercialization after demonstration of coal-ammonia co-firing and LNG-hydrogen co-firing manly by KEPCO and public power generation companies • Establish hydrogen clusters in Incheon, Jeonbuk, Gangwon, Ulsan, and Gyeongbuk (2027)

■ The 5th Hydrogen Economy Committee (Nov 2022)

The new government announced the comprehensive roadmap to broaden and bolster the use of hydrogen during the 5th Hydrogen Economy Commission Meeting through the three major growth strategies (“3UP”) aim to “Scale-Up”, “Build-Up” and “Level Up.”

“Scale-Up” strategy sets out to expand the clean hydrogen ecosystem by establishing a global supply chain and creating large-scale hydrogen demand in terms of power generation and transportation. It aims to achieve hydrogen enriched combustion combining hydrogen and ammonia, and to enlarge the supply of high-mobility like hydrogen buses and trucks. Large-scale

production bases will be built overseas.

“Build-Up” intends to establish a legal framework for the distribution infrastructure for accelerating clean hydrogen utilization. This includes building the world’s largest liquid hydrogen plant and fueling station, an ammonia and liquid hydrogen receiving terminal as well as installing a hydrogen pipeline. Plans also include opening a hydrogen bid market, hydrogen business laws legislation and introducing a clean hydrogen certification system.

“Level Up” is about technological innovation to become the world-leading hydrogen powerhouse. This entails securing core technologies for not just hydrogen utilization, but also for all areas across the full hydrogen lifecycle from production to distribution. Seven major strategic areas (e.g., water electrolysis, hydrogen turbines) are to be nurtured, and companies with technical prowess will receive support. Business-hampering regulations will be removed and domestic production will be commercialized for exporting to overseas markets.

The Government further outlined the following three courses of action plans for realizing the abovementioned hydrogen policies.

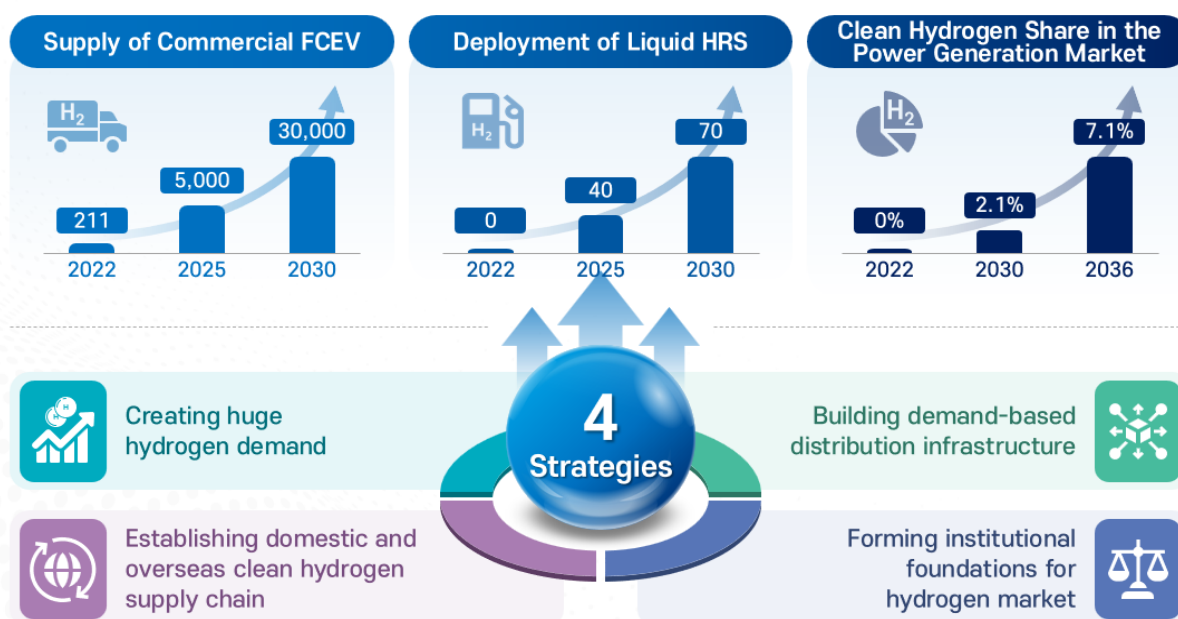
One, the Ministry of Trade, Industry and Energy (MOTIE) will be in charge of fostering a clean hydrogen ecosystem. Action plan includes the goal of producing 30,000 hydrogen-powered commercial vehicles by 2030, building 70 liquid hydrogen fueling stations and composing 7.1 percent of the nation’s power generation mix with clean hydrogen by 2036.

Two, MOTIE will also take the reins of developing Korea into a global hydrogen powerhouse by securing advanced technologies, 10 top-ranked items and nurturing 600 hydrogen-focused companies by 2030.

Three, the Ministry of Science and ICT (MSIT) will undertake the task of achieving the super gap in hydrogen technologies, such as fully localizing the water electrolysis technology, gaining the liquefaction and ammonia process technology and leading the hydrogen mobility market.



Specific Targets to Promote the Supply of Clean Hydrogen



■ The 6th Hydrogen Economy Committee (Dec 2023)

The government held the sixth Hydrogen Economy Committee on December, 2023 and announced four major policies for accelerating the transition to a clean hydrogen ecosystem and nurturing the hydrogen industry.

- **Clean Hydrogen Certification Management System**
This system aims to support the certification of production and import of hydrogen and provide incentives when the amount of greenhouse gas (GHG) emissions falls under a certain level in accordance with the Hydrogen Act. Specifically, the committee meeting set GHG emission of 4kg or less per every 1kg of hydrogen as the standard for certification as clean hydrogen, and also established relevant procedures, certification system and support measures. As a result, it is expected that both the launch of the Clean Hydrogen Portfolio Standard (CHPS), slated for next year, and enforcement of related laws will be able to proceed smoothly; companies will also begin to make clean hydrogen investments in earnest.
- **Strategy for Nurturing the Hydrogen Industry's MPE (materials, parts, equip.) Sectors**
40 core items across 10 major hydrogen industry areas were selected for the development of hydrogen MPE industries, including water electrolysis, liquid hydrogen carrier and hydrogen turbines; support will be given to secure proprietary technology, accelerate commercialization and strengthen the supply chain. These measures are anticipated to achieve 80 percent localization of the top 10 strategic areas' MPEs by 2030 and nurture 20 top global MPE companies.
- **Measures to Increase the Distribution of Fuel Cell Electric Vehicles (FCEVs)**
With the goal of distributing 0.3 million units of FCEVs and establishing over 660 hydrogen charging stations by 2030, the plan is to increase the number of different kinds of charging stations, including those for charging liquid hydrogen and "convergence" types; in step with rising hydrogen demand, the Government has developed measures for strengthening the hydrogen supply response system and diversification.

- Measures for Managing the National Hydrogen Priority R&D Centers
Establish priority R&D centers concentrating on each of the water electrolysis technologies for R&D on basic and proprietary technology for technological localization and for providing performance evaluation support to secure technical credibility.

■ Clean Hydrogen Portfolio Standard (CHPS)

In Korea, power generation companies sell the electricity they produced to Korea Electric Power Co. (KEPCO) through the Korea Power Exchange (KPX). As prices of the electricity set in the market are coupled with fuel prices, renewables such as solar and wind power - which are not subject to fuel price fluctuations - are not traded in the traditional energy bid market under KPX. Instead, renewables and hydrogen power have been traded in renewable energy certificates under the Renewable Energy Portfolio Standard, or the RPS system. However, since economic feasibility of hydrogen power is yet competitive to wind or solar power, MOTIE decided to separate hydrogen-derived power market from RPS system and prepared 'general' and 'clean' hydrogen bidding market or CHPS. Through CHPS, the government aims to promote competition across hydrogen-based power generation technologies and drive down costs quicker.

Korea opened the world's first hydrogen power bidding market on June 9th 2023. The hydrogen power bidding market have opened biannually, with the aim of contracting 650GWh for each round, and ending up awarding 715GWh respectively for delivery in 2025. While above general hydrogen bidding market will gradually shrink, clean hydrogen bidding market will open next year for contract of 3.5TWh with delivery in 2027. Korea aims to deliver 14.7TWh of hydrogen-based energy into 2028 through auctions completed in previous years.

On Nov 14th 2023, MOTIE announced that the proposal for an amendment to the 'Hydrogen Act' has passed, enabling government to establish a clean hydrogen certification system as proposal contains applicable provisions for enforcement, including those regarding the clean hydrogen certification standards and procedures, post-management and the designation of certifying institutions.

01 Threshold – gradual strengthening

- 1st Phase: (Domestic & Overseas) well-to-gate, threshold 4kgCO₂e/kgH₂(Temporary Exclusion of Ship Emissions)
For domestic hydrogen production, additional burden of importing raw material (LNG, etc.) and CO₂ shipping to overseas CCS sites are considered
- 2nd Phase: (Domestic) well-to-gate (Overseas) well-to-port
- 3rd Phase: (Domestic & Overseas) well-to-wheel

02 Final Product

- 1 kg of hydrogen

03 Base Year & LCI BD

- Use the 2021 LCI DB(SNU)
- Site Specific data can be accepted after review by certification bodies

04 Offset Mechanism

- Any reduction unrelated to hydrogen production activities is not allowed
- Only direct allocation methods related to hydrogen will be allowed (review by certification agency)

United States

■ Infrastructure Investment and Jobs Act (November 15, 2021)

The Infrastructure Investment and Jobs Act (IIJA), commonly known as the Bipartisan Infrastructure Bill, was signed into law by President Biden on November 15, 2021. Included in the bill was a total of \$9.5 billion for various clean hydrogen programs, as well as direction for the Department of Energy to develop the United State's first National Clean Hydrogen Strategy and Roadmap.

- \$1 billion for development of a Clean Hydrogen Electrolysis Program
- \$500 million for creation of a Clean Hydrogen Manufacturing and Recycling research development, demonstration, and deployment activities
- \$8 billion has been directed over five years of Fiscal Year (FY) 2022-2026 to establish a program to develop Regional Clean Hydrogen Hubs (H2Hubs) across the country.

■ Inflation Reduction Act of 2022 (August 16, 2022)

The Inflation Reduction Act of 2022 was signed on August 16, 2022, and included a wide array of financial incentives aimed at driving the investment and deployment of clean hydrogen and fuel cell technologies, as well as the creation of a new Credit for Production of Clean Hydrogen. This creates a new ten-year incentive for clean hydrogen production tax credit (PTC) with up to \$3.00 / kilogram or 30% investment tax credit (ITC). The credit provides a varying incentive depending on the carbon intensity of the hydrogen production pathway. The credit measures emissions up to the point of production using the Argonne National Laboratory Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies (GREET) Model. The incentive breakdown is detailed in the following table.

Kg of CO ₂ per kg of H ₂	Credit Value (\$)
4 - 2.5 kg CO ₂	\$0.60 / kg of H ₂
2.5 - 1.5 kg CO ₂	\$0.75 / kg of H ₂
1.5 - 0.45 kg CO ₂	\$1.00 / kg of H ₂
0.45 - 0 kg CO ₂	\$3.00 / kg of H ₂

2023 has been focused on implementation of this credit with specific focus on how the Biden-Harris administration would determine the lifecycle analysis for this credit. Initial proposed guidance is expected to be released before the end of the year.

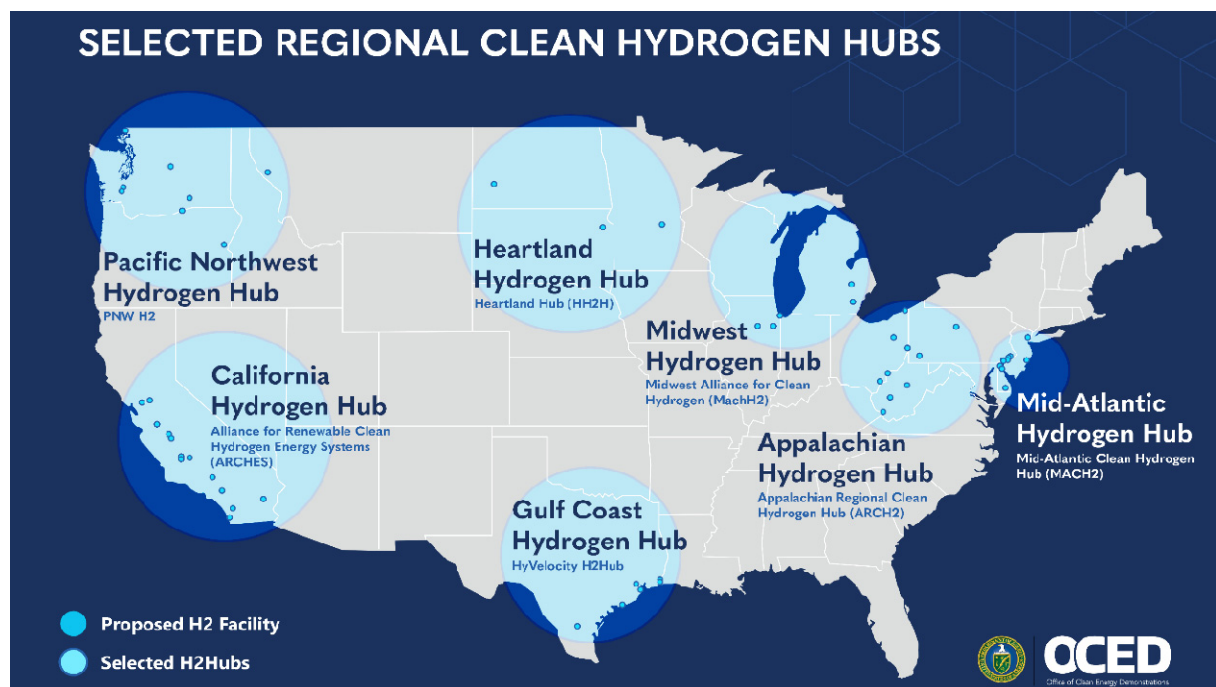
The Inflation Reduction Act implemented or extended several other important tax credits for the U.S. hydrogen and fuel cell industry, including:

- Energy Credit extends the 30% fuel cell ITC through 2024 before a transition to the technology-neutral Clean Energy Investment Credit.
- Energy Storage Credit adds a new provision to the energy ITC for energy storage, including hydrogen storage, available through 2024 before a transition to the Clean Energy Investment Credit.
- Alternative Fuel Refueling Property Credit extends the credit through 2032, increases the 30% credit cap from \$30,000 to \$100,000.

- Carbon Oxide Sequestration Credit provides an enhanced rate of carbon oxide captured for storage and utilization for qualified facilities through 2032.
- Clean Vehicle Credit provides \$7,500 for the purchase of fuel cell electric vehicles by creating a new clean vehicle credit built on the 30D credit for plug-in battery electric vehicles. Eliminates the per automaker cap of 200,000 vehicles. Adds a retail price cap of \$55,000 for new cars and \$80,000 for pickups, vans, and SUVs.
- Qualified Commercial Clean Vehicles Credit creates a new 30% credit for commercial fuel cell electric vehicles through 2032 which is capped at \$40,000.
- Advanced Energy Project Credit revives the credit providing \$10 billion to fund manufacturing projects producing fuel cell electric vehicles, hydrogen infrastructure, electrolyzers, and a range of other products.
- Elective Payment for Energy Property adds an election for direct pay provisions to a range of tax credits including clean hydrogen production credit, the energy ITC, the carbon capture and sequestration credit, alternative fuel vehicle refueling property credit, advanced energy project credit, and others.

■ Regional Clean Hydrogen Hubs

On October 13, 2023, the Biden-Harris Administration announced seven Hydrogen Hub projects selected for award negotiations. Totalling \$7 billion from the federal government, the investment will be joined by more than \$40 billion in selectee cost share. These Hubs are expected to create tens of thousands of new jobs and reduce national carbon dioxide emissions by 25 million metric tons.



Below is an overview of Hydrogen Hub award selectees including the expected award amount, region location, as well as hydrogen production, midstream, and end-use applications supported.

Name/Federal Cost Share	Location	Production	Midstream	End Uses
Appalachian Hydrogen Hub (ARCH2) Up to \$925 million	Ohio, Pennsylvania, West Virginia	Hydrogen produced from natural gas, with carbon capture and storage	Hydrogen pipelines, hydrogen fueling stations, permanent CO2 storage	Fuel cell electric mining vehicles, heavy-duty vehicles, heavy industry
California Hydrogen Hub (ARCHES) Up to \$1.2 billion	California	Electrolysis	Freight network between California and Pacific Northwest Hub, hydrogen fueling stations	Backup power generation, heavy-duty vehicles, port equipment, public transit
Gulf Coast Hydrogen Hub (HyVelocity H2Hub) Up to \$1.2 billion	Texas	Electrolysis, hydrogen produced from natural gas, with carbon capture and storage	Hydrogen pipeline, salt cavern storage, hydrogen refueling stations	Heavy-duty vehicles, power generation, ammonia, refineries/petrochemicals, marine fuel
Heartland Hydrogen Hub (HH2H) Up to \$925 million	Minnesota, North Dakota, South Dakota	Electrolysis, Biomass Gasification	Open access to storage and pipeline infrastructure	Fertilizer, power generation
Mid-Atlantic Clean Hydrogen Hub (MACH2) Up to \$750 million	Delaware, New Jersey, Pennsylvania	Electrolysis	Expanded pipeline infrastructure, upgraded bus mechanic depots, hydrogen refueling stations	Heavy duty vehicles, refuse and sweeper trucks, power generation, combined heat and power
Midwest Hydrogen Hub (MachH2) Up to \$1 billion	Illinois, Indiana, Michigan	Electrolysis, hydrogen produced from natural gas, with carbon capture and storage	Hydrogen refueling stations	Steel and glass production, power generation, refining, heavy-duty vehicles, sustainable aviation fuel
Pacific Northwest Hydrogen Hub (PNWH2) Up to \$1 billion	Montana, Oregon, Washington	Electrolysis	Freight network between California and Pacific Northwest Hubs	Heavy-duty vehicles, ports, refining, peaking plants/generators, refineries, data centers

European Union

■ EU Hydrogen Strategy

The EU strategy on hydrogen (COM/2020/301) was adopted in 2020 and suggested policy action points in 5 areas: investment support; support production and demand; creating a hydrogen market and infrastructure; research and cooperation and international cooperation. The full list of 20 key actions was implemented by the first quarter of 2022. Hydrogen is also an important part of the EU strategy for energy system integration.

Since the Fit-for-55 package (July 2021) has put forward a number of legislative proposals that translate the European hydrogen strategy into concrete European hydrogen policy framework. This includes proposals to set targets for the uptake of renewable hydrogen in industry and transport by

2030. It also includes the Hydrogen and decarbonised gas market package (COM/2021/803 final and COM/2021/804 final), which puts forward proposals to support the creation of optimum and dedicated infrastructure for hydrogen, as well as an efficient hydrogen market.

Furthermore, the recovery plan NextGenerationEU has been made available to EU countries to invest in hydrogen projects across the value chain.

Investment support has also been provided through the Important Projects of Common European Interest (IPCEIs) on hydrogen. The first IPCEI, called "IPCEI Hy2Tech", which includes 41 projects and was approved in July 2022, aims at developing innovative technologies for the hydrogen value chain to decarbonise industrial processes and the mobility sector, with a focus on end-users.

In September 2022, the Commission approved "IPCEI Hy2Use", which complements IPCEI Hy2Tech and which will support the construction of hydrogen-related infrastructure and the development of innovative and more sustainable technologies for the integration of hydrogen into the industrial sector. Finally, the Clean Hydrogen Partnership was established in November 2021 (taking over from FCH 2 JU) to support research and innovation in the hydrogen ecosystem.

The policy framework was completed with 2 delegated acts, formally adopted on 20 June 2023, applicable to renewable hydrogen under the 2018 Renewable Energy Directive. The first one covers renewable fuels of non-biological origin (RFNBOs) and sets the criteria for products that fall under the 'renewable hydrogen' category. The other one puts forward a detailed scheme to calculate the life-cycle emissions of renewable hydrogen and recycled carbon fuels to meet the greenhouse gas emission reduction threshold set in the directive.

■ European Hydrogen Bank

The European Commission has proposed to establish a global European hydrogen facility to create investment security and business opportunities for European and global renewable hydrogen production. President Von der Leyen announced a European Hydrogen Bank in her State of the Union speech in 2022 and the initiative was included in the Commission work programme for 2023.

The Communication on the European Hydrogen Bank (COM/2023/156), published on 16 March 2023, describes its concept, tasks and structure. The European Hydrogen Bank is a financing instrument run internally by Commission services. It is not designed to be a physical institution. The main objective of the facility is to unlock private investments in hydrogen value chains, both domestically and in third countries, by connecting renewable energy supply to EU demand and addressing the initial investment challenges. It will establish an initial market for renewable hydrogen, offering new growth opportunities and jobs. On 23 November 2023, a pilot auction (competitive bidding) was launched under the Innovation Fund, supporting the production of renewable hydrogen for European consumers. The terms and conditions for the pilot auction were published by the Commission on 30 August, allowing potential bidders to start preparing.

Furthermore, green hydrogen partnerships will facilitate the promotion of the import of renewable hydrogen from third countries and contribute to incentivising decarbonisation. Together, the European Hydrogen Bank and the green hydrogen partnerships aim at delivering a framework to ensure that partnerships established by the EU countries and the industry provide a level-playing field between EU production and third-country imports.

Chile

Date	Policy	Agency
Jan 2023	Second Version of the Green Hydrogen Accelerator Program	Energy Sustainability Agency
Mar 2023	Environmental Evaluation Criteria: Green hydrogen Integrated projects	Environmental Assessment Service
Mar 2023	Call for companies interested in submitting local electrolyzers manufacturing	Agency of Economic Development
Apr 2023	The Green Hydrogen Action Plan 2023 - 2030 starts engagement at the local level	Ministry of Energy
Jun 2023	Financial Facility of US\$ 1 billion 2023 - 2030	Agency of Economic Development (CORFO)
Jul 2023	Creation of the Strategic Committee formed by former presidents, ministers, NGOs, governors and universities	Ministry of Energy
Ago 2023	30 Boosting Measures for the Green Hydrogen Action Plan 2023-2030	Ministry of Finance and Ministry of Energy

■ Clean H2 Support Policy; scheme, regulation, quotas, subsidy, standard.

The national incentives have mostly been provided through the Economic Development Agency (CORFO). One of the initial programs in 2021 involved providing financial support to accelerate the development of green hydrogen production projects, up to a total of US\$50 million.

This year CORFO announced the Financial Facility for Green Hydrogen, which will initially manage US\$ 1,000 million, with loans and contributions from 4 development banks (IADB, WB, EIB, KfW) plus additional resources from CORFO. These resources will be used to capitalize financial instruments of the financial program, make available other CORFO's instruments and support the operation of the Financial Program.

In terms of tax incentives, the R&D Tax Incentive allows a reduction in the Income Tax of 35% of the investment in R&D, by tax credit. With a maximum of USD 1.2 million. It also allows to consider the remaining 65% of R&D investment, as required expenses to deduct Income Tax.

The Ministry of Finance offers a tax exemption program available for sustainability projects, including green hydrogen, called the Tax Credit Fund, which can be credited against the first category tax for investments with a high multiplier effect..

■ Green Hydrogen Action Plan 2023

The main objective of this plan is to define a roadmap between 2023 and 2030 to develop a sustainable green hydrogen industry and its derivatives through coordinated actions between various Government ministries and bodies, together with regional and local initiatives.

This action plan includes opportunities for participation, such as inter-ministerial task forces, citizen participation initiatives, an advisory council, and the strategic committee whose members are a multidisciplinary group of experts, which includes former government ministers, aims to achieve a broad consensus on the development of this new industry.



The Strategic Committee of the Green Hydrogen Action Plan 2023-2030 includes former President of Chile Michelle Bachelet, former ministers, governors of Antofagasta and Magallanes, civil society, and universities representatives. Santiago, July 2023.

The action plan includes four main lines of action:

1. **Promoting the industry and social returns:** This line of action will address incentives and mechanisms to develop the industry in a way that ensures the greatest medium and long-term benefits to society.
2. **Enabling infrastructure:** Promoting infrastructure for the sustainable development of green hydrogen, focused on efficient use and appropriate deployment.
3. **Carbon neutrality and off-takers in Chile:** This line of action will review the role of mining and other Chilean industries in green hydrogen demand, which will help the country to reach its carbon neutrality goals.
4. **Sustainability and local value:** Fostering a more competitive, diversified, and innovative economy in harmony with local communities; promoting high-quality employment; and developing local value.

Kingdom of Spain

■ DRAFT UPDATE TO PNIEC

On June 28, 2023, the government presented the draft of the updated National Integrated Energy and Climate Plan (PNIEC), which includes 29 new measures while assessing the progress of the 78 measures published in the 2021 version. Of the new measures included in this draft, 15 are in some way related to the hydrogen sector.

This draft update follows the requirements established by Article 14 of Regulation (EU) 2018/1999 of the European Parliament and the Council of December 11, 2018, regarding the governance of the Union's Energy Union and Climate Action.

In the updated PNIEC project, which Spain has already submitted to the European Commission, considering the progress achieved in various indicators, the advancement of the initially planned measures, and the maturation of various sectors, the ambition has been increased to a 32% reduction in greenhouse gas emissions compared to 1990, 48% renewables in the final energy consumption, 44% improvement in energy efficiency, and 81% renewable energy in electricity generation.

■ ADDENDUM TO THE RECOVERY PLAN

On October 2, 2023, the European Commission approved the Addendum. This will provide the PERTEs with nearly €27 billion in additional resources from transfers, loans, and the RepowerEU program, allowing for the continuation and completion of grant calls, financing incentives, and additional investments.

The Addendum includes a new chapter dedicated to the financing of actions under the RepowerEU initiative, with approximately €7 billion in funding, of which around €4.2 billion is allocated to the PERTE for Renewable Energies, Renewable Hydrogen, and Energy Storage (ERHA).

Likewise, the commitment to Renewable Hydrogen is evident by doubling the initially planned investment, with the addition of an extra €1.6 billion for the development of the value chain, new pioneering projects, the creation of hydrogen valleys, and the support of Projects of Special European Interest (IPCEI).

■ GUARANTEES OF ORIGIN SYSTEM

The GoO legislation was established with Royal Decree 376/2022, dated May 17, 2022, and the system is operational as of March 2023. However, it is relevant to mention that the guarantees of origin, for the moment, do not serve as certification mechanisms for the sustainability and emission intensity criteria for renewable hydrogen set by the delegated acts on the production of renewable liquid and gaseous fuels of non-biological origin, presented by the Commission in 2023.

■ ENVIRONMENTAL ASSESMENT

On June 13, 2023, the annexes of Law 21/2012 on Environmental Assessment were amended. Annex 2 includes industrial facilities to produce electrolytic, photoelectric, or photocatalytic hydrogen from renewable sources. B. (Clean H2 Support Policy; scheme, regulation, quotas, subsidy, standard, etc.)

■ FUNDINGS

1. Cadena de Valor

The Ministry for Ecological Transition and Demographic Challenge (MITECO) has launched a second call for proposals for the incentives program aimed at the innovative value chain and knowledge of renewable hydrogen. This call is funded with €66.6 million from the Next Generation EU's Recovery, Transformation, and Resilience Plan (PRTR), in addition to the €40

million from the same program in its initial call. Associated with the Strategic Project for the Economic Recovery and Transformation of Renewable Energies, Renewable Hydrogen, and Storage (PERTE ERHA), these initiatives aim to boost the development of basic-fundamental research projects, innovative pilots, and training in key enabling technologies within the renewable hydrogen value chain.

2. Pioneros

The call aims to encourage the implementation of innovative projects with commercial viability for the local production and consumption of renewable hydrogen, especially in sectors where decarbonization is more challenging, such as industry or heavy mobility.

It is integrated into the Strategic Project for the Recovery and Economic Transformation of Renewable Energies, Renewable Hydrogen, and Storage (PERTE ERHA), part of the Recovery, Transformation, and Resilience Plan, and is managed by the Institute for Energy Diversification and Saving (IDAE). This call is funded with €150 million.

Australia

The most significant policy developed this year was the AHC's response to the Australian Government's review of Australia's National Hydrogen Strategy.

The AHC believes Australia has an enormous opportunity to create a vibrant hydrogen industry, both for domestic use and for export. Australia has the renewable energy resources, technical skills, and the track record with international partners to become a global hydrogen leader. However, the transition to net zero energy emissions — and hydrogen's role within the transition - will require unprecedented rates of investment in new or repurposed energy sources, infrastructure, and energy use equipment.

This will need to be synchronised with an equally unprecedented exit, stranding or repurposing of existing capital stock (e.g., coal-fired power stations, gas networks, oil import supply chains, coal export supply chains). Those investments will arise from the interplay of policies and programs of the Australian Government and jurisdictional governments, regulatory bodies, private sector companies, energy users from households to major industrial consumers, the RD&D community and the governments and companies of our major trading partners.

The scale of this task requires planning, funding, and targeted demand stimulation.

During the initial stages of this energy transition, governments and industries have not always done the heavy lifting. As a result, there are perceptions of endless possibilities, ranging from overly optimistic scenarios of a transition without any costs, to the idea of an unchanged environment, or an economy that benefits everyone without any drawbacks.

The AHC would include in this the notion that hydrogen developments can be activated by discrete tasks with surgical precision. Hydrogen is not separate from the energy transition and everything this entails; it fundamentally affects, and is affected by, multiple systems and requires an ecosystem to enable it to be produced, stored, delivered and used efficiently.

The AHC's response to the National Hydrogen Strategy refresh proposed 53 comprehensive recommendations to guide policy development, with emphasis on the following recommendations as key components to ensure success of the hydrogen industry in Australia:

- Tasking stewardship of the NHS to a central coordinating body, the Net Zero Economy Agency

The energy and industry transition will connect complex systems and require fundamental change, planning and creativity across sector, state, departmental and political boundaries. Australia needs cross-departmental steering of net zero work which includes the refreshed NHS.

- Setting priorities and targets, based on robust analysis

Within the overall net zero programme, the Australian Government must set priorities and meaningful targets, and there needs to be a government commitment to fill current knowledge gaps to a reasonable degree.

- Committing to planning and financial support for shared physical and social infrastructure, including via Hydrogen Economic Zones

Almost all the physical infrastructure required for a future hydrogen industry at scale is new, and it is long-lived with long planning lead times. There must be planning and co-optimising of different assets to address a range of different markets and to not over-burden consumers' and taxpayers' willingness to pay, or communities' willingness to tolerate construction in their midst. This requires an extension of the current Renewable Energy Zones and hydrogen hubs concept to create zones that can support and be supported by local industries and communities.

- Building scale and capability in the sectors and applications that will be hard to abate

This is the best 'no regrets' approach that can be taken in an uncertain environment.

- Keeping export options open

For export, there are two main uses of hydrogen: exporting hydrogen and its derivatives as an energy vector and using hydrogen to process ores that are then exported. Both options need to be pursued to grow our international relationships, support regional energy security, and build Australia's capability for the future, including paying for our own transition.

- De-risking projects through public finance

The Australian government needs to deploy appropriately scaled public levers that will crowd in and de-risk investment in hydrogen. Ideally, the current and future iterations of the recently announced \$2 billion Hydrogen Headstart program will need to incentivise demand or assist project developers to manage demand side risk. The approach must also prioritise timeliness, both to build momentum and to align prospective projects with the timelines for regional offtake (and as a response to the investment challenge posed by the IRA).

To view this and other reports prepared by the AHC this year, visit:

<https://h2council.com.au/ahc-publications/>

Canada

■ Canada Hydrogen Strategy

Canada sees a sizeable role and competitive advantage in the production, distribution and use of hydrogen given its abundance of feedstocks, skilled workforce and existing position as a leader in intellectual property and export of hydrogen technologies. Hydrogen is expected to form a key

plank of Canada's pathway to meeting its net-zero goals. In December 2020, Canada published the Hydrogen Strategy for Canada, designed to spur investments in hydrogen production and use, and create partnerships that establish Canada as a global supplier of hydrogen. Early actions outlined in the Strategy can be supported by several programmes identified as part of the government's Strengthened Climate Plan, "A Healthy Environment and a Healthy Economy", and the 2021 federal budget. This includes a CAD 1.5 billion (EUR 1 billion) Clean Fuels Fund that supports the build-out of new clean fuel production capacity (including hydrogen) and the CAD 8 billion (EUR 5.3 billion) Net-zero Accelerator that supports industrial decarbonisation. If the hydrogen opportunity outlined in the Strategy is fully seized, it is estimated that by 2050 over 350 000 new high-paying jobs could be created nationally as well as revenues in excess of CAD 50 billion (EUR 34 billion), relative to the 832 500 direct and indirect jobs in the energy sector in 2019.

■ 2023 Federal Budget

The federal budget confirmed the details of the Clean Hydrogen Investment Tax Credit (ITC), which is a refundable investment tax credit on clean hydrogen projects. The credit offers varying levels of support between 15 and 40 per cent of eligible project costs, with projects that produce the cleanest hydrogen receiving the highest levels of support. The Clean Hydrogen ITC will also extend a 15 per cent tax credit to equipment needed to convert hydrogen into ammonia in order to transport the hydrogen. The tax credit will only be available to the extent the ammonia production is associated with the production of clean hydrogen.

The 2023 Budget also included the following measures to ensure that Canada can accelerate the deployment of hydrogen and other clean-energy technologies:

- Clean Technology Investment Tax Credit: A refundable 30% tax credit on capital cost of investments made by taxable entities in wind, solar PV and energy-storage technologies. This Credit will be available to all project spending starting today, March 28, 2023, though to 2034.
- Clean Electricity Investment Tax Credit: A newly announced, refundable 15% tax credit on the capital costs of investments made by non-taxable entities, such as Indigenous communities, municipally owned utilities and Crown corporations that make investments in renewable energy, energy storage and inter-provincial transmission and other non-emitting electricity infrastructure.
- Canadian Infrastructure Bank: Budget 2023 also includes \$20 billion in support for Clean Electricity investments, including at least \$10 billion through the Clean Power priority area and at least \$10 billion through the Green Infrastructure priority area.
- Canada Growth Fund: The Budget provides an enhanced commitment to carbon-price stability via new tools in the Canada Growth Fund, which will be managed by the Public Sector Pension Investment Board.

The Canadian Government's support for hydrogen has increased steadily over the past year and has included the launch of the Hydrogen Strategy for Canada in 2020 along with funding support under the \$1.5 billion Clean Fuels Fund and other budgetary commitments. Provincial governments have expressed their commitment to hydrogen, including the release of hydrogen roadmaps in Alberta, Ontario and Quebec.

Argentina

Argentina is working on three Strategic Hydrogen Policies:

- Low-emissions Hydrogen Law
 - Led by Secretariat of Energy (Ministry of Economy)
 - Focused on investment promotion, fiscal and financial incentives.
 - Currently submitted to the National Congress, in discussion.
- National Hydrogen Strategy
 - Led by Secretariat of Strategic Affairs
 - Roadmap for a local hydrogen industry development, setting production targets for 2030 and 2050.
 - Released on September 12th, 2023.
- Strategic Environmental Assessment
 - Led by Secretariat of Strategic Affairs and Ministry of Environment and Sustainable Development
 - Socio-environmental predictability framework
 - In process

Focusing on National Hydrogen Strategy, its foundations are:

- To promote local technological and productive development throughout the whole hydrogen value chain
- Contemplate hydrogen production based on their emissions level rather than its “color”
- Set two distinctive approaches for the deployment of H2 economy: local market, and export market.

Related to the main goals for 2030-2050, highlights are:

- Production costs
 - 1.1-2.1 USD/kg H2 from natural gas with CCUS
 - 1.7-3.4 (2030) 1.4-2.7 (2050) USD/kg H2 from renewable water electrolysis
- Market volume projections
 - 4 Mton H2/y by 2050 for exports, aiming to supply 5% of the global traded market
 - 1 Mton H2/y by 2050 for domestic consumption, focused on Synthetic fuels, Steel Industry, and Gas blending.
- Strengthen and generate local supplier development, including:
 - Equipment for renewable energies
 - Containers and compressors
 - Technological services
 - Electrolyzers
- Infrastructure

- Promote at least 5 industrial Hubs
- Adapt and/or build 2 to 5 ports to export H2
- Reinforce at least 3 low-carbon corridors
- Develop CO2 storage infrastructure for CCUS deployment

Full access to the National Hydrogen Strategy can be found on: [Argentina.gob.ar](https://argentina.gob.ar)

Regarding certification, Argentina along with more than 10 countries in the LAC region signed on November 8th the Joint Declaration for the Implementation of the Clean and/or Low Emissions Hydrogen Certification System in Latin America and the Caribbean "CertHILAC". This initiative has the support and sponsorship of OLADE and the Inter-American Development Bank. CertHILAC will focus on the certification of clean, low-emission hydrogen produced in Latin America and the Caribbean, ensuring product traceability and providing detailed information on its origin and production technology, among other key attributes.

In relation to the announcement of production projects, the YPF group, the main player in the oil & gas sector in Argentina, announced the incorporation of 26 MW of electrolysis for the production of green H2. This production will be transformed into green ammonia through the company Profertil, which already have an ammonia production facility in Bahia Blanca, province of Buenos Aires.

In addition, at the H2MEET 2023 conference, YPF signed a MoU with POSCO Holdings to explore potential business opportunities.

France

■ A French strategy that needs to evolve

In September 2020, France adopted an ambitious national hydrogen strategy aimed at becoming a world production leader of low emission hydrogen. The deployment of this strategy has now reached a milestone, with the announcement in 2022 that it would be reviewed by the relevant ministers (Energy Transition and Industry). It is right to take stock of what has been achieved and to fill in any gaps in the initial scheme. It is also crucial to maintain the initial ambition, which is critical for structuring a sovereign and sustainable industry that creates value and jobs in the regions. It's an ambition based on a decarbonisation target and an industrialisation objective, where the deployment of a robust industry and a competitive offering go hand in hand with the stimulation of demand and the development of technologies that promote different uses.

■ Support for renewable and low-carbon hydrogen production

While we wait for the new framework of objectives in the revised National Strategy, the government is implementing its commitment to the industry. At the end of August, the Minister for Energy Transition announced the introduction of a support mechanism to produce low emission hydrogen from electrolysis (renewable and nuclear). The aim is to deploy one gigawatt of electrolysis capacity through calls for tender in tranches of 150, 250 and 600 MW, between 2024 and 2026. A total of €4 billion has been earmarked for this scheme as part of the overall €9.2 billion package earmarked for the hydrogen industry between now and 2030.

■ ADEME calls for projects 2023

The national agency has funded 35 hydrogen ecosystems since 2018, under two calls for projects. Worth €320 million, these ecosystems will give rise to 100 hydrogen stations and represent more than 80 MW of electrolysis. The third round of the Territorial Ecosystems call for projects was relaunched in May, with funding of €175 million. The aim of this new wave of projects is to encourage the installation and operation of new hydrogen production infrastructures (using water electrolysis or biomass pyrogasification) and new distribution infrastructures. It also covers the extension of existing hydrogen ecosystems (with new transport uses). It also includes the acquisition or rental of equipment (vehicles, ships, machinery) requiring the use of hydrogen for the transport of people or goods, or for the handling of materials or goods.

Singapore

■ National Hydrogen Strategy (Oct. 2022)

Singapore is committed to achieving net-zero greenhouse gas emissions by 2050, and hydrogen is a key plank of Singapore's clean energy transition plans. According to Singapore's National Hydrogen Strategy (NHS), hydrogen is outlined to account for at least half of Singapore's entire fuel mix by 2050 (2050 Hydrogen Goal).

The 2050 Hydrogen Goal is Singapore's "Holy Grail", and is essential to Singapore achieving net-zero greenhouse gas emissions by 2050. In order to achieve the 2050 Hydrogen Goal, the NHS broadly targets the adoption of hydrogen across the power generation, industry, maritime, aviation and land transport sectors. Together, these sectors account for 97.9 per cent of Singapore's current greenhouse gas emissions.

The NHS focuses on:

- Experimenting with the use of advanced hydrogen technologies at the cusp of commercial readiness through pathfinder projects. Singapore will be experimenting with advanced hydrogen technologies in an incremental manner and will start with pathfinder projects in ammonia power generation and maritime bunkering. The EMA and MPA have launched an expression of interest process to build, own and operate low or zero-carbon power generation and bunkering projects on Jurong Island. Proposals are due by the end of April 2023. On an international level, the MPA and Jurong Port have also joined the multinational Castor Initiative to ensure and support the complete ecosystem required for ammonia-fuelled tankers to operate sustainably and safely.
- Investing in research and development to unlock key technological bottlenecks. Research and development (R&D) efforts will be organised around being able to import, store, handle and utilise hydrogen (and all carrier forms deemed suitable for Singapore) safely, economically and at scale. This will include technologies relating to improving the process of liberating hydrogen, improving the economics of transporting and storing liquefied hydrogen, utilising hydrogen in sector applications and managing hydrogen and ammonia deployment safely.
- Pursuing international collaborations to enable supply chains for low-carbon hydrogen. The NHS also envisions Singapore working closely with industry and international partners to

enable the formation and scaling up of supply chains for low-carbon hydrogen. Such efforts include advancing the development of Guarantee of Origin certification methodologies, ensuring that methodologies are interoperable across jurisdictions, and building a trading and financing ecosystem to facilitate global trade of low-carbon hydrogen.

- Undertaking long-term land and infrastructure planning as well as supporting workforce training and development of our broader economy. In the future, Singapore will also develop the land and infrastructure needed to import, store, distribute and transform hydrogen into power, and pace the implementation of such developments incrementally in accordance with safety concerns, technological developments and costs. At the same time, the NHS strives to ensure that all Singaporeans can share in the opportunities presented by the hydrogen economy by encouraging workers to develop and equip themselves with the necessary skills.

Due to a limited land area, high urban density and limited potential for producing renewable energy locally, it is not presently feasible for Singapore to produce hydrogen locally. It is therefore prudent that Singapore commits to being a net importer of hydrogen instead.

As a net importer, Singapore will be dependent on international hydrogen supply chains and the production of hydrogen overseas. However, there are presently no international standards or universal methodologies for determining the greenhouse gas emissions of hydrogen production. As a result, various countries have adopted differing regulations for hydrogen which could potentially skew producers towards cheaper, more carbon-intensive hydrogen production methods for low-cost export to regions with lenient or no regulations, leaving little supply for countries with more stringent regulations. International cooperation is therefore necessary to harmonise global hydrogen regulations and facilitate international trade in hydrogen. It remains to be seen if Singapore, which regularly punches above its weight in international affairs, can advance the development of globally harmonised regulations to measure the greenhouse gas emissions of hydrogen production.

Technology relating to the import, storage, handling and utilisation of hydrogen is still relatively nascent. By leveraging on its unique position as a net importer of hydrogen, strong R&D ecosystem, ability to attract investments from technology companies and dense urban grid, Singapore can develop large-scale test-beds to test different technologies together and assess how they interoperate in the grid. The Low-Carbon Energy Research (LCER) Funding Initiative (FI) is the primary weapon in Singapore's R&D arsenal. As part of the first phase of the LCER FI, Singapore has awarded S\$55 million to projects in areas such as the development of catalysts for ammonia cracking and methane pyrolysis. An additional S\$129 million has been earmarked for the second phase of the LCER FI.

Hungary

■ National Hydrogen Strategy (May. 2021)

- "HUNGARY'S HYDROGEN STRATEGY" JOHN SZAB, Research Institute for Sustainability (RIFS) Discussion Paper, Potsdam, June 2023

Hungary has been a frontrunner in articulating hydrogen ambitions. The government and a number of companies were quick to jump on the "hydrogen train", with the former taking the lead

by publishing the National Hydrogen Strategy (henceforth, simply Strategy) in May 2021 (Government of Hungary, 2021). This followed the European Commission's (2020) 'A hydrogen strategy for a climate-neutral Europe' and other strategies relatively quickly (World Energy Council, 2021), which may be surprising given the size of Hungary's hydrogen market and the relatively moderate climate and renewable ambitions. This paper explores the roots of Hungary's interest in hydrogen and pieces together the role international forces play in shaping this energy carrier's and related technology's role in the country's energy system and, more broadly, the economy.

Table 1: Hungary's 2030 hydrogen plans

<i>Category</i>	<i>Production</i>	<i>Demand</i>		
		<i>Industrial Demand</i>	<i>Transport</i>	<i>Balancing the electricity grid</i>
<i>Low-carbon H₂</i>	20k tonnes	20k tonnes		
<i>Carbon-free and renewable H₂</i>	16k tonnes	4k tonnes	10k tonnes	
<i>Additional infra-structural plans</i>	240 MW electrolysis capacity		20 charging stations / 40 charging points 4,800 fuel cell vehicles	60 MW balancing capacity 2% blending (where reasonable)

Source: Government of Hungary, 2021

The Strategy indicates that only a portion of future hydrogen demand will be met via renewable, carbon-free, or low-carbon hydrogen by 2030 (see table 1). It proposes that 24,000 tonnes of green, low carbon, or carbon-free hydrogen per annum will substitute emitting (grey) hydrogen in the industrial sector. Moreover, the transportation sector's demand will reach 10,000 t by 2030, which will grow to 65,000 t by 2040 and 212,000 t by 2050. Heavy-duty transportation is the driver of the latter's growth as the diesel engines of trucks, buses, and garbage trucks are phased out. The Strategy envisions a need for twenty charging stations by 2030, which would optimally be distributed along highways near larger cities (Szab et al., 2022). The Strategy also envisions that hydrogen be blended into the natural gas grid to decarbonise natural gas, which plays an important role in meeting household and commercial energy needs 73% of households used natural gas directly throughout the country (KSH, 2019). It also presents hydrogen as a tool that could support balancing the grid by helping meet peak electricity demand and store energy when necessary. Thus, future consumption has four pillars: (1) industry, (2) transportation, (3) balancing the electricity grid, and (4) decarbonising gas consumption by blending. That is, most demand originates from the decarbonisation of natural gas (heating, industry, electricity generation) and petroleum products (transportation).

A force that is set to alter the Strategy is the government's recent pivot to support battery manufacturing. Industrial policy has shifted to welcome the development of battery-related megaprojects undertaken by a host of multinational companies, including South Korean Samsung or Chinese CATL. Battery production is a tremendously energy-intensive activity and current estimates suggest that projects in the pipeline will increase domestic electricity demand by 3.5

TWh, which equates to approximately 8%~9% of 2021 total demand (Bucsky, 2023). Government policy has sought to facilitate this expansion and state-owned energy enterprises will invest in capacities to substantially increase electricity generation. Measures that can help dampen the mismatch between supply and demand include three natural gas combined cycle gas turbines with a total installed capacity of 1650 MW. These can both help meet peak demand and the baseload demand of battery manufacturing facilities from the mid-2020s onwards. They are also planned to be hydrogen-ready, further increasing hydrogen's potential role.

Hydrogen's uptake is also supported by supply-side factors, given the infrastructure disposition and energy politics of Hungary. The country's long-term hydrogen ambitions emphasise a gradual shift to green hydrogen, while relying on low-carbon and carbon-free hydrogen in the interim. Green ambitions are premised on the continued boom of solar photovoltaics. The installed capacity of solar PV rapidly rose over the course of the past 6~7 years, from effectively nil to nearly 4 GW by December 2022 (MAVIR, 2022). This is especially substantial when considering the size of the electricity market, where peak demand highs were just over 7 GW in 2022 (MAVIR, 2023). The solar boom led a lopsided development, as government policy effectively banned the construction of wind installations that would have been able to balance some of solar PV's intermittency. Meanwhile, the grid has become saturated and pilot projects that connect batteries to the grid are only being introduced by the regulator. The intermittency stemming from solar output and limitations for the grid to absorb generation underpins the case for project developers to explore hydrogen production, but the economic case is not there just yet according to developers.

The Paks nuclear power station is a further driver of zero-carbon hydrogen. The four reactors that began operations in the 1980s have a total installed capacity of 2 GW and provide approximately half of Hungary's domestically generated electricity. They will remain operational into the 2030s and, in parallel, the government began to explore the option to build a nuclear power station - Paks 2 - that would substitute the existing one. Initial plans indicated that the two power stations' operations would overlap, leading a number of experts to propose that surplus electricity be used to produce hydrogen. Delays in the construction of Paks 2 make overlapping operations increasingly unlikely, but nuclear is still framed as a mainstay in Hungarian energy affairs and there is still a push from the government and private actors' interest to construct an electrolyser that would harness abundant baseload electricity from the plant to produce hydrogen (Balogh, 2021). This introduces a feedback loop whereby nuclear-based electricity underpins a case for hydrogen and interest in hydrogen underpins the case for nuclear generation.

The third supply-side driver for hydrogen is the extensive role natural gas plays in Hungary's energy system. Hungary has an extensive gas grid, large natural gas storage facilities, and natural gas infrastructure developed by end-users to meet energy needs (e.g., household heating or industrial demand). This enables the uptake of low-carbon hydrogen in a number of ways. The gas grid could be converted to support the blending of hydrogen which can either be domestically produced or imported. If domestically produced, Hungary can continue to import natural gas, which it can convert into hydrogen via steam methane reforming paired with CCS. Hungary's geological potential for CCS is held to be good, but projects have not yet been implemented (CCS4CEE, 2023). MOL - a regionally important oil and gas company - has experience with CO₂ injection for enhanced oil recovery (EOR), and Hungarian stakeholders have participated in three large EU projects on CCS (EU GeoCapacity, CGS Europe, and CASTOR). Despite limited experience, stakeholder involvement in projects alongside common discourse and objectives in the Strategy indicate that there is an interest to produce blue hydrogen and utilise the stakeholders' experience with natural gas.

■ Power-to-X Strategy (March. 2022)

The Government has formulated four objectives that collectively contribute to overcoming the barriers for PtX and plot a course for the development and expansion of green hydrogen and green PtX products. The Government is thereby taking the first major holistic step towards a new utilities sector.

Objective 1: Power-to-X must be able to contribute to the realisation of the objectives in the Danish Climate Act

The Government aims to ensure that PtX can contribute to the achievement of Denmark's climate objectives, namely the 70 percent target by 2030, the long-term target of climate neutrality by 2050 at the latest and the reduction of Denmark's global climate footprint. The Government aims to ensure that PtX can contribute to the achievement of Denmark's climate objectives, namely the 70 percent target by 2030, the long-term target of climate neutrality by 2050 at the latest and the reduction of Denmark's global climate footprint.

Accordingly, the Government will:

- Push for ambitious, pan-European requirements for CO₂ intensity reduction targets in the negotiations on the EU Commission's "Fit for 55" package, including in the shipping sector.
- Push for higher pan-European sub-requirements for PtX fuels in aviation, as well as the option for individual Member States to set higher national requirements.
- Initiate an analysis of biological resources for the green transition.

Objective 2: The regulatory framework and infrastructure must be in place for Denmark to utilise its strengths and allow Power-to-X to perform on market terms in the long run.

The Government will work to ensure that Danish hydrogen and PtX products can eventually compete with biofuels and foreign PtX products on the market. Accordingly, the Government will create the appropriate economic and regulatory framework for ensuring that the production and use of PtX products can eventually perform on market terms. The Government will also establish the framework conditions for a hydrogen infrastructure in Denmark that can support flexible operation of the PtX plants and transport hydrogen over long distances.

Accordingly, the Government will:

- Invest DKK 1.25 billion towards operating support for the production of hydrogen and other PtX products. The purpose of the PtX tender is to support the industrialisation and upscaling of PtX production in Denmark and thereby reduce the costs associated with hydrogen production. This is envisaged to encourage growth and job creation as well as Denmark's commercial and export potential in the PtX area. These subsidies will be granted as a fixed price subsidy for a 10-year period.
- Enter into dialogue with the European Commission on allocating DKK 344 million of REACT-EU funds and the Just Transition Fund to establish a national investment funding scheme for innovative green key technologies with a particular focus on PtX and hydrogen, including green production and demonstration projects.
- Initiate a 360-degree review of Denmark's legislation in relation to hydrogen.

- Develop a national regulation for a Danish hydrogen market.
- Give Energinet and Evida the possibility to own and operate hydrogen infrastructure.
- Act on the recommendations from the South Jutland growth team to establish a commercial beacon for green energy and sectoral linking.

Objective 3: The integration between Power-to-X and the Danish energy system must be improved

The Government will work towards creating a framework that ensures that PtX can contribute to an integrated and flexible energy system where PtX is integrated into the system so that it works in harmony with the electricity, gas and heating sector. The Government will accordingly strengthen the basic conditions for ensuring that PtX plants are located in places around Denmark where they can create value for the electricity system by offering flexibility and reducing the need for grid expansion and reinforcement.

Accordingly, the Government will:

- Provide the option for geographically differentiated consumption tariffs, giving Energinet and grid companies the option to differentiate consumption tariffs for large electricity consumers based on their geographical location and thereby ensuring that the tariffs reflect the true cost of electricity to a greater extent. This can provide a financial incentive to choose appropriate locations in the electricity grid for PtX plants and thereby contribute to more efficient use of the electricity grid.
- Create an application-based scheme for establishing direct links between major electricity consumers and electricity producers, e.g. between a PtX plant and a wind farm/solar park, when deemed socio-economically beneficial to do so.
- Act on the recommendations from the South Jutland growth team to establish a commercial beacon for green energy and sectoral linking, including links between PtX and district heating.

Objective 4: Denmark must be able to export Power-toX products and technologies

The Government will work to ensure that Denmark contributes to the realisation of the EU's reduction targets for 2030 and 2050 as well as those of the Paris Agreements, while at the same time exploiting the commercial and export potential for Danish businesses by enabling an upscaling and development of the Danish PtX industry across the entire value chain. Foreign investors can make a significant contribution in that regard, and promoting investments can further help towards achieving that goal. At the same time, a focus on innovation can contribute to promoting future Danish exports and attracting foreign investment.

In addition to the investment support scheme that will contribute to the upscaling and development of PtX technologies (see objective 2), the Government will therefore strengthen the framework for 1) creating access to financing for major demonstration projects such as PtX plants, 2) ensuring that Danish companies can export certified green hydrogen and green PtX fuels and 3) establish a hydrogen infrastructure in Denmark that can eventually be used to export hydrogen to other European countries.

Accordingly, the Government will:

- Propose that Denmark should aim to build upwards of 4 - 6 GW of electrolysis capacity by 2030.
- Support the export of hydrogen and PtX products by creating the framework for a hydrogen infrastructure that can eventually be linked to a common European hydrogen infrastructure.

- Improve access to venture capital, including Danish businesses' access to export financing, with a view to supporting the commercial development of PtX technologies and products both in Denmark and abroad.
- Support Danish businesses' exports of hydrogen and PtX technology and work to attract foreign investment in Danish PtX projects.
- Work to create clear and uniform rules in connection with European certification for green hydrogen and biogenic sustainable CO₂.

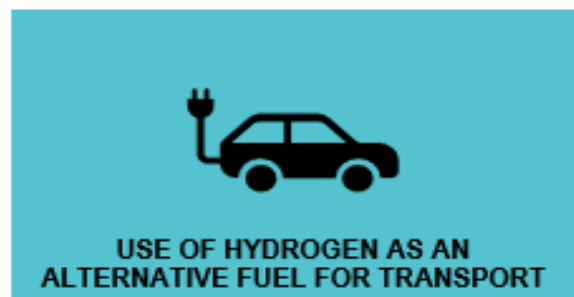
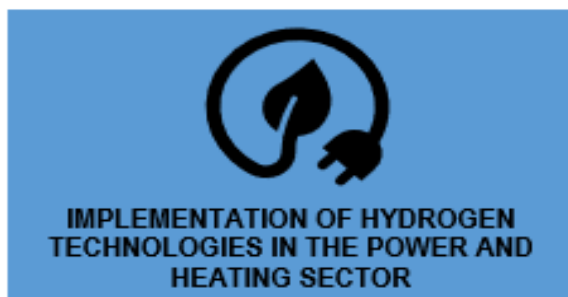
Republic of Poland

■ Acceptance of comments to the Hydrogen Act

- At the end of October 2022, the Polish climate ministry sent for consultation a 31-page draft amendment to the energy law, the so-called Hydrogen Act, which turned out to be heavily over-regulated,
- As part of these discussions, one of the key achievements was the acceptance of Hydrogen Poland's comments to the amendment of the 'Hydrogen Act' under the leadership of board member Beata Superson-Polowiec. This success is important for the further development of the hydrogen sector, exemplifying the industry's effective response to changing regulatory conditions.
- Changes introduced as a result of Hydrogen Poland's comments:
 - Waiving the obligation to obtain a licence for hydrogen transmission.
The decision to waive the licensing requirement for hydrogen transmission is an important step towards encouraging the development of new operational and business models. Remaining with the idea in which a hydrogen producer and a dedicated infrastructure connected to the consumer are required to obtain a licence for its use could conflict with other measures to stimulate investment in such installations.
 - Exemption from licensing for hydrogen generation by electrolysis.
The law has taken into account Hydrogen Poland's suggestions by exempting the production of hydrogen by electrolysis, regardless of volumes, from the licensing requirement. This will generate a minimal carbon footprint making its production more environmentally friendly. This is particularly important from the perspective of the EU's climate objectives, which Poland is implementing as one of its 27 members.
 - Change in the volume and value of turnover requiring concessions.
Significant changes have been made to the concession requirements, raising the order of magnitude of both volume (>55,000 Nm³) and value (annual turnover value > one million euros). These changes have a positive impact on the flexibility of the hydrogen market, allowing it to adapt to local needs, especially in the area of transport.
 - Abandon the idea of defining hydrogen.
The inclusion of Hydrogen Poland's proposal to abandon the definition of hydrogen is an important step in stimulating and encouraging the market. Instead, the legislature has focused on defining types of hydrogen according to carbon footprint, which is in line with long-term environmental goals.

■ Polish Hydrogen Strategy to 2030 with an Outlook to 2040 (November 2021)

- The Polish Hydrogen Strategy to 2030 with an Outlook to 2040 (PHS) is a strategic document that defines the main objectives for the development of the hydrogen economy in Poland and the directions of activities necessary to achieve them. The document is part of global, European and national efforts to build a low-carbon economy.
- The vision and overarching goal of the PHS is to create a Polish hydrogen industry and its development for achieving climate neutrality and maintaining the competitiveness of the Polish economy.
- The document identifies 6 specific goals:



- Implementation of the PHS goals will help accelerate the decarbonization of the most energy-intensive sectors. Its provisions will allow for environmentally friendly hydrogen production on an industrial scale and a gradual move toward building a zero-carbon economy in Poland.
- The PHS identifies a total of 44 actions that will enable the realization of its goals. The effects of the actions specified in the PHS will support the achievement of climate and energy goals, decarbonize hydrogen production, minimize the negative socio-economic effects of the shift away from coal-based energy, increase the share of RES in the Polish energy mix and remove regulatory barriers to the development of the hydrogen market

- Implementation of the measures specified in the PHS will support the development of individual regions of Poland through, among other things, the creation of hydrogen valleys in these regions, which will allow to build a value chain related to the hydrogen economy, such as production, transport, storage and final use of hydrogen in industry. Among other things, the valleys will host B+R+I and investment projects that will contribute to cooperation between local, national and foreign stakeholders.
- The PHS also defines horizontal activities concerning the utilization of Poland's R&D potential in hydrogen technologies and the development of production facilities for hydrogen-powered vehicles and components necessary for the hydrogen economy.
- PHS supports all methods of low- and zero-emission hydrogen production with an indication of: water electrolysis process, biomass gasification, fermentation or pyrolysis technology, biogas steam reforming, biomethane steam reforming, waste gasification, thermal processing or pyrolysis, waste gases, hydrocarbon steam reforming using CO₂ capture and storage (CCS/CCU) technology, coal gasification using CCS/CCU technology, IGCC technology, and IGFC technology.
- The indicators for achieving the above targets by 2030 will be:
 - Installed capacity of low-carbon hydrogen production facilities: 50 MW by 2025 and 2GW by 2030.;
 - Number of hydrogen valleys: at least 5;
 - Number of hydrogen buses in use: 100-250 by 2025 and 800-1000 by 2030.;
 - Number of hydrogen stations: min. 32 by 2025r.;
 - Conclusion of the Agreement for the Construction of the Hydrogen Economy (concluded on 14.10.2021);
 - Creation of the Hydrogen Valleys Innovation Ecosystem;
 - Establishment of Hydrogen Technology Center.

■ Selected national acts on hydrogen production

Poland's regulatory environment for hydrogen and derivatives is gradually beginning to develop in response to very strong regulatory dynamics at the European level.

- Draft Law dated 21.12.2022 on Amendments to the Energy Law and Certain Other Laws (legislative stage - opinion)
 - introduces a general definition of hydrogen with a distinction between types: Low-carbon hydrogen; Electrolytic hydrogen; Renewable hydrogen, and expands the definition of "fuel" to include hydrogen.
 - introduces a definition of electrolytic conversion and electrolytic conversion facilities (equipment for the conversion of the energy carrier: electricity-hydrogen)
 - establishes a new body (Hydrogen Committee) within the NCRD that will evaluate applications and allocate funding for hydrogen R&D activities.
 - implements regulations defining the rules for the operation of hydrogen storage facilities.
 - indicates that hydrogen storage is a form of energy storage.

- defines hydrogen storage and indicates what is not within the scope of the definition (e.g.: storage at refueling stations).
- implements the principles of equal third-party access to storage infrastructure.
- allows hydrogen storage system operators to provide electrolyzer sharing services.
- introduces an obligation to prepare instructions for the operation and use of hydrogen storage facilities.
- Law on Electromobility and Alternative Fuels of January 11, 2018.
 - introduces a national target for the share of low-carbon hydrogen, electrolytic hydrogen and renewable hydrogen in total transportation fuels, set at a level that supports the development of electrolytic hydrogen and renewable hydrogen (along the lines of the EU's RFNBO target for transportation).
- Law on Amendments to the Geological and Mining Law and Some Other Laws (legislative stage - entered into force on 28.10.2023).
 - implementation of regulations directly allowing underground tankless storage of hydrogen.
 - underground storage will be able to take place in underground salt caverns, depleted hydrocarbon deposits and in aquifers - brine formations.
 - recognition of such investments as public purpose investments.
 - companies exploiting the deposits will have priority to obtain a license for hydrogen storage in the deposit.
 - inclusion of hydrogen deposits under mining ownership.
- Law on the system of monitoring and controlling the quality of fuels on 25.08.2006.
 - establish the basic principles of hydrogen certification and the obligations of generators related to it
 - determination of the scope of hydrogen certification testing through an accredited laboratory
 - determination of mandatory deadlines for hydrogen quality testing and certification
 - determination of the content and details presented in the hydrogen quality certificate
 - on December 29, 2022, the Executive Order of the Minister of Climate and Environment on methods for hydrogen quality testing by an accredited laboratory was published.

■ Non-legislative actions

In pursuit of the goals set forth in the PHS, the Government of Poland plans to take a number of measures to support its implementation, which include:

1. Establishing an agreement to build a hydrogen economy: The purpose of the proposed Agreement is to define a list of long-term measures for the development of the new industry, to which public and private entities will commit themselves. It will present a catalog and offer of legislative, organizational, institutional and financial instruments. Thus, it will create a kind of action plan to build the hydrogen economy and will be a key implementing instrument of the PHS.
2. Creation of the hydrogen valleys innovation ecosystem: the Polish Hydrogen Valleys Innovation Ecosystem will include innovative industrial ventures, large-scale, multi-year investment

projects implemented within a defined geographic area, relying on selectively and purposefully selected and coordinated within the hydrogen valleys in the innovation, technological, infrastructural, industrial and natural dimensions. The construction and operation of the ecosystem must be coordinated at the national level and integrated into the international economic system. It will be managed by a "Coordinating Institution" to ensure the emergence of a Polish hydrogen industry with globally competitive potential.

3. Establishment of a hydrogen technology center: In order to take advantage of Poland's scientific and technological potential in the field of hydrogen technology, it will be necessary to establish a unit whose tasks will include:
 - coordinate ongoing research projects and support the scientific community in establishing specialized research groups, including virtual ones, and commercializing research results;
 - providing finished products for the hydrogen economy to the market for use by domestic and foreign entities;
 - providing extensive consulting, services and development work in the area of hydrogen technology utilization;
 - initiating work on new solutions in the area of hydrogen;
 - acquiring funds for new projects and research work;
 - education and dissemination of knowledge in the hydrogen field.
4. Competence building for the hydrogen economy;
5. Educational activities and social campaigns;
6. European and international cooperation.

■ Anticipated capital expenditures and funding sources

- Due to the early stage of development of hydrogen technologies and the need for in-depth analyses, the available knowledge allows only a limited estimate of the investment costs necessary to implement the PHS goals.
- By 2025, the implementation of the goals related to the implementation of hydrogen technologies in public transport, together with the hydrogen refueling infrastructure and the provision of the planned production (commissioning of a plant for the production of hydrogen from low-carbon sources) will require investments of about PLN 930 million.
- In the 2030 timeframe, available knowledge allows us to estimate only the costs associated with investments in electrolyzers, which will exceed PLN 9 billion, depending on the chosen technology (alkaline/PEM/SOE), and the purchase of more buses, which will amount to about PLN 1.8 billion.
- In total, in the period 2021-2030, the necessary investment in the implementation of hydrogen technologies in public transport, together with the necessary infrastructure and the achievement of the assumed capacity of installations from low-carbon sources at the level of 2GW, will amount to about PLN 11 billion.
- The following, among other things, are planned to ensure financing for the achievement of PHS goals:

- Launch of programs to support research and development in hydrogen technology - anticipated value of the fund is PLN 1 billion;
- Launch in 2021. NFO iGW's "New Energy" Program - estimated budget for the hydrogen component - up to PLN 600 million;
- Launch in 2021. "Green Public Transport" Program (Phase I) - estimated budget for the hydrogen component - about PLN 320 million;
- Launch in 2021. Program "Support for electric vehicle charging infrastructure and hydrogen refueling infrastructure" NFO iGW - about PLN 100 million. The purpose of the program is to support the development of electric vehicle charging infrastructure and hydrogen refueling infrastructure. Local government units, entrepreneurs, cooperatives, housing communities and individual farmers will be able to apply for non-refundable subsidies;
- EU Cohesion Policy Funds provide for the possibility of financing public transport in cities and functional areas powered by alternative fuels, including bus fleets with hydrogen refueling stations. Support will be directed to operators and organizers of public mass transport.

People's Republic of China

■ China's National and Regional Hydrogen Development Strategies

In September 2021, China announced what it called its "dual carbon goal" of carbon peak by 2030 and carbon neutrality by 2060. As a first step toward achieving that goal, China's State Council introduced an Action Plan for Carbon Dioxide Peaking Before 2030, which emphasized the role of hydrogen in sectors such as steel, petrochemicals, and transportation (including heavy-duty freight), as well as technologies such as renewable hydrogen production. This was soon followed by the announcement of China's National Plan, which lays out the vision for China's hydrogen industry by 2035. The National Plan strategically positions hydrogen as: (1) an important part of China's future energy system; (2) an important carrier for achieving a low-carbon energy transition in China; and (3) a key emerging industry and development direction of future industries in China. While most of China's specific targets in this strategic plan are for 2025, many other countries' national hydrogen strategies outline quantified targets for 2030 (and beyond), which can create the perception that their strategies are more ambitious. China's plan, however, includes the long-term vision to fully establish the hydrogen industry value chain by 2035. Nonetheless, among the most important of these 2025 targets is the deployment of 50,000 fuel cell vehicles and the production of 0.1 to 0.2 Mt of renewable hydrogen toward a broader goal of reducing annual CO₂ emissions by 1 million to 2 million tons by 2025.

Other highlights from the National Plan include an aim to establish a hydrogen supply system that uses both industrial by-product hydrogen and renewable hydrogen; meanwhile, the use of carbon capture and storage technologies to produce hydrogen from fossil fuels is absent from the strategy. The short-term emphasis on utilizing by-product hydrogen (which is unique to China) is due to the substantial volume of wasted by-product hydrogen (largely fossil-based) extracted from industrial waste gas in sectors such as coking, chlorine, and propane dehydrogenation. Aligned with this plan, numerous local governments (e.g., Anhui, Shanxi, Jilin, Hebei, Shandong, and Hunan) prioritize by-product hydrogen as the primary supply source through 2025. The

development of collection and purification technologies for this hydrogen is also given priority across regions.

The National Plan marked a significant shift in China's overall energy strategy by making hydrogen a fundamental component of its emerging energy system, positioning the country well to achieve global leadership in hydrogen technologies such as fuel cell vehicles and electrolyzers. Out of the 34 regions that make up China, 18 have independently introduced their own hydrogen industry 14th Five-Year Plan, a strategic blueprint outlining a province's economic and social development goals over a five-year period, while the others have incorporated hydrogen into their broader industrial strategies. Given their consideration of diverse provincial resources, infrastructure capacities, and strengths, these regional-level strategies hold valuable insights. One critical conclusion that can be drawn from them is that local policy and industry developments are already moving far beyond the conservative targets of the National Plan. The regions' cumulative targets for renewable hydrogen amount to over 1.1 to 1.2 Mt by 2025, or 5 to 12 times the national target. For instance, Inner Mongolia has an ambitious objective of 480,000 tons of renewable hydrogen by 2025, more than twice the national target.

Localized hydrogen strategies are tailored to leverage regional advantages and infrastructure, leading to varied approaches across provinces. Regions with abundant renewable resources, such as Sichuan with its hydropower potential, prioritize renewable hydrogen production via hydropower. In contrast, coal-rich regions, such as Shanxi, primarily focus on industrial by-product hydrogen from coal-chemical production. Regions with an abundance of both renewable and coal resources, such as Inner Mongolia, adopt a diversified approach.

Different regions also prioritize different applications according to their unique needs. For instance, Inner Mongolia, Shanxi, and Shaanxi aim to deploy hydrogen for fuel cell forklifts and trucks to contribute to mining operations, while Zhejiang focuses on leveraging hydrogen for combined power and heating as well as fuel cell electric vehicles (FCEVs) in its public and port logistics transportation system. On the other hand, all regions emphasize establishing hydrogen refueling stations and deploying FCEVs, with many identifying specific quantities of each that should be achieved. This is consistent with China's longstanding policy of promoting FCEV development, both passenger vehicles and trucking, through the expansion of hydrogen refueling infrastructure and other related technological innovations. The National Plan only reinforces this policy.

Overall, China's regional strategies show that local governments will play a crucial role in the early stages of China's hydrogen development, enabling the central government to "test the waters" in the hydrogen sector. Local government officials and senior management in state-owned enterprises are also collaborating with central ministries to implement hydrogen-related policies, such as incentivizing FCEV development and establishing demonstration projects for other hydrogen applications, and the potential for career advancement incentivizes them to align with the national government's development objectives, which include the advancement of a hydrogen economy and aligning the "dual carbon" goal.

■ Revision of Basic Hydrogen Strategy (activated on June 2023)

- Japan released a revised Hydrogen Basic Strategy in June 2023. Japan was motivated by G7 commitments to move away from a reliance on Russian energy, growing calls for climate action, and new hydrogen subsidies under the EU's Green Deal Industrial Plan and the US' Inflation Reduction Act.
- Japan's first strategy, released in December 2017, was the world's first national hydrogen strategy; however, the energy landscape has changed drastically since then. Japan's revised strategy intends to generate public and private sector investment in hydrogen worth 15 trillion yen (NZD173.4bn) over the next 15 years, and increase the use of hydrogen six fold by 2040.
- Japanese government officials highlighted three new features of the refreshed strategy:
 - a new mid-term volume target of 12 million tonnes per annum by 2040 (a six fold increase from current levels);
 - a "pathway" to low-carbon hydrogen, aiming for 3.4kg of CO₂ emissions or less for 1kg of hydrogen produced;
 - a 10% target for Japanese companies' share of the global electrolyser market.
- Japanese government officials also highlighted support schemes to be implemented under the new strategy: 1) cluster development support to establish internationally competitive industrial clusters and supply chains (1 trillion yen/NZD11.5bn¹ of public and private investment expected) and 2) a producer support scheme with a view to expanding the supply volume and reducing supply cost (more than 7 trillion yen/NZD80.9bn¹ investment expected). Japan's Ministry of Economy, Trade and Industry (METI) expects to release information on a more detailed scheme by March 2024.
- At a press conference, Minister of Economy, Trade and Industry NISHIMURA Yasutoshi said "We would like to steadily build a supply chain for hydrogen in Asia and the Indo-Pacific region by further expanding Japan's (hydrogen) technology, which has been world-leading." In order to promote Japan's policy toward hydrogen and ammonia, the Ministry of Economy, Trade and Industry (METI) established a new division for hydrogen and ammonia policy separately from its hydrogen and fuel cells strategy office in July 2023.
- Below is a table summarising some of the targets that have been set out in the revised strategy.

Targets	Current	Revised Hydrogen Strategy - June 2023
Volume (use)	2 Mt/pa	3 Mt/pa by 2030 12 Mt/pa by 2040* 20 Mt/pa by 2050 <i>*New additional mid-term target</i>
Volume (domestic production)	2 Mt/pa	No numeric target
Volume (imports)	-	No numeric target, but assumes large volume of supply to be via import
Electrolyser capacity	-	By 2030, 15 GW of water electrolyzers to be installed by Japanese-related companies (including sub-material manufacturers) globally
Low-carbon intensity	-	Hydrogen: 3.4kg-CO ₂ e/kg-H ₂ (well-to-gate) Ammonia: 0.84kg-CO ₂ e/kg-NH ₃ (gate-to-gate)
Price efficiency	100 yen/Nm ³	30 yen/Nm ³ by 2030 20 yen/Nm ³ by 2050
Refuelling stations	180	1,000 by 2030
FCV uptake	7,700+	Equivalent 800,000 passenger vehicles by 2030 (no separate targets for e.g. buses)
Co-firing %[2]	Hydrogen: 30% Ammonia: 20%	Hydrogen: 30%+ (demonstration) by 2030 Ammonia: 20%+ (commercial) by 2030 (dependent on size) Longer term aspirations of 50%.
Installed home fuel cells	-	3 million by 2030
CCS storage capacity	-	between 6-12 million tonnes annually by 2030

The Republic of Colombia

The Hydrogen Roadmap of Colombia was released in September 2021 and is structured in 4 large blocks of analysis.

- Production: The cost of hydrogen and its derivatives (in its different forms gray, blue, green, or produced from the network) has been determined throughout the country, evaluating the potential of renewable resources, as well as the reserves and prospective costs of natural gas and coal. The analyzes considered the tax incentives of Law 2099 and considered medium and maximum capacity factors, dividing the country into 8 regions.

- Demand, emissions, and exports: The potential uses in the different sectors were evaluated, as well as their impact on the energy matrix, and the reduction of associated emissions in 3 scenarios: National Energy Plan (PEN (for its Spanish acronym), IEA and scenario according to the results of production deliverable. After analyzing the domestic demand, the export potential was determined by identifying the main importing markets and comparing the costs of green hydrogen from La Guajira against that of other countries.
- Regulation and gaps: The current legislation was analyzed (energy transition law, resolution of zero and low emissions fuels, among others), an international regulatory benchmark, and an analysis of gaps with relevance for hydrogen, as well as a Legal Roadmap identifying the responsibilities of the different public entities in the country was made.
- Socialization plan: The Roadmap is the result of a collaborative work between multiple public and private actors. At the beginning of the analysis, a preliminary consultation was launched in which 46 national and international entities participated, contributing their vision for hydrogen opportunities in the country. During the analysis, 26 interviews were carried out with entities that had already shown interest in the development of hydrogen projects and initiatives. In addition, 9 virtual workshops were held in which the results of the Roadmap were shared.

■ Main Results

1. Competitiveness of Colombia's low carbon hydrogen and derivatives

Blue hydrogen:

- Natural gas: Colombia is currently a natural gas producer with a national balance close to self-sufficiency. The country has reserves of 2.949×10^6 MMbtu, which, at the current production rate, would take 7.7 years to run out.
- Coal: Colombia is the largest coal producer in Latin America and one of the largest exporters worldwide.

There are reserves of more than 4500 Mt of coal; at the current production rate, it would take more than 50 years to deplete.

- Regarding the competitiveness of hydrogen, a levelized cost of blue hydrogen of approximately 2.4 USD / kg is obtained for both routes (natural gas and coal). The cost remains constant over time as the reduction in technology costs is offset by the upward trend in the cost of inputs and the price of CO₂ emissions (at a CO₂ cost of 20 USD / T). It should be noted that this cost is for new plants; existing gray hydrogen plants that implement CCUS will have more competitive costs.

Green hydrogen: Regarding green hydrogen, Colombia has a high potential for renewable. The best capacity factors are found in the Guajira region with an average and maximum solar factor of 19% and 21%, respectively. Regarding wind power, there is an average and maximum factor of 46% and 63%, respectively. These factors allow to obtain:

- Current cost of green hydrogen between 2.1 and 2.8 USD/kg.
- By 2030, costs will be reduced by between 1.7 and 2.2 USD/kg.
- By 2050 they will reach values of between 1.1 and 1.5 USD/kg.
- The lower limit corresponds to areas with minimum values and the upper limit to the average values with wind power.

- In addition to the high resource, Guajira has a high renewable potential of at least 25 GW of onshore wind and 45 GW of solar, thus bringing together the necessary elements to become a global green hydrogen production hub.

2. Demand and emission reduction.

Previous analyzes allowed the construction of a techno-economic scenario for the penetration of hydrogen in Colombia's energy matrix, where hydrogen will be developed in three phases:

- Existing applications (2020-2026), low-emission hydrogen will begin to be consumed in refining and will begin to be used for heavy land transport.
- Emerging applications (2027-2035), use in light transport vehicles and fertilizer production.
- Disruptive applications (2036-2050), there will be a great deployment in the previous uses and, in parallel, new applications will be created, such as maritime and air transport through derivatives, flexible electricity generation in combined cycle plants, steel production and the use of hydrogen mining trucks.

It is expected that in 2030, demand for low-emission hydrogen will reach 120 kt per year, being located in the industrial sectors (93% of demand) and transportation (the remaining 7%). However, the transport sector will experience strong growth until it reaches 47% of demand in 2040. In the decade between 2040 and 2050, new uses of hydrogen will consolidate, estimating an annual internal demand of 1,850 kt by 2050. By then the analysis production of synthetic fuels and the growth in demand in land transport will make it the main demand for hydrogen with 64% of the total.

Previous demand for hydrogen will lead to abatement of emissions of between 2.5 and 3 million tons of CO₂ during the 2020/2030 decade, allowing to decarbonize sectors that are difficult to abate such as heavy transport, long-distance or industrial processes.

3. Export oriented country

Colombia's high renewable potential and its access to maritime trade routes due to its position with access to 2 oceans, make it a country with an export role. Green hydrogen produced in La Guajira may be used for exports to:

- Asia (Japan, Korea, and China)
- Europe
- Panama Canal, given the expected weight of ammonia in the maritime transport sector and the future demand for hydrogen for the refueling of ships.

4. Pillars of the Roadmap

The strategy is based on five pillars that seek Colombia's social, environmental, and economic development:

- Hydrogen as a key piece to achieve carbon neutrality in Colombia.
- The development of the value chain or as a path towards an export economy.
- Hydrogen as an enabler of a just energy transition.

- The National Government committed to the deployment of hydrogen.
- Hydrogen as a way of integrating the territory and a tool for inclusive development.

■ Goals, measures, and national ambition

Ambitious national goals have been set for 2030, the achievement of which will allow the development of the technical and industrial capacities necessary to take Overview of Hydrogen Policy by Countries 2022 GHIAA Annual Report 29 advantage of the full future potential of hydrogen. By 2030 It is expected to:



To guarantee the achievement of goals and the correct development of hydrogen, an action plan divided into 4 axes has been drawn up:

- Legal and regulatory enablers; some of the main actions to be carried out are: continue with the regulation of the hydrogen market and definition of the roles of entities, develop the hydrogen emissions certification system, review and update the technical regulations for production, storage and use of this fuel.
- Market development instruments, some of the main actions to be carried out are: analysis of new incentives for hydrogen, structuring financing mechanisms for hydrogen projects, development of programs to promote demand for this clean fuel.
- Support for the deployment of infrastructure, some of the main actions to be carried out are: study the availability of other natural resources for hydrogen production (ex. Biomass), evaluate the potential of CCUS in the country, analysis of mixtures of natural gas with hydrogen and assessment of transportation infrastructure needs.
- Promotion of technological and industrial development, some of the main actions to be carried out are: Regulation and implementation of Sandbox for the energy sector to promote the

development of pilot projects, structuring of I+D+I programs in H2 technologies for industry and academia.

The plan includes 28 lines of work and 57 specific measures such as the simplification of administrative procedures or the development of a guarantee of origin system.

A study was carried out on potential hydrogen pilot projects in Colombia. Taking as a starting point 23 international reference projects and 22 initiatives detected in Colombia in the socialization plan; a final list of 14 pilot projects of interest in different areas of the value chain for hydrogen and derivatives was drawn up. Optimal locations, key companies for its execution and associated benefits were identified for each project.

Law 1715 - 2014. Non-Conventional Renewable Energy Sources (FNCER)

The Law 1715 integrates unconventional renewable energies into the national energy system. It establishes tax benefits and investment incentives for unconventional energy source projects:

- Income deduction, within a maximum period of 15 years, on 50% of the total investment made.
- Exemption from VAT on the acquisition of equipment, elements, machinery, or services for the generation of unconventional renewable energy and efficient energy management.
- Accelerated depreciation for machinery, equipment, and civil works necessary for the reinvestment, investment, and operation of projects for the generation of unconventional energy sources. The annual global depreciation rate cannot exceed the threshold of 33.33%.
- Extension of tariff rights on the importation of machinery, equipment, materials, and supplies intended for investment or reinvestment activities in projects with unconventional energy sources.

Law 2099 - 2021. Energy Transition Law

Law 2099 establishes the necessary provisions for energy transition and the revitalization of the energy market. It defines green hydrogen, blue hydrogen, and white hydrogen as FNCER (Unconventional Renewable Energies) and introduces tax incentives for CCUS (Carbon Capture, Utilization, and Storage). This law is complemented by the Executive order 895 2022.

- It allows the National Government to define mechanisms, conditions, and incentives for promoting innovation, research, production, storage, distribution, and use of hydrogen for providing public electricity service, energy storage, and decarbonization in sectors such as transportation, industry, and hydrocarbons, among others.
- The national government will design public policy to promote local research and development of technologies for the hydrogen value chain. Likewise, it is authorized to use the General Budget of the Nation to finance projects for the generation, distribution, and small-scale commercialization of FNCER.
- Deduction of income tax for investments in assets, machinery, and equipment intended for the production, storage, conditioning, distribution, re-electrification, research, and final use of green and blue hydrogen.
- Enables the Unconventional Renewable Energy and Efficient Energy Management Fund (FENOGE) to finance projects in the hydrogen value chain.

Executive Order 1476 - 2022

Decree for the Adoption of Measures Aimed at Promoting Innovation, Research, Production, Storage, Distribution, and Use of Hydrogen.

- Defines low-emission hydrogen and certification of origin and storage.
- Requests the Ministry of Mines and Energy to design a regulatory sandbox for the energy sector to promote pilot developments of clean fuel.
- Empowers the Ministry of Mines and Energy to implement an Information System involving hydrogen agents and the value chain.
- Establishes a shared responsibility effort to consolidate the hydrogen market:
 - The Ministry of Environment and Sustainable Development (MADS) must define the maximum emissions threshold to consider hydrogen as low emission.
 - The Ministry of Mines must adopt a public mechanism for certifying the origin of hydrogen produced in the country, ensuring the uniqueness and traceability of inputs used for production and their associated emission intensity.
 - The Ministry of Transportation will regulate technical or operational conditions for service provision and issue requirements, procedures, conditions, and incentives for hydrogen use in the sector.
 - The Ministry of Science will establish Science, Technology, and Innovation (STI) programs to promote the development of scientific, technical, and technological capabilities for research, technological development, and innovation related to technologies in the hydrogen industry value chain.

Kingdom of Norway

In October 2021, the minority government led by the Labour Party and the Center Party announced in its government platform that it will contribute to building up a coherent hydrogen value chain where production, distribution and use is developed in parallel. Hydrogen is a vital part of the government's roadmap for an industrial revival on the Norwegian mainland. Norwegian petroleum and energy minister Terje Aasland has on several occasions stated that the government plans to have enough domestically produced hydrogen to cover own demands by 2030, and the government has initiated energy and industrial partnerships with Germany, Great Britain, France, Sweden, Denmark, Japan and USA.

The 2020 Norwegian Hydrogen Strategy emphasizes that Norwegian industry is well positioned to take a leading role in the hydrogen economy, concentrating efforts on areas of particular potential for industry growth and value creation, such as clean hydrogen production and offtake in the maritime sector and heavy industries.

The strategy was complemented by a Hydrogen Roadmap in 2021, which provides an ambition to establish 5 hydrogen hubs for maritime transport, 1-2 large industrial projects with production facilities for hydrogen and 5-10 pilot projects for the development of cost-effective hydrogen solutions and technologies by 2025.

The Norwegian state agency Enova in December 2021 granted support to three large industrial projects - led by Yara International, Tizir Titanium & Iron and Horisont Energi - and in June 2022 followed up with further support to 5 hydrogen hubs along the Norwegian coast, as well as 7 hydrogen and ammonia vessels. The total number of vessels that have received support from Enova is currently 17. Enova announced in August 2023 that they plan to give additional support

with the introduction of two new support schemes for investments in hydrogen and ammonia vessels.

During autumn 2023, Enova has supported 4 hydrogen refuelling stations for heavy-duty transport, as well as 10 light hydrogen trucks. The government has also provided funding for two research centers of expertise on hydrogen and ammonia.

However, investment decisions in most of these projects are still pending, due to uncertainties related to market conditions and future governmental support schemes.

In June 2023, Norwegian minister for trade and industry, Jan Christian Vestre, announced that Norway will take part in the first auction of the European Hydrogen Bank. The Norwegian parliament has also requested the government to present a plan for a Contracts-for-Difference (CfD) scheme in 2023. At the time of this writing, it was still not clear whether Norway will establish a national scheme for production and use of hydrogen. This will be decided upon in the state budget negotiations for 2024 and finalized early December.

Requiring zero or nearly-zero emissions in public procurement has been a successful tool for the Norwegian government to electrify and phase in other climate-friendly technologies in the transport sector. The government has presented plans to demand zero emissions for ferries as soon as possible and speed boats by 2025. From 1 January 2024, climate and environmental impact must be weighted at a minimum 30 % in public tenders. Already, the public purchasing power of The Norwegian Public Roads Administration has been used to put the world's first liquid hydrogen passenger ferry, MF Hydra, into operation in March 2023. Another ferry will come into operation at Vestfjorden in 2025.

The Netherlands

■ Development hydrogen backbone

In letter published on 29 June 2022, Minister Jetten published a rollout plan for the development of a hydrogen grid, which is aimed at connecting the current large industrial clusters in different areas of the Netherlands, developing storage facilities, and connecting the Netherlands with its neighbouring countries. This grid will be largely developed by repurposing existing gas grid pipelines.

Three phases for the roll-out are envisaged at this stage:

- Phase 1 (aim 2025-2026):

Phase 1 will focus on connection the large industrial clusters on the Dutch coast (particularly around Rotterdam, and in the Schelde-Delta region and Groningen) with each other, with storage facilities (in the Rotterdam area), and potential for the export to Germany;

- Phase 2 (aim 2027-2028):

Phase 2 will focus on connecting industrial clusters in the rest of the Netherlands and expanding connections with neighbouring countries;

- Phase 3 (TBD):

The development of phase 3 will depend on the demand for transport and storage capacity. It will

look at expansion of the grid by using compression to allow more hydrogen to flow through the grid and by including more existing natural gas pipelines as reliance on natural gas reduces. The Minister made it clear that the roll-out plan is not set in stone and will be dependent on the appetite in the market. For that reason, HNS already concluded so-called Expressions of Interests with several companies, which are likely to be a prelude for connection and transmission contracts. In fact, the Dutch Government already needed to adjust the roll-out plan due to the war in Ukraine. The rerouted delivery of gas means that certain gas grid pipelines will continue to be used for gas transmission and the conversion of these pipelines for the transportation of hydrogen will be delayed as a result.

■ Guarantees of Origin

After the successful 'HyXchange' pilot in which 18 market parties participated, VertiCer announced in October of last year it is ready to issue guarantees of origin for green hydrogen. As in the case of electricity and gas, the guarantee of origin must be written off upon consumption. If the hydrogen is used in the transport sector, the guarantee of origin can also be converted into a so-called renewable energy unit (HBE).

The Dutch Government previously announced it will, for the time-being, only certify green hydrogen, guarantees of origin are not yet available for blue hydrogen. It is however not ruled out that in the future guarantees of origin will be made available for blue hydrogen.

Guarantees of origin are also not yet available for imported hydrogen. A more international hydrogen certification system is expected in the near future based on European regulations, which are still under discussion. After the successful pilot, HyXchange is now focusing on a spot market simulation to develop an exchange-based hydrogen trading platform.

The Federal Republic of Germany

■ National Hydrogen Strategy (Updated July 2023)

On 26th July 2023, the German government coalition presented an update of its National Hydrogen Strategy, initially adopted in 2020. Hydrogen technologies are an important tool that Germany can use to significantly reduce carbon emissions, and the updated strategy aims to further scale up the hydrogen market in the country in order to achieve climate neutrality by 2045 and strengthen the security of energy supplies. Based on the strategy, the hydrogen demand in Germany is expected to reach 95-130 Terawatt hour (TWh) by 2030. In order to meet this demand, the domestic electrolyzers capacity target will need to reach 10 gigawatts, which is double the target initially envisaged in the 2020 strategy. Around 50-70% of the hydrogen will need to be imported from abroad through pipelines, mainly from Norway and Denmark. The revamped strategy also clarifies that direct government subsidies on the production side will be limited to renewable hydrogen, but applications using low-carbon hydrogen, including blue hydrogen produced from fossil fuels with carbon capture and storage, can now be supported during the ramp-up phase of the hydrogen market. In parallel, Germany is also working on developing a Carbon Management Strategy, which will define guidelines for dealing with CCS and CCU and the possible fields in which these technologies can be used to support Germany's ambitious climate goals.

The United Kingdom

■ Hydrogen Strategy Delivery Update (December 2023)

The 2021 UK Hydrogen Strategy set out how UK Government intended to realise its vision for this new low carbon energy vector over the 2020s and 2030s, outlining a whole system approach and the joint efforts of government and industry needed to deliver supporting policy and actual projects. This vision has expanded since 2021, with the ambition increasing to have up to 10 GW of low carbon hydrogen production capacity by 2030, subject to affordability and value for money, and at least half of this capacity comprising electrolytic or ‘green’ hydrogen. Government has announced a range of new policy to support this heightened 2030 ambition, and have also set a stretching interim ambition to have up to 1 GW of electrolytic and up to 1 GW of CCUS-enabled hydrogen production operational or in construction by 2025.

For more information, visit nationalarchives.gov.uk/doc/open-government-licence/version/3.

■ Production

Government is providing funding for both capital and operational expenditure via the Net Zero Hydrogen Fund (NZHF), Hydrogen Business Model, and Hydrogen Allocation Rounds (HARs). So far, 15 electrolytic projects have received £37.9m under the £240m NZHF, and the first 11 projects under HAR1 shared £400m, amounting to 125MW. HAR2, which has just opened, seeks to support 875MW.

Industry is scaling up to deliver a minimum of two decarbonised industrial clusters by the 2025, and four by 2030. These include both CCUS enabled and electrolytic hydrogen production. Industrial users are being funded to decarbonise via the Industrial Energy Transformation Fund, with £289 million already committed.

The UK’s Low Carbon Hydrogen Standard has been set at 20g CO₂ / MJ LHV, and work is in hand to develop a certification scheme with a view to international trade.

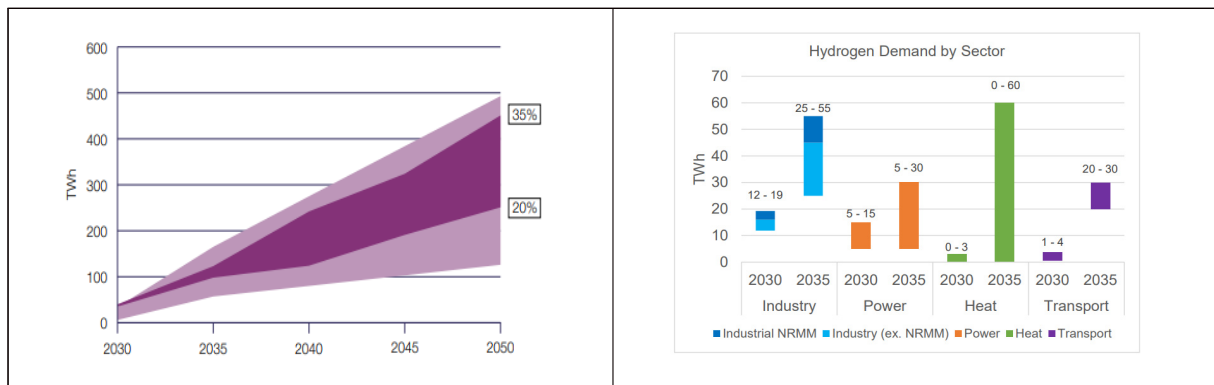
■ Hydrogen transportation and Storage

UK Government is developing business models to support hydrogen transportation and storage. A Regulated Asset Base approach combined with subsidies is favoured for the former and private law contracts for the latter. Business models are due to be in place by 2025 and the recently published Hydrogen Transport and Storage Networks Pathway lays out the vision for strategic / national evolution.

■ Hydrogen Use

Hydrogen could account for one third of the UK’s final energy demand by 2050

Hydrogen demand and proportion of final energy consumption in 2050 (Source, Hydrogen Strategy, BEIS, 2021)	Illustrative hydrogen demand in 2025 (Source: Hydrogen Production Delivery Roadmap, DESNZ, December 2023)
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- The UK's largest industrial clusters emit around 40 million tonnes of CO₂ per year and the Government's plan is for 50 TWh of industrial fuel switching to low carbon fuels, including hydrogen, by 2030. Low carbon hydrogen production is being focused in four industrial clusters to 2030 with consortia of producers and users working together.
- Having hydrogen available in the power system could achieve lower emissions at a lower cost than a system without hydrogen. The UK Government is consulting on how to support hydrogen for power, which includes fuel for low carbon flexible generation technology ("hydrogen to power") to help balance electricity supply and demand, and as a decarbonisation pathway for existing unabated gas power plants.
- The UK is active across the full range of hydrogen mobility applications:
 - Home to the world's first hydrogen fueled aircraft
 - £23m investment to establish the UK's first multi-modal hydrogen transport hub, with others to follow
 - £200m zero carbon freight trials recently announced.
 - ~£100m Clean Maritime Competition supporting over 100 projects, 40 of which focus on hydrogen or hydrogen derivatives
 - One of Europe's largest fleet of Hydrogen buses in operation in the UK.
- A strategic decision to allow blending of up to 20% into the national gas grid has recently been taken. If and where supported and enabled, this would be to deliver market building benefits, acting as an offtaker of last resort to support hydrogen economy growth, whilst ensuring it does not 'crowd out' the supply of hydrogen to alternative end users who require hydrogen to decarbonize.
- A decision on the use of hydrogen to decarbonize domestic heating will be taken in 2026, with work in progress to confirm engineering, safety and economic viability, together with practical demonstrations.

Sweden

■ Hydrogen Strategy

In developing the country's hydrogen strategy, the government first tasked Fossil Free Sweden, an industry-based government initiative, with the formulation of a strategic plan for hydrogen

development. In January 2021, Fossil Free Sweden published its hydrogen strategy (Fossil Free Sweden, 2021). The government then commissioned the Swedish Energy Agency to develop a comprehensive proposal for a national hydrogen strategy. The Swedish Energy Agency presented its draft of the hydrogen strategy in November 2021 (Swedish Energy Agency, 2021). Although the two published strategies differ somewhat in their scope, the outlined vision and priorities for hydrogen development are largely aligned. At the core of the interest in hydrogen is the decarbonization of the country's energyintensive industries, particularly steel production, alongside long-haul transportation. The formulated targets for new electrolyzer capacities are very high compared to European targets. The document published by Fossil Free Sweden envisages the need for 3 GW in new electrolyzers by 2030, while the draft strategy of the Swedish Energy Agency proposed an even higher target of 5 GW, thus reflecting the growing industry interest. An additional 10 GW in electrolyzer capacity is to be put into operation between 2030 and 2045. According

to an expert involved in the development of the national hydrogen strategy, while the EU hydrogen strategy served as an important background document, the specific Swedish targets for electrolyzer capacity were not based on EU targets. The national hydrogen strategic documents operate with the term 'fossil-free' hydrogen, which leaves the possibility for using both renewable energy sources and nuclear power for producing hydrogen. The planned electrolyzer capacities are intended entirely to meet domestic demand. So far, there have been no articulated plans by the Swedish government and industry associations to import or export hydrogen. The main vision has instead been to export goods produced with fossil-free hydrogen, such as 'green steel', and to enter the global supply chain for fossil-free hydrogen production technologies. Nevertheless, the draft of the national hydrogen strategy suggests that Sweden should assess whether or not to become a hydrogen exporter (Swedish Energy Agency, 2021, p. 9). Although an external hydrogen strategy has been lacking, the Swedish government and particularly Swedish industry stakeholders have increased their international activity in this area.

As of November 2022, the official adoption of the national hydrogen strategy by the government is still pending. Sweden held general elections on 11 September 2022, which resulted in the formation of the first-ever minority center-right government supported by the far-right populist party Sweden Democrats. While it remains to be seen whether the new government will introduce substantial changes to the national hydrogen strategy, some preliminary assessments in this regard are included in this contribution.

Emerging regional Hydrogen clusters in Sweden based on projects and plans as of 2021



Source: Fossil free Sweden, 2021.

IV. Recent In-Country Development

Republic of Korea

■ Clean H₂/Ammonia Production Demonstration/Commercial Projects

Korea plans to secure advanced high-efficient and mass-production technology through domestic demonstration project, while constructing overseas clean hydrogen production plant for economic supply chain.

■ Major Domestic Clean Hydrogen Project ■

JeJu 12.5MW Green Hydrogen Pilot Project (Completion by March 2026)	Jeonbuk Buan 2.5MW PEM Hydrogen Project (Full scale by May 2025)
	
Demonstrating all four existing types of electrolyser system; AEC, PEM, SOEC, AEM. Produced H ₂ will be supplied for 200 cleaning vehicles and 300 intercity buses	Produce 1tonH ₂ /day and supply nearby filling station. FEED completed by Hyundai E&C (Nov 2023)
Pyeongtaek LNG Reforming Blue Hydrogen Project (Constructed in August 2022)	Pyeongchang 2.5MW Green Hydrogen Project (Full scale by April 2025)
	
Producing 7tonH ₂ /day and supply 33 filling station nearby. Reformer supplied by Woniltni	Wind power based H ₂ Production of 1ton/day. Organized by Hanwha Solution
Ulsan Hydrogen Liquefaction Plant (Completion by early 2024)	Incheon Hydrogen Liquefaction Plant (Demo. since Oct. 2023)
	
Produce 13kton/yr of liquid hydrogen under cooperation of Hyosung Group and Linde Group. Construct 30 liquid hydrogen filling station simultaneously	SK E&S produces 30kton/yr of liquid hydrogen, and operates charging station that can refuel 60 heavy-duty trucks per day and 24 passenger cars per hour

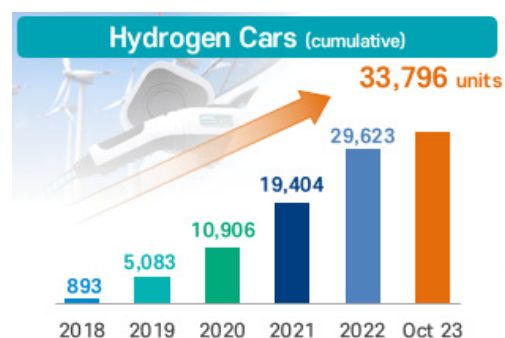
Oversea Clean Hydrogen Project

Queensland SunHQ 1MW PEM Hydrogen Hub (Production start in 1Q 2024)	Sarawak H2biscus Clean Hydrogen Project (FID by end of 2024)
	
Produce green hydrogen based on 124MW solar power plant in Queensland, Australia. Constructed by Ark Energy.	Produce 150kton/yr of green hydrogen in Sarawak, Malaysia. FEED ongoing by Samsung Engineering.

Hydrogen Mobility

Korea is actively promoting hydrogen mobility with ambitious goal of deploying 30,000 commercial FCEVs by 2030, and build 70 liquid hydrogen fueling stations across the country. The government has been expanding subsidies for purchasing hydrogen buses and trucks. For October 2023, Korea has deployed 33,245 passenger vehicles, 541 buses, and 10 trucks in the country, while installed 255 commercial HRS units.

Last June, Hyundai motor Group completed construction of 'HTWO Guangzhou' hydrogen fuel cell system manufacturing plant located in Guangdong Province, China. The plant will produce 100kW class fuel cells, with annual production capacity of 6,500 units.



Beside FCEVs, Korea is also developing various mobility technologies including forklifts, drones, UAMs, trams, fuel cell and ammonia powered ships.

			
LH2 Carrier	H2 fueled Ships	H2&NH3 fueled Ship	
			
AIP approved from KR and LISCR in Oct. 2020 [20,000m3]	Commercialize NH3 Vessel by 2024 AIP approved NH3 fueled ship from KR in Sep. 2022 LH2 fuel cell system from DNV in Nov. 2022	Commercialization by 2025 MOU Signed in Sep. 2022 (Joint R&D for NH3/H2 propulsion system)	
			
FC system for vessel	Fuel Cell Leisure Boat	H2 folk lift	
			
Commercialization by end of 2022 MOU Signed in Jul. 2021 (Commercialization of FC system for vessel)	Commercialization by 2023 Signed MOU in Jun. 2020 (FC system supply and boat development) Demonstration in Progress in Ulsan	Commercialization by 2023 MoU signed in Feb. 2020 Hydrogen Folk-lift Demonstration in Ulsan	MoU signed in Apr. 2022 Pilot Operation in Cheonan in first half of 2023
			
H2 DRON	H2 UAM	H2 Tram	
			
Commercialization by 2025 Implementing National Demonstration Project for Logistics & Cargo Drones	Unveil Hybrid UAS for Freight by 2026 Optimize Urban Operation and Fully-Automatic UAM by 2028 Launch Regional UAM in 2030s	Commercialization by 2023 Hydrogen Tram Demonstration in Ulsan	

■ Fuel Cell Power Plant

Korea is a leading country of deploying fuel cell power plant, generating 1,065 MW as of December 2023. One of the major fuel cell power plants is New Incheon Light Dream Complex.

New Incheon Light Dream Fuel Cell Power Plant
(Completed Construction in Oct. 2021)



Generation Capacity of 78.96MW, 134 units of 440kw class fuel cell, providing electricity for 250k households and heat for 44k households.

United States

■ United States National Clean Hydrogen Strategy and Roadmap

The National Clean Hydrogen Strategy and Roadmap was finalized and released in June of 2023. The document explores opportunities for clean hydrogen to contribute to national decarbonization goals across multiple sectors of the economy. It provides a current snapshot of hydrogen production, transport, storage, and use in the United States and presents a strategic framework for achieving large-scale production and use of clean hydrogen, examining scenarios for 2030, 2040, and 2050.

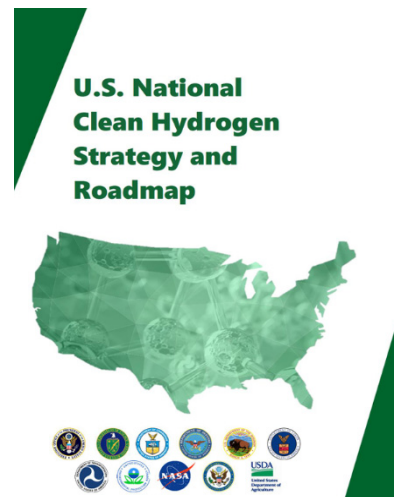
The report also identifies needs for collaboration among federal government agencies, industry, academia, national laboratories, state, local, and Tribal communities, environmental and justice communities, labor unions, and numerous stakeholder groups to accelerate progress and market liftoff.

This roadmap establishes concrete targets, market-driven metrics, and tangible actions to measure success across sectors. It details expected clean hydrogen production objectives of 10

MMT of clean hydrogen annually by 2030, 20 MMT annually by 2040, and 50 MMT annually by 2050.. Clean hydrogen can reduce U.S. emissions by approximately 10 percent by 2050 relative to 2005, consistent with the country's long-term climate strategy.

The adoption of hydrogen under the National Clean Hydrogen Strategy and Roadmap aligns with the Administration's goals, including:

- A 50% to 52% reduction in U.S. GHG emissions from 2005 levels by 2030
- 100% carbon pollution-free electricity by 2035
- Net zero GHG emissions no later than 2050
- 40% of the benefits of federal climate investments are delivered to disadvantaged communities



Chile

■ Clean hydrogen and ammonia production

Hydrogen and its derivatives projects in Chile are being developed mainly in two hydrogen valleys along the country, Antofagasta and Magallanes.

Antofagasta

Antofagasta is located in the north of Chile in the area of the Atacama Desert, the place on earth with the highest solar irradiance.

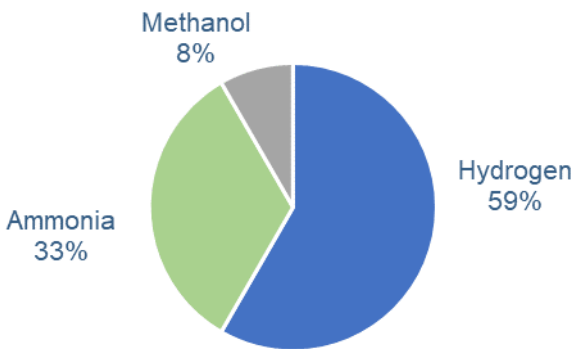


Photo source: soychile.cl.

San Pedro de Atacama Province, Region de Antofagasta

In Antofagasta there are 25 projects, accounting for 42% of the total number of nationwide. These projects are diverse in terms of the products, including the production of green hydrogen, green ammonia, and green methanol.

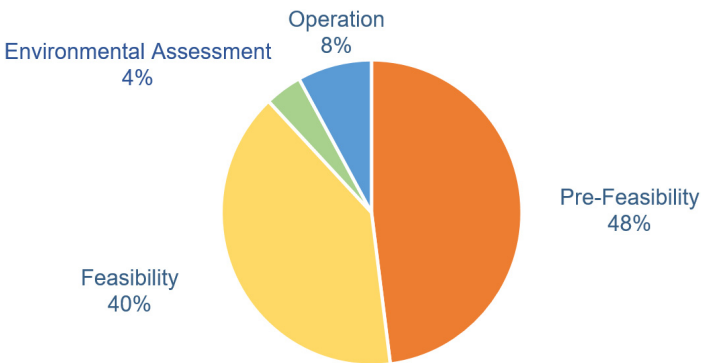
Antofagasta:
Share of hydrogen products in 2023



Source: H2 Chile based on public information.

Regarding the stages of the projects, approximately half of them is in the pre-feasibility stage, while 40% are in the feasibility stage, 4% are in environmental evaluation, and 8% are in operation.

Antofagasta:
Stages of hydrogen projects in 2023



Source: H2 Chile based on public information.

Magallanes

Magallanes has favorable conditions for the development of the green hydrogen and derivatives industry. Among these, its extraordinary wind resource stands out, along with decades of productive experience in related economic activities, a strategic location with bi-oceanic access, a range of instruments and incentives promoting productive development in this southern zone, and its vast expanses of land.

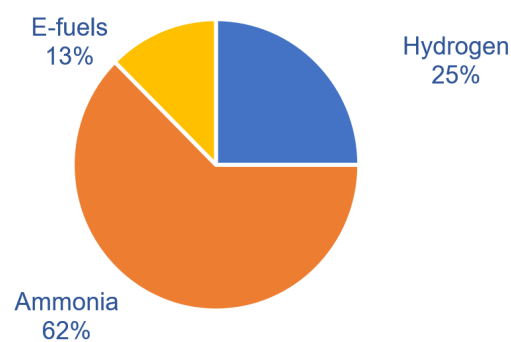


Punta Arenas, Region de Magallanes

In Magallanes, 17 projects have been publicly announced, representing 28% of the total projects announced in the country.

The diversity of announced products in this region primarily includes ammonia and e-fuels for export.

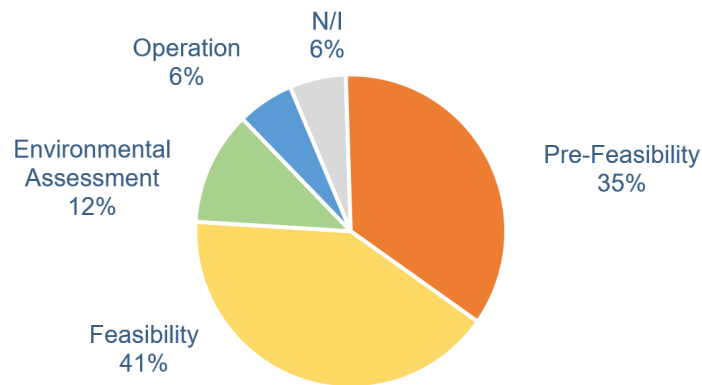
Magallanes: Stages of hydrogen projects in 2023



Source: H2 Chile based on public information.

Regarding the stages of the projects, 35% are in the pre-feasibility stage, 41% are in the feasibility stage, 12% are in environmental evaluation, and 6% are in operation.

Magallanes:
Share of hydrogen products in 2023



■ Infrastructure

Antofagasta

In the hydrogen valley of Antofagasta, Mejillones is an industrial park conveniently equipped with infrastructure suitable for the renewable hydrogen industry.

The Mejillones Port Complex has:

- Puerto Angamos, a multipurpose terminal that allows the berthing of post-Panamax vessels.
- Bulk Solids Terminal allows the transfer of bulk solids and liquids, either through dedicated terminals or multipurpose facilities.



Photo source: Portal Portuario

Bahía de Mejillones, Region de Antofagasta

Magallanes

In the hydrogen valley of Magallanes, the National Oil Company (ENAP) owns multiple ports and storage facilities that it is enhancing and expanding in coordination with the private sector.

The Laredo and Cabo Negro Terminals would be transformed into the initial facility for the introduction of specialized equipment for the construction phases of this emerging industry in Magallanes, with an investment close to US\$50 million. The agreement involves HIF Global, HNH Energy, and Total Eren.



Cabo Negro, Region de Magallanes

The development of Gregorio, in Magallanes will allow the integration and consolidation of the logistical infrastructure needs of multiple green hydrogen projects, accelerating implementation timelines and limiting potential environmental impacts.



Refinería Gregorio, Region de Magallanes

In December of this year, it was launched the Magallanes Logistic Development Plan, an interministerial coordination initiative that involves the Ministry of Energy, Ministry of Transportation, Ministry of Public Works and the Regional Government of Magallanes. Its main objective is to structure the advancement of the green hydrogen industry in port logistics infrastructure, positioning Magallanes as a key player in this emerging industry of international significance.

■ Use of hydrogen

In terms of hydrogen use, the technologies being used and developed in Chile includes a broad range of applications.

13 announced and developing projects related to the transportation industry. Notable examples include pilot projects in mining for trucks and heavy equipment, personnel shuttle buses, and refueling stations (HRS).



First transit fuel cell bus operating in Chile. Santiago, October 2023

In logistics, the efficiency of fuel cells in forklifts is becoming a rapidly adopted solution in distribution centers, with an expected incorporation of long-haul trucks soon.



Former President of Chile Sebastián Piñera and former Minister of Energy Juan Carlos Jobet, inaugurating the first forklift to be used in mining. Minera Los Bronces, Region Metropolitana, 2021

The mining industry is also progressing in the use of renewable hydrogen to reduce emissions across various operations. Engie and Enaex are developing a project to produce explosives from green ammonia.



Rock fragmentation in mining. Enaex

An additional use of hydrogen is the blending of renewable hydrogen with natural gas transported via gas distribution networks to 2.000 households in Coquimbo, a city in a central north region.

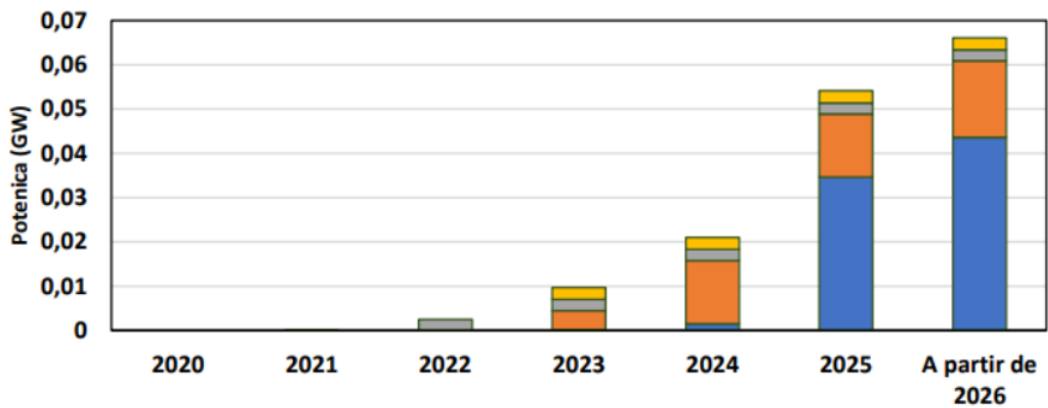


Inspection of the pilot plant H2GN of Gas Valpo. Coquimbo, December 2023

Kingdom of Spain

■ Clean H2/Ammonia Production Demonstration/Commercial Projects

With regard to hydrogen production projects, the AeH2 prepared a Project Census that included the demonstration projects (TRL 7 or higher) of its members, highlighting that it has almost 420 members as of November 2023. A graph is attached where it can be seen that the projects show a modest deployment of installed hydrogen production capacity



■ Aprobado, FID: financial investment decision ■ En construcción ■ En operación ■ En puesta en marcha

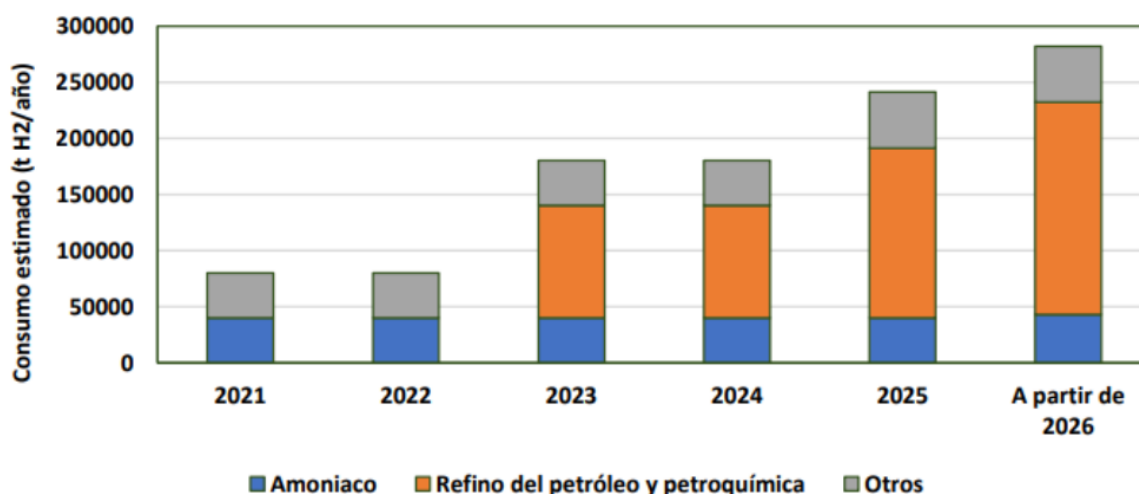
■ Potencia acumulada de los proyectos del Censo con FID o más avanzados ■

In terms of planned projects, the amount increases significantly, reaching 11 GW from 2026 onwards. If these targets are exceeded and assuming the implementation of all these projects, Spain's roadmap target of 4 GW by 2030 would be exceeded:



■ Potencia acumulada de los proyectos del Censo en función de su estado de ejecución. ■

On the other hand, the Project Census lists 17 projects that focus on the use of hydrogen in industry. Fifteen percent of these projects are focused on ammonia production.



■ Consumo estimado de hidrógeno en uso en industria. ■

At electrolyser factories, Cummins plans to open a hydrogen electrolyser factory in January 2024. The company will invest around 80 million euros to start up this plant, with a surface area of more than 20,000 square meters, which will carry out assembly and testing activities for electrolysers and will have the capacity to produce 500 MW of electrolysers per year, with the aim of subsequently reaching a production capacity of 1 GW per year.

■ Infrastructure Project; Terminal/port, pipeline, tanks, HRS

In terms of pipelines, H2Med and the projects associated with the corridor of which it forms part are progressing positively in the process of acquiring the status of Projects of Common European Interest (PCI). In addition, the German operator OGE joins Enags, GRTgaz, REN, and Terga as a promoter of H2Med.

In Spanish ports, notable projects include H2 ports, where two innovative solutions based on fuel cell technologies and a mobile hydrogen supply station specifically designed for the project will undergo demonstration and validation in real port operations at the Port of Valencia. Likewise, the Port of Algeciras will operate as a green hydrogen maritime corridor connecting it with Rotterdam, within the framework of the Andalusian Green Hydrogen Valley.

Overall, the Census Project of the AeH2 registered 20 mobility projects for roads, and six for trains including long-distance and freight trains.

■ Utilization Project; FCEVs factory, UAM, Shipping

As mentioned earlier, the census of projects by AeH2 includes 17 projects focused on the use of hydrogen in industry. 67% of these projects are intended for use in petroleum refining and the petrochemical industry, while 15% is allocated to ammonia production. The remaining projects are oriented towards the food, glass, and ceramic industries. As a specific case, its application in the hydrocarbons sector is noteworthy for its new application in the production of synthetic fuels.

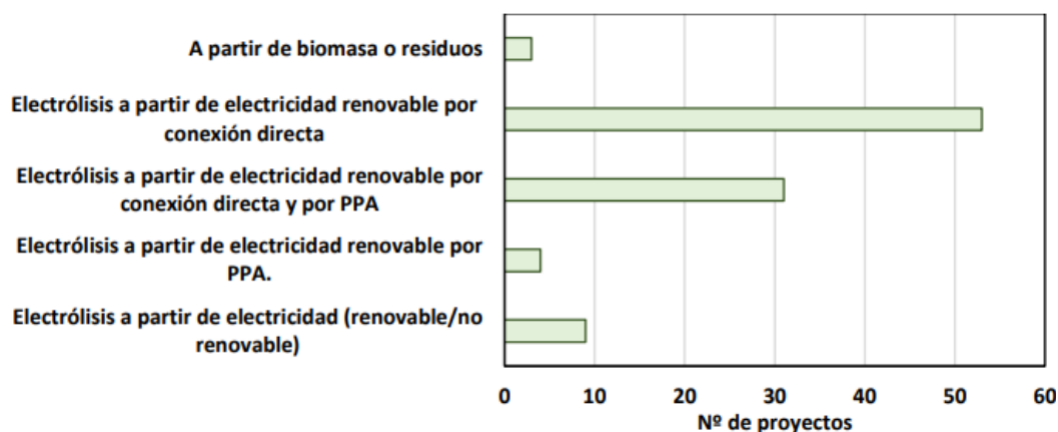
Related to Urban Air Mobility, the Green Hydrogen Alliance in Aviation has been formed by MITMA, Aena, AESA, the Spanish Association of Oil Products Operators (AOP), the Association of Air Lines (ALA), the National Hydrogen Center (CNH2), GASNAM, the National Institute of Aerospace Technique (INTA), the Spanish Hydrogen Technology Platform, the Spanish Association of Defense, Security, Aeronautics and Space Technologies (TEDAE) and the Spanish Aerospace Technology Platform (PAE).

The objective of the signed protocol is to establish the terms of the collaboration to determine the needs of the development, production, storage, and distribution of green hydrogen for aviation in Spain, as well as the research and development of solutions or the exchange of information between the different actors involved in this wide ecosystem.

Related to shipping, Cepsa is already developing the Andalusian Green Hydrogen Valley, the largest green hydrogen project presented in Europe, with an investment of 3 billion euros, the creation of 10,000 jobs, and a production capacity of 300,000 tons of green hydrogen. In the presence of the monarchs of Spain and the Netherlands, Cepsa signed collaboration agreements with Yara Clean Ammonia, a Norwegian multinational and world leader in the field of green ammonia (derived from green hydrogen), and Gasunie, a leading gas transport and infrastructure company, which is connecting the Port of Rotterdam with other European industrial clusters in Germany, the Netherlands, and Denmark. With this corridor, a renewable energy supply chain is created to decarbonize industry and maritime transport, connecting the ports of Algeciras and Rotterdam.

■ Statistics

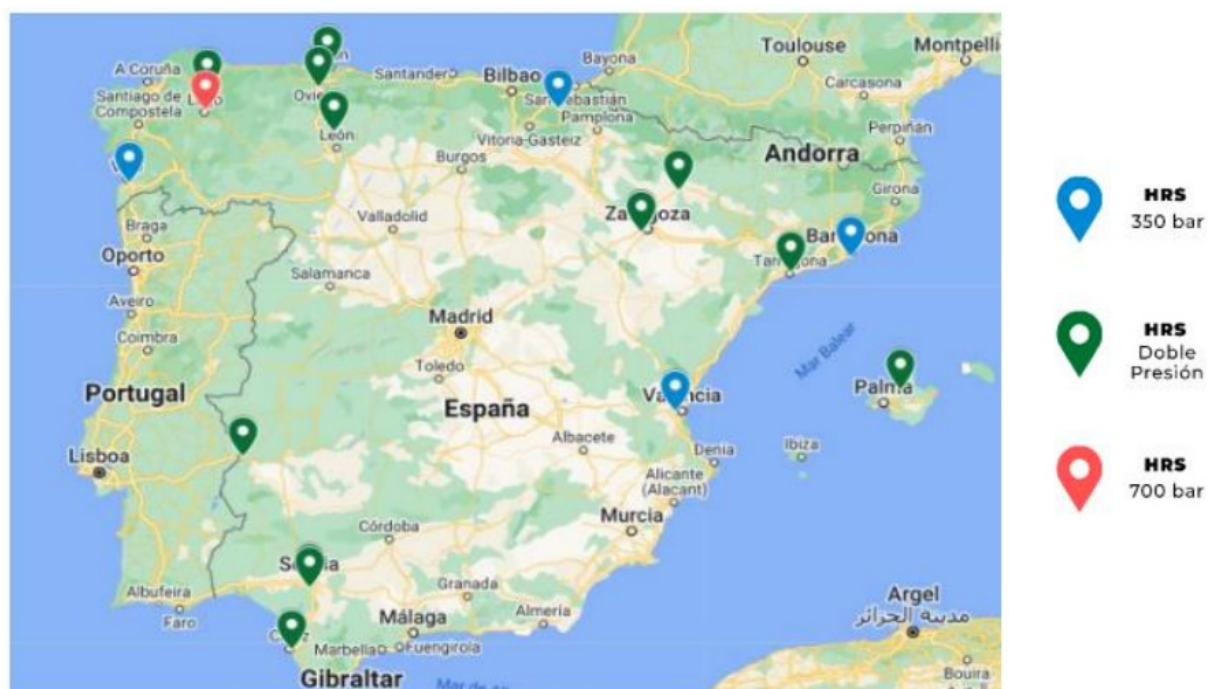
In addition to what was previously mentioned, the Hydrogen Projects Census by AeH2 compiled a chart based on the 123 registered projects, illustrating the source of energy used for hydrogen production.



■ Origen de la energía para la producción de hidrógeno ■

56% of the hydrogen production projects involve the use of renewable energy sources by direct connection and up to 91% of the projects expect to use clean energy, although some involve the use of Power Purchase Agreements (PPAs).

The Census of Projects lists 34 HRS of which 21 are publicly accessible and 13 are privately accessible.



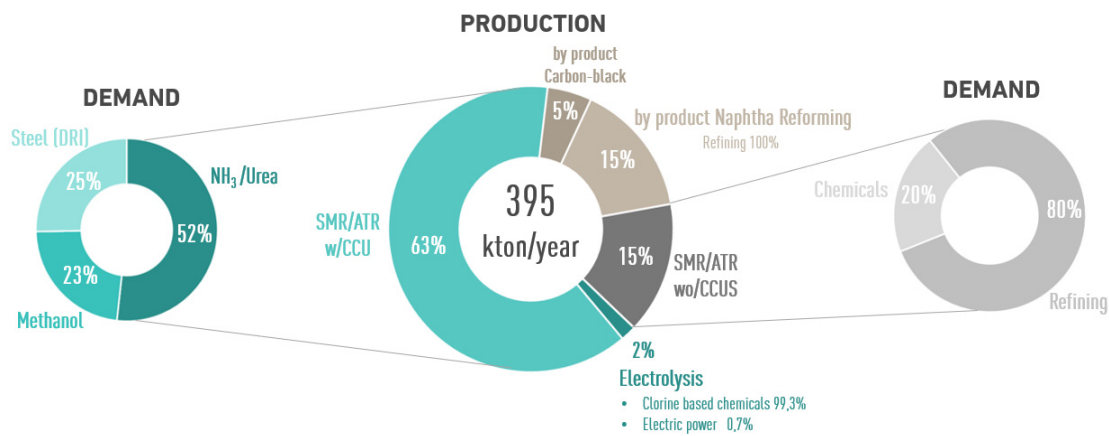
■ Mapa HRS planeadas de acceso público del Censo. ■

According to the AFIR, an infrastructure of hydrogen refuelling stations (HRS) is required on the trans-European transport network from 2030 onwards. This infrastructure must be able to supply both cars and trucks at all urban nodes and every 200 km along the core network. This will involve the installation of 78 HRS in Spain.

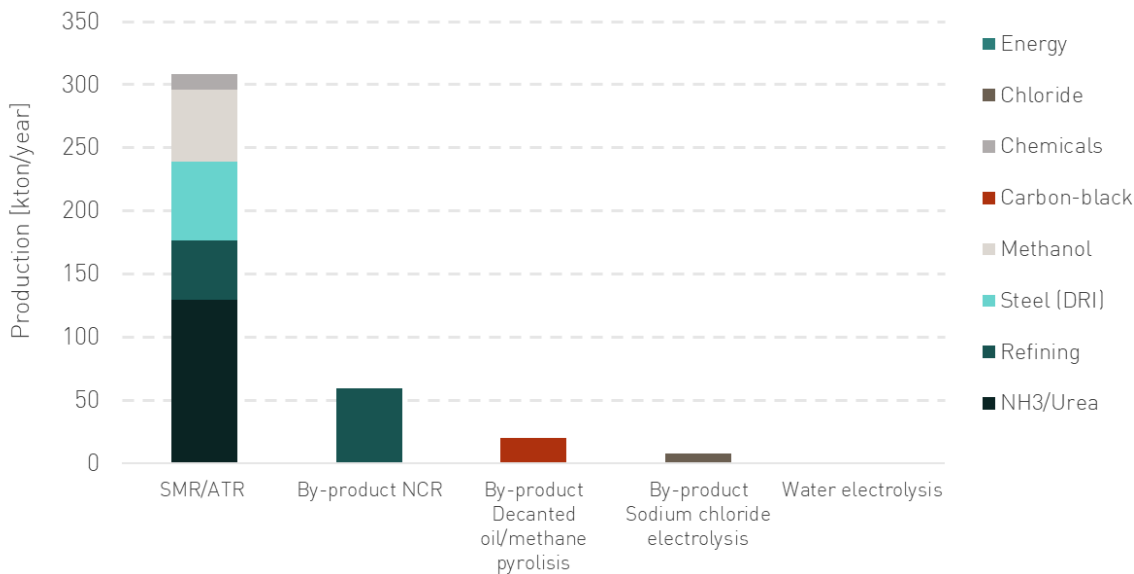
In addition to the census, there is a GASNAM HRS map that includes more entities than those that are members of the AeH2. In it, there are more than 34 HRS that are forecast.

Argentina

Argentina already produces and consumes hydrogen in large quantities. The following chart shows the distribution and end users.



Leading production pathway is by natural gas reforming:



■ H2 production

In line with the French National Hydrogen Strategy and the European Union's roadmap for an energy transition that guarantees industrial and energy sovereignty, a number of low-carbon and renewable hydrogen production sites have been identified, most of them located in industrial basins where decarbonisation is a major challenge. The massive scale of the investment means that projects will take a long time to complete, and some are already in the implementation phase.

Depending on local conditions and requirements, the deployment of low-carbon or renewable hydrogen for industry will follow different formats: from centralised systems around industries that consume large amounts (refineries) or emit large amounts of energy (steelworks, cement works), to ecosystems that combine uses (industry, energy, mobility), as in port areas for example.

■ Pipeline and storage

The deployment of hydrogen in France is based around 7 major geographical basins (the ports, the Seine and Rhine valleys and the borders with Spain and Germany), making the commissioning of massive transport and storage infrastructures essential. The transmission network is essential in more ways than one: firstly, to interconnect these basins and deliver hydrogen to the various users, and secondly, to link up with cross-border networks for possible import requirements, as part of the European backbone. GRTgaz and Teréga are major players in this project.

Teréga's HySow* hydrogen transport and storage infrastructure project is an essential component of this future European hydrogen pipeline network in the heart of south-western France, between Nouvelle-Aquitaine and Occitanie. It was the subject of a call for expressions of interest in spring 2023. Alongside the deployment of 600 km of pipelines, 30% of which could be converted from natural gas to hydrogen, the project includes the development of salt cavern storage capacity, which will help to ensure European flexibility and security of supply.

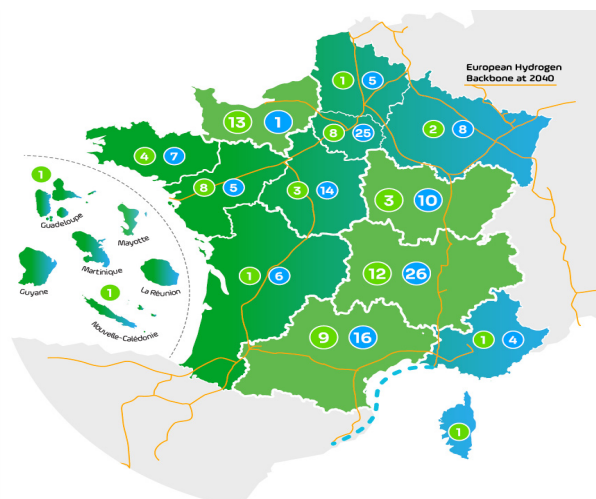
September 15 marked a new stage in the industrialisation of this storage technology. Storengy, the Engie subsidiary, officially inaugurated HypSTER, the first demonstrator of renewable hydrogen storage in a salt cavern at its Etrez site in the Auvergne-Rhône-Alpes region. The facility, which has a storage capacity of 50t (eventually), will be able to produce 400kg of renewable hydrogen a day from a 1MW electrolyser fuelled by local renewable energy sources. The site will be used to supply manufacturers and hydrogen distribution stations in the region.

■ Hydrogen refuelling stations

Mobility is more than ever at the forefront of deployment across the country, and the network of stations in France is beginning to take shape. The Ile-de-France region occupies a prime position, with seven operational stations to date, including the largest production station in Europe, capable of producing 1t of hydrogen per day, at Porte de Saint-Cloud, and six distribution stations at Orly and Roissy-Charles-de-Gaulle airports, as well as at Issy-les-Moulineaux. Hype, the hydrogen taxi operator, and Hynamics, an EDF subsidiary, are the main operators in the region. Hynamics, as part of a programme run by Vallée Sud Hydrogène for the Hauts-de-Seine region, has laid the

foundation stone for the largest hydrogen production-distribution station project in the world, at Châtenay-Malabry. Expected output: 2.2 tonnes a day from a 5 MW electrolyser.

In Auvergne-Rhône-Alpes, 12 stations are currently operational: through the Zero Emission Valley project, Hymulsion and its partners inaugurated the network's fourth distribution station at Clermont-Ferrand Gravanches in July. The site produces, stores and distributes renewable hydrogen for light vehicles, heavy goods vehicles and industrial applications. By mid-2024, six stations will have been added to the network, particularly on the north-south axis.



As of November 2023:

- 68 HRS in operation in France
- 127 HRS to be put in operation by 2025

■ Mobility uses

Hydrogen-powered buses are taking over the urban landscape. After Pau, Lens and Auxerre, it's Belfort's turn to switch to hydrogen for its public transport. Operated by Optymo, seven new hydrogen-powered buses have been tested since July, with commissioning scheduled for the final quarter of 2023. The stated ambition is to equip half the fleet by 2025, bringing the total to 27 hydrogen-powered buses.

Alongside its hydrogen vehicle based on the Renault Master, Hyvia launched its refuelling solution in the autumn. In partnership with Ataway, the joint venture between Renault and Plug has launched Hywell, a range of medium-capacity hydrogen refuelling stations for its business customers, which can supply up to 20 vehicles a day (Master vans), open to models from competing brands welcome. At Hyvolution in February, Hyvia and Hysetco, operator of public charging stations, announced their new partnership.

To optimise the development of a complete hydrogen ecosystem and make progress in terms of customer experience in a market where much remains to be invented. Also at Hyvolution, Stellantis and Engie formalised an alliance aimed at offering fleet managers a comprehensive package including hydrogen stations and vehicles. Betting on the availability of a wide range of vehicles in the medium van segment by 2024, the two partners are proposing three levels of capacity for the stations in their packaged solutions, from 20 to 400 vehicles/day.

■ Hydrogen production project

Historic player Air Liquide has taken a new step forward in its deployment of hydrogen technologies in the Seine Valley, with the announcement of an investment of more than €400 million for the Air Liquide Normand'Hy project, with an electrolysis capacity of 200 MW. This equipment, the largest PEM electrolyser ever built, is part of an agreement with TotalEnergies to deliver 100 MW of renewable, low-carbon hydrogen to the Gonfreville refinery by 2026. The remaining 100 MW will be used by other local industries and for mobility purposes.

In June, independent renewable energy producer Qair and the Agence Regionale Energie Climat

(AREC) d'Occitanie announced and launched the construction of their Hyd'Occ* renewable hydrogen production unit, with the laying of the foundation stone. This project is part of the local drive to make Port-La Nouvelle the port of the energy transition in Occitanie. Ultimately, 6,000 t/year of renewable hydrogen will be produced using a 50 MW electrolyser powered by local renewable energy. The site will supply energy, industry and mobility applications within a 250 km radius (powering the Hydromer dredger for port maintenance, fuelling distribution stations for light commercial vehicles and heavy goods vehicles with refrigerated trailers).

Lhyfe is continuing to develop its renewable hydrogen production sites, as part of a dynamic regional ecosystem. These new units will supply mobility and industrial applications.

In the West, after the Vendee and its birthplace of Bouin, Lhyfe is setting up in Brittany as part of the Valle Hydrogène Grand Ouest (VHyGO) project. The hydrogen produced will supply 2 refuelling stations operated by HyGO in Lorient Agglomération by the end of 2023.

To the east, in a cross-border region undergoing rapid re-industrialisation, the hydrogen produced at the Epinal site will be used for local, trans-regional and cross-border purposes, as part of a hydrogen industry scheduled to be operational by the end of 2027.

To the south, in December Lhyfe Occitanie commissioned its Bessieres site, which, thanks to a 5 MW electrolyser, will supply the various fuelling stations planned as part of the Corridor H2 Occitanie project, aimed at decarbonising road transport (people and goods) on the Albi - Toulouse stretch.

■ Electrolysis manufacturing plants

At the heart of the industry's need to decarbonise, electrolyser gigafactory projects are being structured around champions of different technologies. The next two years should see the emergence of manufacturing capacities that are equal to the challenges of technological and industrial sovereignty in this segment.

Several electrolyser manufacturers are developing their capacity, such as McPhy and John Cockerill on high-power alkaline electrolysers, with production sites at Belfort and Aspach near the German border respectively; Elogen on PEM (proton exchange membrane) electrolysis, with a gigafactory of PEM stacks and the gradual internalisation of production of associated components at Vendeme; Genvia and solid oxide electrolysers at Beziers; Gen'Hy, a newcomer to the closed circle of IPCEI projects, with its AEM (anion exchange membrane) electrolyser plant in Belfort, will support the reindustrialisation of the Burgundy-Franche-Comte region.

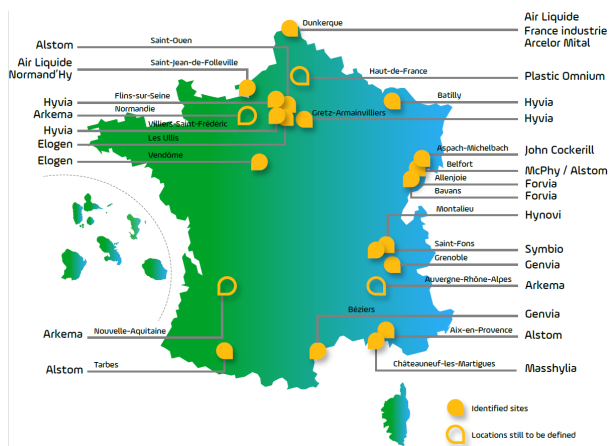
■ Storage systems manufacturing plants

Two weeks after the laying of the foundation stone for Plastic Omnium's fuel tank factory in Compiègne (Oise), Forvia officially opened the doors of its Allenjoie plant in the Doubs region of France. The tanks produced will equip Stellantis and Hyvia light commercial vehicles (LCVs), as well as heavy goods vehicles, in the latter case with large capacity (25kg). The aim is to produce 100,000 tanks a year by 2030 and cut production costs by a factor of 5 within two years.

■ Fuel cells manufacturing plants

At the beginning of September, Symbio's 700 employees took possession of the integrated SymphonHy site (head office, fuel cell gigafactory and training centre) at Saint Fons near Lyon. This site will rapidly ramp up its production of fuel cell stacks and systems for road mobility, with production of 15,000 systems a year from 2024, rising to 50,000 systems a year from 2026.

Originating from a collaboration with CEA-Liten, the Grenoble-based start-up INOCEL has gone big and set up shop in Belfort. Scheduled to come on stream at the end of 2024, its high-power (300 kW) fuel cell production site is targeting the heavy-duty mobility, road, sea and rail markets, as well as stationary hydrogen applications. At the end of February, HDF Energy laid the foundation stone for its high-power fuel cell plant at Blanquefort, near Bordeaux. Production is due to start in 2024, with a capacity of 100 MW per year. The industrial objective for 2030 is to reach an annual production capacity of 1 GW, in a plant that will employ more than 500 people.



■ Components manufacturing plants

Industrialisation is also taking place for 38 key components, with Toulouse-based start-up Hycco investing €8 million to develop its first industrial production line for bipolar plates in composite materials for fuel cells. The aim is to produce 165,000 bipolar plates by 2027, creating around thirty additional jobs within 3 years.

■ French SME's international cooperation

This spring, HDF, developer of large-scale renewable hydrogen infrastructures and manufacturer of high-power fuel cells, signed three memorandums of understanding with major players in Asia's energy sector: in the Philippines, with the Mindanao Development Authority (MinDA), the Philippine Department of Energy and the Philippine National Power Corporation (NPC), and in Indonesia, with the local public electricity company to facilitate the establishment of Renewstable® hydrogen power plant projects. To develop hydrogen power plants to improve the supply of stable electricity in off-grid areas of the country.

Heading south for HRS, the Grenoble-based manufacturer of fuelling stations, which has launched its first international subsidiary in Spain. The programme includes the opening of 9 stations, 8 of which will be operated by pHYnix, an independent supplier of renewable hydrogen and services.

Elogen, leader in PEM electrolysis, has announced the signature of two contracts for the design and manufacture of a 2.5 MW electrolyser: one for a mobility project in Pyeongchang with its Korean partner Valmax, and the other for an offshore wind turbine project off the coast of the Netherlands with Crosswind.

Denmark

Outcome of the Danish PtX Tender: In October 2023, the settlement of the PtX tender of DKK 1.25 billion marked a turning point, revealing overwhelming interest from Danish businesses in pioneering the production of green fuels. With bids exceeding DKK 4 billion, equivalent to over 675 MW of new electrolysis capacity, five winning projects emerged. European Energy/Vindtestcenter Måde K/S, European Energy/Padborg PtX ApS, Electrochaea/Biocat Roslev, European Energy/Kassø PtX Expansion ApS, og HyproDenmark/Everfuel secured the victory and will build a total of 180 MW electrolysis capacity.

New green state aid of 1 billion DKK: Additionally, December 2023 ushered in a new wave of green state support, earmarked for businesses in the wind, hydrogen, and Power-to-X industries. The government's commitment to a DKK 1 billion investment in 2024 underscores its dedication to fortifying Denmark's green prowess.

Infrastructure

Projects and direct lines: In the realm of infrastructure, Denmark currently boasts 48 announced projects strategically distributed across the nation. A groundbreaking political agreement on ownership and operation of hydrogen infrastructure has entrusted Evida and Energinet with key roles in shaping a pipeline-led infrastructure supporting the future hydrogen economy. The agreement allows for direct lines between producers and consumers of green electricity. Direct lines are expected to become a central tool in ensuring increased utilization of renewable energy and green technologies such as Power-to-X and heat pumps. These direct lines also contribute to a better utilization of the collective electricity grid. Additionally, are the agreements for allowing geographically differentiated tariffs, and local collective tariff structures, reinforcing our commitment to accessibility and sustainability.

Energy park on land agreement: The energy park agreement in December 2023 paved the way for larger onshore energy parks, integrating solar cells and wind turbines to accelerate the green transition.

German offtake: a pivotal collaboration between Germany and Denmark envisions a hydrogen pipeline connecting the two nations. Germany's ambitious plan to invest nearly €20 billion in a 9,700 km hydrogen pipeline network, with the first hydrogen flowing by 2025, aligns seamlessly with Denmark's commitment to green energy. A formalized collaboration between German Gasunie and Danish Energinet signifies a significant step towards a sustainable energy future and an offtake for Danish PtX production.

Green Aviation Agreement: The Green Aviation Agreement, incorporating a subsidy framework, features elements such as a passenger levy. The agreement plays a role in funding a sustainable domestic route by 2025 and achieving completely green domestic aviation by 2030. In this context, hydrogen and its derivatives are poised to play a crucial role in advancing the development of green fuels, marking a significant step toward reshaping both domestic and, eventually, international aviation into a more sustainable industry.

Republic of Poland

In 2023, some of the most significant developments in hydrogen in Poland include:

■ Central hydrogen valley

- A Central Hydrogen Valley will be established in Poland. A letter of intent to this effect was signed at the Kozienice Power Plant on July 17, 2023 on the construction of the Central Hydrogen Valley, which is to operate in the area of three voivodeships: Łódź, Mazowieckie and Świętokrzyskie. The Laszczynski Brothers Central Hydrogen Valley will be built on the basis of the Swietokrzyskie Industria Industrial Group's hydrogen cluster belonging to the Industrial Development Agency. In Kozienice, construction of power units using gas-steam technology has already begun. The Central Hydrogen Valley will produce electrolyzers with a capacity of 250 MW. Eleven hydrogen valley projects are operating in Poland today.



■ First hydrogen refueling station

- On September 11, 2023, the first publicly available hydrogen refueling station for hydrogen-powered passenger cars (FCEVs) was launched.
- The refueling station was established in Warsaw and is the result of an investment by the private company PAK-PCE Stacje H₂, owned by PAK-Polska Czysta Energia, an entity roughly half-owned by the listed companies: Cyfrowy Polsat and ZE PAK. - The station operates under the Neso brand - an acronym for "Doesn't emit fumes cleans the air."
- Polsat Plus Group and ZE PAK Group will build a full value chain of a green hydrogen economy. Starting with electrolyzers - the first electrolyzer with a capacity of 2.5 MW with the potential to

produce 1,000 kg of hydrogen per day should be commissioned soon. Meanwhile, a second electrolyzer of the same capacity will begin operation in 2024. Also, the corporation itself has developed a design for a Polish electrolyzer. For the time being, its capacity is 0.5 MW, which has the potential to produce 200 kg of hydrogen per day.



■ Hydrogen locomotive

- On September 17, 2023, the first test run of the SM42-6Dn hydrogen-powered shunting locomotive took place. The run took place on the route from Gdynia to Hel (about 60 km). The locomotive was purchased by Orlen from PESA Bydgoszcz. Orlen Group's hydrogen strategy calls for the use of hydrogen in rail and public transportation. By 2030, the corporation will spend PLN 7.4 billion on investments in hydrogen technologies based on renewable energy sources and technology for converting municipal waste to hydrogen.
- The contract between Orlen and PESA Bydgoszcz also includes a four-year service package, which will include standard maintenance and possible repairs. The capacity of the locomotive's tanks is more than five times that of hydrogen-powered buses, at 175 kg. It gives the locomotive the possibility of 24-hour operation.
- The locomotive's traction system includes two fuel cells of 85 kW each, a battery and four traction motors.

■ Local government hydrogen company Hydro Sanok

- Thanks to its favorable geological and infrastructural conditions (its location along the San River), Sanok is perfectly positioned to implement a hydrogen project. To this end, the Sanok municipal utility SPGK established the Hydro Sanok hydrogen company in 2022. On April 25, 2023, the selection of a minority investor to enter the company was announced. The company became Hynfra P.S.A. - A member of Hydrogen Poland, which was the only one to present a

comprehensive plan for the decarbonization of Sanok's local government and declared its participation in this innovative procedure..

- The Hydrogen Project is of significant importance for Sanok. It represents not only an important step on the road to sustainable energy development, but also an opportunity to create new jobs, attract investment, as well as increase innovation and competitiveness of the region," says Krzysztof Jarosz, president of Sanok Municipal Management Company Ltd. and Hydro Sanok Ltd.
- The project to transform Sanok's energy with hydrogen is comprehensive and primarily includes: the construction of its own electricity generation sources (photovoltaic panels), the construction of an energy and heat storage facility, the construction of a hydrogen electrolysis plant, the establishment of a hydrogen refueling station and rapid charging of electric vehicles. The city will also invest in a state-of-the-art heat pump to reduce carbon dioxide and greenhouse gas emissions and other ancillary installations.
- Hynfra P.S.A., as a technology partner, will be responsible for the project's implementation, conception and acquisition of financing. One of the first steps will be the preparation of a feasibility study that will determine the optimal way to carry out the project

The Republic of Colombia

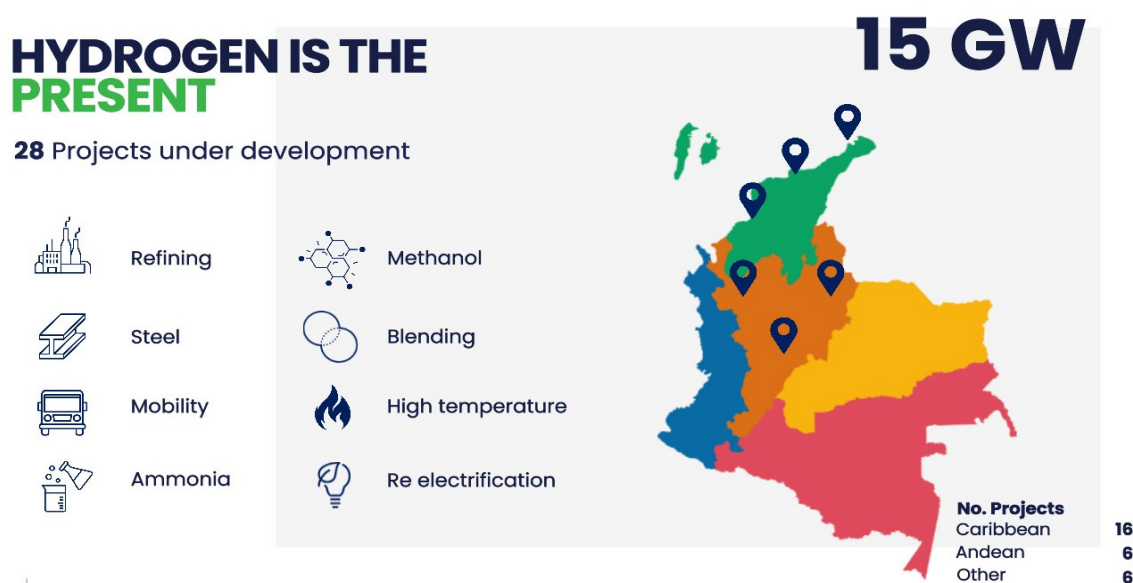
H2 Projects database: The Colombian Hydrogen Association has developed an information database that tracks projects across the entire hydrogen value chain in Colombia. As of now, we report 28 ongoing projects with a potential of 15 GW of electrolysis and 190 Kton/year of blue hydrogen. Most of the compiled projects are in their early stages and are in various sectors of the economy, including refineries, mobility, derivatives, blending, high-temperature processes, and re-electrification. Of the 28 projects, approximately 60% are in the Caribbean region, ~20% in the Andean region, and the remaining 20% are spread across different regions of the country.

Some highlighted projects to date are:

- Hevolution: Production of green ammonia from a small hydroelectric plant (2.3 MW). Electrolysis capacity of 1,000 kg/day. Located in Antioquia.
- Ecopetrol: 60 MW electrolyzer at the Cartagena refinery, with 60% of production focused on domestic consumption and 40% for third-party commercialization. This project is being developed in alliance with Total Eren.
- Ecopetrol: 60 MW electrolyzer at the Barrancabermeja refinery, with 60% of production focused on domestic consumption and 40% for third-party commercialization. This project is being developed in alliance with EDF.
- Total: Green hydrogen production project for export of 5 GW in the department of La Guajira.
- Aes: 1 GW production of green hydrogen intended for ammonia production in the department of La Guajira.
- TGI: Hydrogen Hub Caribbean, green hydrogen production in the departments of La Guajira and Cesar (2 GW).
- TW Solar is developing several big scale hydrogen projects in Colombia. Currently there are 4

projects in the pipeline with a planned capacity of 1.23 Mt-H₂/year:

1. HUB Sucre: 3 GW of RE capacity - 433 kt-H₂/year - End use: Methanol production. (Progress for FID: 40%)
2. HUB Atlantico: 3.8 GW of RE capacity - 669 kt-H₂/year - End use: Ammonia production. (Progress for FID: 50%)
3. Offshore Santa Marta: 1 GW of RE capacity - 37 kt-H₂/year - End use: Local Industry. (Progress for FID: 16%)
4. Guajira: 3 GW of RE capacity - 99 kt-H₂/year -End use: HVO (hydrotreated vegetable oil) and ammonia production. (Progress for FID HVO: 66%) (Progress for FID ammonia: 38%)



National Energy Plan: The National Energy Plan (PEN) 2022-2052, from the Mining-Energy Planning Unit (UPME), aims to ensure the supply of energy in a sustainable, efficient, and competitive manner. For this year's edition, the technical unit of the Ministry of Mines and Energy proposed the inclusion of hydrogen in the sustainable diversification of the Colombian energy matrix, complementing the goals set for the country in the Hydrogen roadmap of 2021. The 2023 plan establishes guidelines for renewable electricity generation and goals for the Just Energy Transition promoted by the national government.

- In its Just Energy Transition scenario, the PEN promotes an electrolysis capacity of 3 GW by 2030 and 16 GW by 2052. This generation capacity implies an increase of ~32 GW in renewable capacity. For blue hydrogen, it also sets goals of 50 Kton by 2030 and 250 Kton by 2052.
- In blending proposals, the entry of blending into the market is estimated between 2030-2040 with 2% natural gas. By 2052, blending should account for between 5% - 7% of total industrial energy consumption.
- In the transportation sector, the entry of the first SAF (Sustainable Aviation Fuel) plant in 2030 is highlighted, with hydrogen blend percentages. In the industry of heavy-duty hydrogen vehicles, the UPME estimates the entry of 23,000 to 40,000 vehicles.
- In 2052, the UPME estimates the incorporation of direct uses in the industry, in derivatives such as ammonia and methanol, and the export of 1,260 — 1,360 Kton of H₂ per year.

Kingdom of Norway

The actors involved in building up the Norwegian hydrogen industry come partly from the country's strong historic research and industrial community on hydrogen and hydrogen technology, which has roots back to 1929 when Norway produced its first ammonia from hydropower and water at Hydro's Rjukan site, but also from the strong renewable industry, the maritime industry, and the offshore oil and gas industry. In addition to significant competence in the fields of electrolyzers, fuel cells, storage tanks and hydrogen refuelling stations, Norway is at the forefront when it comes to developing new solutions in areas such as compressors, subsea hydrogen storage, bunkering solutions and other technologies for maritime application, hydrogen and ammonia ships, safety, carbon capture and innovative concepts for offshore hydrogen production. The country's substantial sub-suppliers in the oil and gas industry can further utilize its competence to develop renewable and low-carbon equipment and appliances for the hydrogen economy.

NHF recently conducted a screening of the Norwegian Hydrogen Landscape. Since 2021, the number of projects related to hydrogen production, consumption, R&D and technology scale-up has increased from approximately 50 to 179 in October 2023. There are at least 59 plans to produce hydrogen, including ammonia, methanol and e-fuels. If all these projects are realized, they will amount to a production capacity of 12.035 MW in 2030, of which 6.610 MW will be renewable and 5.425 low-carbon hydrogen. So far, 9 projects have reached Final Investment Decision (FID), construction or operation phase, corresponding to 53-72 MW production capacity in 2025.

Among the mapped projects are several hydrogen technology manufacturing facilities, for example for electrolyzers, fuel cells, storage tanks and compressors. The most well-known is Nel Hydrogen's recent opening of the world's largest automated factory at Herøya. Both Hystar and HydrogenPro also have bold ambitions for electrolyser manufacturing, and Norway is particularly well-positioned to contribute to a large share of the 100 GW electrolyser manufacturing capacity needed in the EU to reach its 10 million tons of renewable energy production target. Further, there are plans to scale fuel cell manufacturing in Norway. For example, TECO 2030 is building up Europe's first giga production facility of hydrogen PEM fuel cell stacks and modules in Narvik and targets 1,6 GW output capacity in 2030. On May 15th, they produced their first stack. Several other companies develop, test and demonstrate fuel cell technologies for maritime applications. These and other companies could sharply increase and multiply their manufacturing capacities in Norway.



V. Major Milestones of 2023

Republic of Korea

■ International Cooperation

On January, companies from Korea and the United Arab Emirates have signed 7 memorandums of understandings (MOUs) and a contract, enhancing bilateral cooperation on energy including hydrogen.

Samsung C&T Corp. signed agreement with UAE's Masdar on hydrogen and new renewable energy business cooperation. The Korea National Oil Corp. agreed with Abu Dhabi National Oil Company, or ADNOC, to forge a strategic partnership for joint production of clean hydrogen of clean hydrogen.



On April, Korean and the United States have signed 23 agreements to boost bilateral cooperation, and of the agreements, 13 MOUs were on energy industries, including hydrogen.

Lotte Chemical signed an MOU with CF Industries Holdings Inc. for collaboration in the production of blue ammonia in Louisiana and its application to electricity generation in Korea. Korea Electric Power Corp. and GE agreed upon strong cooperation on development of technologies for hydrogen, ammonia, and other renewable energy.



On October, energy ministries from Korea and Saudi Arabia signed the Hydrogen Oasis Initiative (H2Oasis) with the aim to strengthen partnership and support project developments in clean hydrogen.

Alongside the initiative, KEPCO, Posco Holdings, Lotte Chemical from Korea and Aramco of Saudi Arabia signed LOI for blue ammonia production in Ras Al Khair. Hyundai Oil bank and Aramco signed MOU for clean hydrogen energy project cooperation. KEPCO and Aljomaiah Energy & Water agreed on hydrogen project cooperation.



On November, Korea and Japan announced the Hydrogen Ammonia Global Value Chain concept when two leaders visited Stanford University in California. Two countries agreed to join forces on the procurement of clean hydrogen and ammonia from overseas, jointly negotiate prices of

imports in order to reduce costs, while ensuring a stable overseas supply of hydrogen by 2030 to reach net-zero goals.



■ International Forums/Expo

On April, along with commemorating 20th anniversary of FTA agreement between Korea and Chile, two energy ministers from Korea and Chile discussed way to boost cooperation on clean hydrogen and renewable energy development and held Korea-Chile Hydrogen Energy Strategic Partnership Seminar in Seoul.



On September, the world's largest hydrogen industry exhibition, 'H2MEET 2023', held from September 13th to 15th at KINTEX in Goyang, Gyeonggi Province. This year's H2MEET saw participation from 303 companies and institutions from 18 countries in three sectors : H2 Production, H2 Storage & Distribution, and H2 Utilization. H2MEET Conference was consisted of three sessions: Leaders Summit, Country Day, and Tech Talk, with the participation of 184 speakers, including global leaders in the hydrogen industry, policymakers, and experts. Furthermore, GHIAA held its general meeting and forum with the representatives from 15 countries



On November, two Energy Ministries from Korea and U.S. held the Korea-U.S. Clean Energy Conference in Seoul. The conference was held to boost the Carbon Free (CF) Alliance with more than 200 participants from both ministries, companies, and research institutes. The CF Alliance was launched by Korean President Yoon during the UN general Assembly session last September to promote active employment of clean energy in order to achieve global carbon goals.



United States

■ Federal Funding Programs

Outside of the seven Hydrogen Hubs funding awards, in 2023, the U.S. Department of Energy had several Hydrogen Funding Opportunity announcements, including:

- \$6.3 billion Industrial Decarbonization Demonstrations Program which will focus on the highest emitting and hardest to abate industries.
- \$1 billion Demand Side Hydrogen Program to accelerate commercial liftoff of the clean hydrogen economy.
- \$450 million Clean Energy Projects on Mine Lands to repurpose mine lands for clean energy projects.
- \$20 million ARPA-E Geologic Hydrogen to develop technologies that can stimulate the generation of hydrogen within the subsurface.
- \$19 million Clean Hydrogen to develop cutting-edge solutions to make clean hydrogen more available and affordable.
- \$6.4 million University Turbine Systems Research to develop advanced materials and components to improve the performance of hydrogen-fueled turbines.

■ 9th Annual National Hydrogen & Fuel Cell Day

On October 8, 2023, FCHEA, its members, industry organizations, and state and federal governments commemorated the 9th Annual National Hydrogen and Fuel Cell Day with a variety of activities and events across the country. National Hydrogen and Fuel Cell Day was created by FCHEA to help raise awareness of hydrogen and its economic and environmental benefits. October 8th (10.08) was chosen in reference to the atomic weight of hydrogen (1.008).

■ International Cooperation



- FCHEA is a founding member of GHIAA
- In 2023, FCHEA became a partner organization of the Hydrogen for Development Partnership (H4D), a program of the World Bank, that aims to foster capacity-building and regulatory solutions, business models, and technologies toward the roll out of low-carbon hydrogen in developing countries.
- In November 2023, FCHEA signed a Memorandum of Understanding (MoU) with Ukraine's Minister of Energy German Galushchenko, establishing a cooperative energy partnership to advance hydrogen in the United States and Ukraine.



- 20th Anniversary International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)

In October, FCHEA was honored to host a gala celebration dinner to commemorate IPHE's historic 20-year anniversary milestone with IPHE members, the U.S. Department of Energy (DOE), and several industry representatives.



Other international collaborations in 2023 between FCHEA and other countries included:

- Denmark - Denmark Green Hydrogen Alliance
- France - France Hydrogène B2B Workshop
- Spain - US-Spain Chamber of Conference Renewable Energy Symposium
- Germany - U.S. - Germany International Cooperation Workshop



■ International Forums/Expo

- The Hydrogen & Fuel Cell Seminar

The Hydrogen & Fuel Cell Seminar, the longest-running industry conference in North America, was held February 7-9, 2023, in Long Beach, California. Managed by FCHEA, the Seminar attracted more than 1,000 attendees, 70 exhibitors, and 200 plenary and technical speakers. The Republic of Korea was the Seminar's first Host Country Sponsor, helping bring Korean companies and government representatives to engage with participants.



At the Seminar, FCHEA and H2Korea organized an Industry Roundtable that included governmental and industry representatives from both countries for a high-level meeting and discussion.



Chile

In Chile, various project developers are making substantial investments in hydrogen production and storage facilities, as well as large-scale electrolysis plants powered by renewable sources such as solar and wind.

Collaborative public-private partnerships are instrumental in developing hydrogen infrastructure. For example, the National Oil Company (ENAP) had signed agreements with several companies for enhancements to existing transportation networks, upgrades to export terminals, and the construction of new facilities.

In April of this year, ENAP signed the first agreement with private entities to develop enabling infrastructure for the development of green hydrogen in the Region de Magallanes.

Then, in July, ENAP have formed an alliance with six companies (Total Eren Chile, HIF Chile, FreePower Group, Grupo EDF, RWE, and HNH Energy) to generate the largest development of green hydrogen infrastructure in the country.

In December of this year, the National Petroleum Company (ENAP) and HIF Global signed a memorandum of understanding to jointly develop a business model to facilitate the trade and use of carbon-neutral fuels, or e-fuels. The agreement envisions the generation and commercialization of between 22.5 million and 37.5 million liters of e-gasoline from the future plant that HIF will build in Cabo Negro.

Additionally, the private sector has started operations for the production and distribution of hydrogen and its derivatives in different hydrogen valleys across the country.

In central Chile, Walmart Chile has initiated a plan to operate its entire green hydrogen logistics network at its two major distribution centers, located in Quilicura and San Bernardo in the Metropolitan Region.



Inauguration of the first plant of green hydrogen in Chile of Walmart Chile, led by the the President and CEO of Walmart Inc., Doug McMillon, President and CEO of Walmart Chile, Cristián Barrientos, featured the participation of the former president Michelle Bachelet; the ministers of Finance, Mario Marcel; and Energy, Diego Pardo.

Another example in Magallanes is the first commercial export of e-fuels produced in the Haru Oni plant by the company HIF Global. They shipped 24,600 liters in tanker containers to a vessel bound for the United Kingdom.



Haru Oni Plant of HIF Global, Region de Magallanes

■ Governmental agreement or MoU signing

Chile has been establishing agreements with different countries that are very interested in having Chile as a trade partner for renewable hydrogen and its derivatives.

The EU has ambitious targets for green hydrogen and is exploring various sources for its production. Chile's potential to produce green hydrogen using renewable energy aligns with the EU's goals.



The President of the Republic of Chile, Gabriel Boric Font, together with the President of the European Commission, Ursula von der Leyen, signing two new instances of cooperation between the European Union and Chile, which will contribute to the development of the renewable hydrogen industry in Chile. Santiago, June 2023

Concerning Asia, Chile's geographic advantage, being on the Pacific coast, makes it a potential supplier to Asian markets, including Japan, South Korea, and Singapore — countries that are interested in diversifying their energy sources and reducing carbon emissions.



Nicolás Grau, Minister of Economy of Chile and Jeong Yeol Yu, President of Korea Trade-Investment Promotion Agency (KOTRA) signed a MoU to promote investment between the two countries. Santiago, October 2023.



Diego Pardow, Minister of Energy of Chile and Nobumitsu Hayashi, Deputy Governor of Japan Bank for International Cooperation (JBIC) signing and MOU to boost renewable hydrogen development. Santiago, August 2023.

The United States is incentivizing the development of a hydrogen economy, and Chile is exploring opportunities to supply low-carbon hydrogen to meet demand in the U.S. market.



President Gabriel Boric of Chile and President Joseph R. Biden, at the White House to deepen the U.S.-Chile bilateral relationship, discussing ways the United States and Chile can continue to combat the climate crisis. Washington D.C., November 2023.

■ International Forums or Expo hosted

Hyvolution

HyVolution Chile was a professional event (B2B), organized by FISA and co-organized by H2 Chile, that met supply and demand in an exhibition zone of technologies, products and services, conferences, professional meetings, and demonstrations, among other associated activities.

The event had a high attendance, public authorities, representatives throughout the value chain, academia, and civil society, reaching over 4,000 visitors.

Throughout the three days of the event, the importance of speed to seize the country's opportunity to develop the industry and progress toward a fair energy transition was emphasized.



Panel 4: "Green Hydrogen Projects Progress in Chile". Santiago, July 2023.

Kingdom of Spain

■ Governmental agreement or MoU signing

- H2MED

The green hydrogen corridor H2MED, designed to produce and transport this energy from Portugal and Spain to France, gains momentum with the inclusion of Germany. This project and the associated projects within the corridor are progressing positively in the process of acquiring qualification as European Projects of Common Interest (IPCEIs).

On October 18, an event organized by the European Transmission System Operators (TSOs) promoting the project took place at the Spanish embassy in Berlin. During the event, the German TSO, OGE, expressed its support by signing a memorandum of understanding with the gas system operators in Spain (Enagás), France (GRTgaz and Teréga), and Portugal (REN).

This pipeline will transport green hydrogen produced in Spain and Portugal, contributing up to two million tons, representing 10% of the total consumption target for Europe set by the REPowerEU plan.

The European Commission is expected to publish its proposal for the list of Projects of Common Interest (PCIs) in November, to be confirmed in early 2024 by the European Parliament and Council.

■ Mayor achievements of the private sector

1. Cepsa and Fertiberia have become strategic partners in the project to develop 1 GW of electrolysis capacity in Palos de la Frontera, within the framework of the Andalusian Green Hydrogen Valley. This valley will have a total capacity of 2 GW — 1 GW in the Campo de Gibraltar (Cádiz) and another in Palos de la Frontera (Huelva) — with a production of up to 300,000 tons in the Cepsa Energy Parks.

The agreement reached will optimize the hydrogen and biogenic CO₂ needs of both companies' facilities in the industrial fabric of Palos de la Frontera (Huelva). The green hydrogen, whose production will commence in 2026, will be used for Cepsa and Fertiberia's own industrial consumption, enabling the production of advanced biofuels, as well as ammonia, AdBlue, and sustainable fertilizers.

2. The green hydrogen cluster of the Valencia region (HyVal) at its Castellón refinery. Led by bp, this public-private collaborative initiative is intended to be based around the phased development of up to 2GW of electrolysis capacity by 2030 for producing green hydrogen at bp's refinery.

HyVal is expected to play an instrumental role in decarbonizing the operations of bp's Castellón refinery. Its transformation — including green hydrogen, biofuels, and renewable energy — could see bp invest a total of up to €2 billion in Castellon by 2030.

Green hydrogen — generated by the electrolysis of water using renewable power — will support decarbonization of the refinery's operations, replacing its current use of 'grey' hydrogen generated from natural gas.

Its production of biofuels is expected to increase three-fold, to 650,000 tonnes a year 2030. Green hydrogen will also be used as a feedstock in biofuel production, specifically of sustainable aviation fuel (SAF).

3. Repsol has begun producing renewable hydrogen at the Petronor industrial center in Muskiz, Vizcaya. The 2.5 MW electrolyzer has the capacity to generate 350 tons of renewable hydrogen annually, primarily for industrial use in the refinery as a raw material for manufacturing products with a lower carbon footprint.

The renewable hydrogen is also used at the logistics platform of the Abanto Zierbana Technology Park, located 1.5 kilometers from Muskiz, to power buses and heavy transport.

The commissioning of this electrolyzer is a milestone in Repsol's path toward net-zero emissions, where the transformation of its industrial centers plays a fundamental role. In this regard, Petronor will have two more electrolyzers with capacities of 10 MW and 100 MW in the coming years. The latter, of large scale, has been recognized by the European Commission as a strategic project and of common European interest (IPCEI).

Repsol will install other electrolyzers as a decarbonization lever near its other four major industrial centers in Spain. The one located in Cartagena will have a capacity of 100 MW and has also been classified as an IPCEI; the one in Tarragona, with 150 MW, will be the largest in Spain and has been selected by the European Commission as an innovative project to receive funding under the Innovation Fund program. Near its industrial complexes in Puertollano and A Coruña, Repsol plans to install electrolyzers with a capacity of 30 MW.

■ International Forums or Expo hosted

- World Hydrogen & Renewables Iberia

It took place between September 12 and 14 at the Riu Plaza España Hotel in Madrid. It brought together more than 90 speakers, featured over 30 hours of content, and attracted over 250 attendees from 20 countries.

- Connecting Green Hydrogen Europe 2023

Taking place from July 5 to 6 at the Riu Plaza España Hotel in Madrid, the event brought together 150 speakers and drew in a crowd of more than 5000 attendees.

- Feria Internacional de Energía y Medio Ambiente (Genera 2023)

Taking place from February 21 to 23 at IFEMA MADRID, the event brought together 385 direct exhibitors, including 141 international participants from 21 countries.

Argentina

During April 2023, we hosted the “H2ar Forum”, the first open event of the H2ar Consortium. With over 150 in-person attendants and 90 remote, it was a day of talks and debates with the leading experts from and outside the Consortium, on topics relevant to the H2 economy in Argentina.



We also participated as a Consortium on the following international events:

- GHIAA 4th General meeting, at Kintex convention center, Korea (August 15th)
- H4D 2nd Stakeholders meeting in Santiago, Chile (Oct 24th)
- 5th Green H2 Summit Chile LAC 2023 (Oct 25-26th)

Regarding international relations, in October we joined the *LAC Clean Hydrogen Action Alliance*, integrated by hydrogen associations from Chile, Colombia, Peru, Mexico and Costa Rica, among others. The alliance is an initiative framed in the COP26 with the goal to involve and articulate all the region's players in the hydrogen value chain, to foster industry development and position Latin America and Caribbean in a leading place of the emerging global market.

France

■ France and Chile strengthen their hydrogen cooperation

Olivier Becht, French Minister for Foreign Trade, and Diego Pardow, Chilean Minister of Energy, signed a joint declaration on low emission hydrogen on June 2023 in Chile. A French-Chilean working group on hydrogen has been set up to share perspectives and bring forward common initiatives between stakeholders from both hydrogen economy. This project originated from the meeting between French President Emmanuel Macron and Chilean President Gabriel Boric in September 2022, during their meeting at the U.N. General Assembly in New York. The first meeting of the working group was organised in July, during the visit of the Chilean President in France. A second one took place in November. A French expert on hydrogen has been working at the Chilean Energy Ministry within the framework of this cooperation agreement.

■ Hyvolution 2023, next edition coming

Organised in collaboration with France Hydrogène, the 2023 edition of Hyvolution took place on 1st and 2nd February in Paris. Under the distinguished patronage of the President of the French Republic, Mr Emmanuel Macron, Hyvolution broke its previous records this year by attracting 7,867 professional visitors (73% up on the 2022 edition) and 400 exhibitors and brands including all the sector's big names. The trade show's international dimension, already a fact, grew even more at this latest edition, with visitors from 70 countries against 30 last year and a threefold increase in international visitors, along with 88 exhibitors from abroad. The trade fair asserted itself as the go-to European nexus of political and economic discussion centred on hydrogen solutions, a key contributor to decarbonization.

Hyvolution 2024 will stand from the 30th of January until the 1st of February. The event will host the next meeting of the GHIAA. The next meeting of Hydrogen Europe's national association working group will also be at Hyvolution. International and European association are offered a booth within a National Associations Hub, within the International Zone of the Summit. Three days of conferences will be organised, on international hydrogen strategies, certification and standardisation, and financing.

Republic of Poland

■ Establishment of the 3 Seas Hydrogen Council

- Hydrogen Poland acted as an initiator to bring together nine Central European and Baltic countries (Poland, Czech Republic, Estonia, Lithuania, Latvia, Slovakia, Slovenia, Hungary and Ukraine) to form international hydrogen partnerships. The act of establishing the partnership took place during the second edition of H2Poland in Poznań. This unique hydrogen initiative of such a large scale in the region is intended to be a vehicle for dialogue between the members of the agreement and the European Commission and the European Parliament.
- The initiative was also welcomed by the Deputy Minister for Climate, Government Plenipotentiary for Renewable Energy, Ireneusz Zyska, who said: "This is a historic moment. This initiative is an excellent start to build international business partnerships. Our countries have great potential here." He was also present at the creation of the council.
- "We want to create and propose business-friendly regulations at the level of the European Union as well as individual member states, take care of the fair distribution of aid funds, but above all create local and cross-border business projects [...]" commented Hydrogen Poland's CEO, Paweł Piotrowicz.
- Tomoho Umeda, board member of the Hydrogen Poland association, believes that the partnership will bring multifaceted



benefits by supporting local governmental and non-governmental entities on the road to a green transition. It will create opportunities for cooperation and development of a zero-carbon economy, with hydrogen as a key element of this positive change at regional, European and global levels.

- The signatories of the agreement highlight the common elements that gave motivation for the creation of this agreement. Not only the shared history, but also the current conditions in the energy and district heating structure, as well as the analogous climatic conditions, provide an opportunity to exploit the maximum potential of the region. The region as a key production base for the economies of both the West and the world.
- United in these goals, the signatories pledged to strengthen cooperation to assist Ukraine and support its path to energy independence, which, given the turbulent global events, has also become crucial for other European countries. They recognize that solidarity and coordination in this area is unprecedented for regional and global stability.
- Hydrogen organizations affiliated with the 3 Seas Hydrogen Council:
 - 1) Hydrogen Poland
 - 2) Czech Technological Hydrogen Platform (HYTEP)
 - 3) Ukrainian Hydrogen Council
 - 4) Hungarian Hydrogen Technology Association
 - 5) Pomeranian Hydrogen Technology Cluster
 - 6) Estonian Hydrogen Cluster
 - 7) Slovak National Hydrogen Association
 - 8) Latvian Hydrogen alliance
 - 9) Lithuanian Hydrogen Energy Association
 - 10) National Hydrogen Association of Slovenia.



■ Signing of the Memorandum of Understanding between Hydrogen Poland and H2Korea in the Development of Green Hydrogen

- On Friday, July 14, 2023, during the Economic Forum in Warsaw, representatives of H2Korea and Hydrogen Poland ceremoniously signed a Memorandum of Understanding, marking the inaugural agreement of bilateral cooperation in the development of a renewable hydrogen ecosystem. The forum aimed to strengthen economic cooperation between Poland and Korea, focusing on areas such as advanced technologies, energy, infrastructure, and defense. The honorary guests at this prestigious event were President of the Republic of Korea, Yoon Suk Yeol, and President of Poland, Andrzej Duda.
- As a result of the agreement, Jaedo Moon, the president of H2Korea, emphasized Poland's potential in the petrochemical industry, highlighting the need for clean hydrogen in the process of economic decarbonization. Tomoho Umeda, Vice President of Hydrogen Poland, highlighted Poland's role as one of the founders of the 3 Seas Hydrogen, representing Central and Eastern European countries on the international stage.
- Objectives of the Agreement
 - The signing of the agreement aims to actively support cooperation between companies in

Poland and Korea. Signatories commit to exchanging information, connecting investors in hydrogen technologies, developing policies supporting the hydrogen industry, and promoting them at the government level. Another goal is to establish international standards for the value chain of the hydrogen industry and facilitate the exchange of expert experiences.

- Significance of Collaboration for Poland and Korea

- The agreement is a milestone in developing hydrogen cooperation between Poland and Korea. H2Korea, as a government advisory body in Korea, acts as a bridge between the public and private sectors, supporting international business and cooperation projects. Hydrogen Poland represents the interests of Polish businesses both domestically and internationally.
- The signed agreement provides a solid foundation for further development of the hydrogen ecosystem in Poland and Korea. The collaboration aims to meet the growing demand for hydrogen in the energy sector and the strategic development of both countries in the field of decarbonization. Hydrogen Poland, as a key player in the Central and Eastern European region, brings a broader perspective, making this agreement even more valuable for the future of the hydrogen industry.



■ Continuation of Cooperation and Hydrogen Poland's Accession to GHIAA

- After the successful signing of the agreement with H2Korea at the Economic Forum Korea — Poland, Hydrogen Poland proudly announces another milestone. On September 14, 2023, Hydrogen Poland joined the Global Hydrogen Industry Association Alliance (GHIAA).
- During the 4th General Assembly of GHIAA in Korea, Hydrogen Poland, as the first Polish organization, gained honorary membership. This unique event emphasizes the importance of Poland's contribution to the global hydrogen industry. Along with 20 other GHIAA members, the Declaration on the promotion and support of the hydrogen economy worldwide will be officially signed. This document forms the basis for our joint actions and principles.
- Outlook for the Future
 - Joining GHIAA opens new prospects for global cooperation for Hydrogen Poland. We will actively participate in international initiatives, representing the interests of the Polish hydrogen industry on the global stage. As GHIAA members, we will collectively strive for the sustainable and efficient development of the hydrogen sector worldwide.

■ Business Mission in the United Kingdom with the Participation of Hydrogen Poland

- From November 13 to 15, 2023, Hydrogen Poland participated in a hydrogen business mission organized by the Polish Investment and Trade Agency (PAIH). During this event:
- Study visits were conducted at the headquarters of British companies operating in the hydrogen technology sector.

- Meetings were held at the Embassy of the Republic of Poland in London.
- Participation took place in the "Hydrogen Futures Conference 2023," organized by REA - the largest association of the renewable energy and clean technology industry in the United Kingdom.
- Tomoho Umeda represented Hydrogen Poland during the Hydrogen Futures Conference 2023. During his presentation, he outlined a broad spectrum of Hydrogen Poland's activities and its role as initiators of the 3 Seas Hydrogen Council.
- Participation in this conference was a valuable experience, strengthening Hydrogen Poland's role in the hydrogen sector and facilitating effective relationship-building and engagement in the hydrogen sector.

■ Congress of Reconstruction of Ukraine

- Hydrogen Poland Association, assumed honorary patronage of the Reconstruction Congress of Ukraine, held on 21 – 22.09.2023
- The Reconstruction Congress of Ukraine provides an important platform for exchanging ideas, sharing knowledge and formulating effective strategies to help Ukraine in its recovery and reconstruction process. The event brings together leading industry representatives, government officials and key stakeholders, creating a unique opportunity for knowledge sharing and collaboration.

■ Annual Meeting of the Visegrad Group on Hydrogen with the Participation of Hydrogen Poland

- On December 14, 2023 Czech Presidency held presidency during the Visegrad Group 2023/2024 meeting "V4 Citizens" where Hydrogen Poland participated to accelerate cooperation in the region with urgent need to respond to Russia's ongoing aggression against Ukraine. The overarching aim was to address the direct security threat to Ukraine and the broader Eastern neighborhood. The meeting sought to reaffirm the democratic principles integral to the V4 countries, emphasizing support for Ukraine's independence, sovereignty, and territorial integrity.
- Participating countries, through their representatives, discussed and enhanced collaboration, emphasizing the importance of the Visegrad Group as a traditional platform for cultivating good neighborly relations. It is noteworthy that during this event, another GHIAA member was present - Hungarian Hydrogen Technology Association. Considering significant anniversaries, including the 20th anniversary of V4 countries' entry into the EU and the 25th anniversary for Czechia, Hungary, and Poland's NATO membership, the agenda incorporated multifaceted approach, encompassing regional cooperation, celebration of achievements, and sustained commitment to shared principles and partnerships.
- Respecting hydrogen cooperation, participants addressed common themes of the Visegrad Group, including their promotion in the European Commission. Speakers from various organizations presented introductory overviews, fostering subsequent discussions aimed at summarizing the shared objectives of the event. These discussions and presentations highlighted collaborative efforts within the V4 to advance hydrogen technologies, strengthen regional commitment, and contribute to the broader European hydrogen landscape.

The Republic of Colombia

LAC Clean Hydrogen Action: H2Colombia has been chosen to lead the hydrogen regional association which promotes the sustainable development of a hydrogen market in the region, through this alliance topics like certification schemes, hydrogen commerce in the region and sustainability guidelines will be developed to assure the growth of this great opportunity. Latin America and the Caribbean is a region with outstanding renewable resources and plans to use this advantage to export clean energy to the world and decarbonize its own industries.

2nd International Hydrogen Congress: took place on April 20 and 21 in the city of Bogotá. This event brought together the main stakeholders of hydrogen in Colombia and Latin America, addressing key themes in the development of H2 and its derivatives, such as demand scenarios, production technologies, projects and pilots, and various pioneering political and regulatory frameworks in the region.

The event featured a high-level agenda with conferences and expert panels. Government officials, academic leaders, regulators, port directors, and energy sector leaders participated in the discussion spaces with more than 600 attendees.

Our third edition of the congress will be held from April 9 to 11, 2024, under the theme "From Dream to Reality." It will serve as a meeting point for decision-makers and experts from the public, business, financial, and academic sectors, both nationally and internationally.

In this upcoming edition, our objectives are to i) promote international cooperation, ii) facilitate the relationship among key actors, and iii) drive the realization of hydrogen projects in Colombia.

H2 Tour Colombia: is a regional workshop initiative for the period 2023 — 2024 aimed at shaping the future of hydrogen in Colombia. It serves as a platform for regional discussions, providing a space to learn, analyze, and propose solutions to support the development of the hydrogen industry in our country.

In 2023, we established four discussion tables in the Caribbean region, focusing on infrastructure (Barranquilla), regulation, certification, and tax incentives (Cartagena), industrial solutions (Cartagena), and socio-environmental issues (Riohacha). For 2024, we anticipate replicating this effort in the Andean and Pacific regions. As an outcome of these regional discussions, we will present a document outlining lessons learned and policy recommendations during the 3rd International Hydrogen Congress.

Kingdom of Norway

■ Governmental agreement

Several steps have been taken to establish a value chain for large-scale hydrogen exports from Norway to Germany. After Vice-Chancellor Robert Habeck's visit to Oslo in March 2022, Norway and Germany agreed to undertake a feasibility study on large-scale exports by pipeline. The results of the study were published November 2023, and show that a pipeline is indeed both

technically and economically feasible. Norway and Germany have set up a joint Task Force to follow up the results. If a decision is taken to go forth with the plans to build a pipeline, Norway could export 1 Mtpa of hydrogen directly to Germany by 2030, potentially scaling up to 4 Mtpa by the end of the decade. The pipeline will be built with dimensions that are 30 % larger than current low-carbon production plans and will have the capacity to include renewable hydrogen both from the Norwegian mainland and from offshore wind farms along the way. As a symbol of the close collaboration between the two countries, Norwegian minister for Trade and Industry Jan Christian Vestre and German Vice-Chancellor Robert Habeck announced on 8 November during a business summit in Hamburg that Norway will be partner country to Hannover Messe 2024.

There has also been extensive development in the German-Norwegian collaboration at industry level. Equinor and German utility RWE have joint plans to build offshore wind and hydrogen-ready gas-fired power plants in Germany. Several Norwegian industry companies have established partnerships with VNG, among others Equinor and Aker Horizons. Recently, Horisont Energi and VNG signed a letter of intent for clean ammonia offtake, targeting 100-300.000 tons per year from 2028. Gen2 Energy and the German, state-owned utility company SEFE have signed a letter of intent for compressed hydrogen deliveries by ship by 2027. German utility EnBW has invested in Skipavika Green Ammonia and secured exclusive offtake rights for green ammonia from 2026. Recently, Norwegian electrolyser producers Nel Hydrogen and HydrogenPro have signed agreements with leading German companies, such as HH2E and Salzgitter Flachstahl GmbH/Andritz. In September 2023, Hexagon Purus opened a new hydrogen cylinder manufacturing hub in Kassel. Norwegian shipping company Høegh LNG is also set to convert its floating LNG terminals in Germany to import hydrogen from 2028.

In June, Norway and Denmark signed an agreement to deepen energy collaboration. In addition to expanding renewable energy and establishing green transport corridors, the agreement focuses on establishing the infrastructure necessary to realize hydrogen as an energy carrier in the energy transition. In December, Norway signed a similar agreement with Japan.

The cities of Oslo and Rotterdam have signed a MoU to create a new green corridor for short sea shipping. The corridor will be served by Samskip's next generation zero-emission SeaShuttle vessels.

■ Private Sector

The world's first liquid hydrogen powered passenger ferry, MF Hydra, came into operation in March 2023. The development of Norway's second ferry line on hydrogen, Vestfjorden between Bodø and Moskenes in the Lofoten Islands, has continued. Ferry operator Torghatten Nord has chosen GreenH for delivery of hydrogen for 15 years, starting in 2025.

The Norwegian fertilizer producer Yara plans to put the world's first pure ammonia containership, Yara Eyde, into operation by 2026. The vessel is being developed by ammonia producer and shipowner Yara Clean Ammonia and the Norwegian container operator North Sea Container Line. The vessels shall go into operation between the Oslo fjord and Yara's facilities in Northern Germany. To enable ammonia bunkering, Yara has further invested in Azane Fuel Solutions AS, a Norwegian startup that develops proprietary technology and services for ammonia fuel handling. Yara has pre-ordered 15 units and given Azane the green light to build its first bunkering unit in Florø, Norway.

The Norwegian aluminium producer Norsk Hydro achieved a major milestone in 2023 when it

succeeded in producing its first ever recycled aluminium by green hydrogen, replacing natural gas. The test was accomplished at Hydro's extrusion facility in Navarra, Spain.

In heavy-duty transport, German hydrogen truck manufacturer Quantron has chosen Norwegian refueling station operator Vireon as partner in its Quantron-as-a-Service offer. The partnership with Quantron shall contribute to Vireon's ambition to establish a network of 30-50 large-scale HRS by 2027.

In Oslo, NAPOP, Hafslund and Steg Entreprenør have demonstrated the use of hydrogen at Europe's first zero-emission construction site.

The world's first hydrogen plant with integrated CO₂ capture was opened at CCB Energy Park in Kollsnes, Western Norway. The technology was developed and delivered by the Norwegian company ZEG Power.

■ International Forums

In March, NHF in collaboration with Innovation Norway and the Royal Norwegian Embassy in Tokyo hosted a national pavilion at the FC Expo Tokyo. NHF and the Japanese Hydrogen Association JH2A signed a Memorandum of Understanding (MoU), which shall facilitate closer collaboration on hydrogen and ammonia, both at political and industry levels. There were also national pavilions both at Hannover Messe and European Hydrogen Week. Norway will be official partner at Hannover Messe 2024.

VI. History of GHIAA

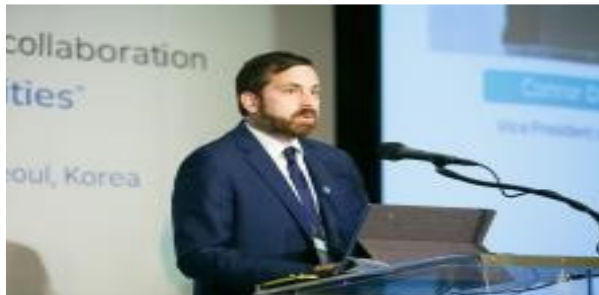
■ 2021 GHIAA Forum (September 2021)

GHIAA was first agreed to be launched after the signing of the Letter of Intent (LOI) with 13 hydrogen industrial associations on a consensus on creating a global cooperation platform for sharing information in hydrogen industry. The event was held during the H2MEET in Goyang, Korea. Korea (H2KOREA), EU (Hydrogen Europe), United States (FCHEA), Australia (AHC), Canada (CHFCA), France (France -Hydrogene), Norway (Norwegian Hydrogen Forum), UK (HEA), Spain (AeH2), the Netherlands (NWBA), Chile (H2Chile), China (IHFCA), Singapore (HFCAS) have participated.



■ 2022 GHIAA Forum (May 2022)

GHIAA was officially launched with the participation of 18 member associations during the H2MEET in Korea. First 2022 GHIAA Forum was held where each participating members shared the national hydrogen policies and industry status.





■ The 1st General Meeting (May 2022)

Following agendas were approved.

- Demark (Hydrogen Denmark), Sweden (Vatas Sverige), Germany (DWW), Argentina (H2ar Consorcio), Colombia (Hidrogeno Colombia) were newly joined.
- Approved Articles of Association and Terms of Reference
- Appointed Jaedo Moon, chairman of H2KOREA, as a Chair, and Frank Wolak, CEO of FCHEA, as vice-Chair of GHIAA
- Designated H2KOREA as an official Secretariat of GHIAA
- Official Website of GHIAA was opened



■ The 2nd General Meeting (October 2022)

The 2nd General Meeting of GHIAA was held during EU Hydrogen Week in Brussel. Following agendas were approved.

- Two members from Japan (JH2A) and Hungary (HH2) joined that total of 20 member associations were participating GHIAA

- Appointed Jorgo Chatzimarkakis, a CEO of Hydrogen Europe, to the Vice chair of GHIAA
- Resolved the Joint Statement to emphasize the importance of hydrogen and the urgency of implementing a hydrogen economy to COP27
- Agreed on publishing the annual report



■ The 3rd General Meeting (Feb 2023)

The 3rd General Meeting of GHIAA was held Following agendas were approved during 2023 Hydrogen & Fuel Cell Seminar (HFCS) in California. GHIAA agreed on published 2023 annual report. The special guest, Dolf Gielen, the hydrogen lead in the World Bank, participated to introduce the H4D initiative which aims to assist developing countries in accelerative low-carbon hydrogen deployment. The participated GHIAA members discussed a way to cooperate to act in accordance with following vision.



■ 2023 GHIAA Forum and 4th General Meeting (September 2023)

2023 GHIAA Forum was held during the H2MEET in Korea. The total of 21 GHIAA members joining the GHIAA, 9 associations introduced the national hydrogen policy and industry during the Forum, while others participating online. H2ar Consortium from Argentina introduced the national hydrogen strategy which was recently released during September.

H2Council from Australia introduced national support policy on hydrogen and investment plan.

IHFCA from China introduced the Hydrogen Industry Mid-Long-Term plan which was released last March and shared national hydrogen strategy.

H2Colombia introduced the national hydrogen strategy and ongoing hydrogen production projects in the country.

French Hydrogen Task Force introduced the national hydrogen strategy which is expected to be released next year and explain in depth about latest cutting-edge hydrogen technology.

Hungarian Hydrogen Technology Association presented hydrogen strategy by 2030 and introduced the six co-related support projects.

NWBA from the Netherlands introduced newly released Hydrogen Roadmap and explained incentive programs and ongoing hydrogen projects.

HFCAs from Singapore introduced the Hydrogen Strategy, which was released last year and explained the four key sectors for low hydrogen deployment.

Hydrogen Poland Association emphasized the importance of hydrogen energy amid the Russia-Ukraine war and introduced the ongoing co-combustion hydrogen project.

During the general meeting, following agendas were approved.

- Poland Hydrogen Association have newly joined
- Released Joint Declaration in Seoul to urge the implementation of hydrogen in the industry and promote financial support
- Publish 2023 Annal Report



Appendix I. GHIAA Articles of Association

CHAPTER 1 GENERALS

Article 1 The Name of the Association

The name of the association shall be Global Hydrogen Industrial Association Alliance (“GHIAA”).

Article 2 Background and Objectives

1. GHIAA is an international initiative with the participation of hydrogen industrial associations from individual countries(and/or union).

2. The objective of GHIAA is to strengthen bilateral and multilateral private international cooperation and promote private participation in the decision-making process of the relevant governments and international organizations by fostering cooperation among the participating organizations of GHIAA (“Members”) (“Objectives”).

Article 3 Major Activities

GHIAA shall perform the following activities to achieve the Objectives described in Article 2 of this Articles of Association (“AOA”).

- 1) Deal with all the relevant matters regarding private international cooperation in all the fields related to hydrogen that are requested by the Members.
- 2) Participate in the activities of hydrogen-related international consultative bodies and international organizations.
- 3) Publish materials related to the vitalization of hydrogen industries.
- 4) Conduct non-profit businesses that serve the Objectives described in Article 2.

CHAPTER 2 MEMBERS

Article 4 Members of the GHIAA

The Member of GHIAA shall be a hydrogen industrial association representing individual countries (and/or union). Only one hydrogen industrial association from each individual country(and/or union) shall be allowed to be a member of GHIAA.

Article 5 Members’ Rights and Obligations

1. The Members shall have the right to request assistance from GHIAA for activities to vitalize the hydrogen industry and freely express their opinions in the General Meeting of GHIAA (as defined below).

2. Each Member may appoint one (1) representative (“**Representative**”). A Representative of a Member shall have the right to participate in the Regular General Meeting and the Special General Meeting, appoint and/or be appointed as the Chair, vote on the agendas, and request the Chair and the Secretariat (as defined below) to introduce an agenda at the General Meeting.

3. The Members shall comply with this AOA and the resolution of the General Meeting, and use reasonable commercial efforts to fulfil the Secretariat’s requests, including but not limited to, contributing to events held by GHIAA as a speaker, providing related materials.

Article 6 Participation and Withdrawal

1. A hydrogen industrial association that wishes to become a Member of GHIAA (“**Applicant**”) shall notify the Secretariat of the intention to participate in GHIAA. The Secretariat shall introduce such intention as an agenda at the General Meeting and notify the Members of this agenda, but not required any quorum for the acceptance of the Applicant. The Applicant shall become a Member of GHIAA when the Applicant and the Chair jointly sign the official form of GHIAA used for a membership application.

2. A Member may withdraw the membership of GHIAA by giving at least thirty (30) days prior written notice to the Secretariat the intention to withdraw the membership of GHIAA along with the desired withdrawal date and the Secretariat shall introduce such intention as an agenda at the General Meeting and notify the Members of this agenda, but not required any quorum for the acceptance of the notice. The Member will be deemed to have withdrawn the membership of GHIAA on the desired withdrawal date.

3. A Member whose representative serves as the Chair and acts as the Secretariat in accordance with Article 13 shall not withdraw the membership of GHIAA until the term of office of the representative as the Chair is completed. Such a Member may withdraw the membership of GHIAA before the ending of the term of office of the representative as the Chair with reasonable grounds when an interim Chair and an interim Secretariat are appointed in the General Meeting.

CHAPTER 3 GENERAL MEETING

Article 7 The General Meeting

The General Meeting is the highest decision-making body of GHIAA.

Article 8 Composition of the General Meeting

1. The General Meeting consists of a meeting of the Representative of each Member. Each Member, acting through their Representative, has the right to appoint the Chair and vote on the agendas. The Members shall give at least three (3) days prior written notice to the Secretariat before the General Meeting is held if they wish to change their Representative.

2. The Secretariat shall give seven (7) days prior written notice to the Members and their

Representatives on the agenda before the General Meeting is held.

3. The Members may appoint their officer or employee to be a Representative in the General Meeting.

4. At least one-half of the Members of the GHIAA present at a General Meeting shall form the quorum. In the event there is no quorum, the Members present at the General Meeting shall be considered a quorum and the General Meeting shall proceed with the agenda of the meeting that was adjourned. Each Member, acting through their Representative, shall have one (1) vote.

5. Members shall be entitled to participate in the General Meeting by following manners without the need for a Member to be in the physical presence of another Member(s).

1) voting through the designated written form showing they agree or disagree with each agenda and notifying the Secretariat within the designated date and time.

2) electronic means, such as video conference or other similar telecommunications means by which all persons participating in the meeting are able to hear and be heard by all other participants.

Participation in a General Meeting in such manner shall be counted in the quorum for the General Meeting; and the General Meeting will be deemed to be held at the place where the Chair is present for the duration of the meeting.

Article 9 Chair and Vice-Chair

1. The appointment of the Chair shall be introduced as an agenda at the General Meeting. The Chair shall be appointed by a two-thirds (2/3) majority vote of the Representatives present.

2. The term of office of the Chair shall be two (2) years and the Chair may serve consecutive terms. The Member, whose Representative serves as the Chair, will also act as the Secretariat during its Representative's term of office.

3. GHIAA shall appoint a maximum of two (2) Vice-Chairmen. The term of office of each Vice-Chair shall be two (2) years and they may serve consecutive terms.

4. The Chair shall have the authority to convene the General Meeting and introduce agendas at the General Meeting. The Members shall give their opinions on the proposed agenda and the Chair shall have adequate time to gather their opinions for more than fourteen (14) days. After the foregoing procedure, the Chair will decide whether such an agenda can be introduced at the General Meeting ("General Meeting Agenda"). The Members and their Representatives will be informed of the General Meeting Agenda with seven (7) days prior written notice before the General Meeting is held.

Article 10 Convening of the General Meeting

1. The Regular General Meeting shall be convened once every half a year.

2. The Special General Meeting shall be convened by the Chair when:

- 1) the Chair considers it is necessary to be held, or
- 2) there is a request by one-third (1/3) of the Members.

3. A prior written notice shall be sent to all the Members and the Representatives at least seven (7) days prior to the General Meeting described in Articles 10.1 and 10.2 above, specifying the time and place of the meeting (including details of the General Meeting for attendees attending by electronic means) and indicating its purposes and the agendas to be resolved in the meeting.

Article 11 Agendas

The following agendas shall be introduced at the General Meeting:

- 1) Amendment of this AOA;
- 2) Appointment and Dismissal of the Chair; and
- 3) All other matters concerning the operation of GHIAA for which the Members' consent is necessary.

Article 12 Adoption of Resolution

1. Unless otherwise stipulated in this AOA, the resolution of the General Meeting shall be adopted with the attendance of the quorum (per Article 8.4) and by the concurrent votes of a simple majority of the Representatives present.

2. In the event of a tied vote at the General Meeting, no action will be taken on the subject matter of the vote.

CHAPTER 4 SECRETARIAT

Article 13 The Secretariat

The Member whose Representative is appointed as the Chair shall be the Secretariat and shall serve as the Secretariat during the term of office of the Chair fulfilling the Objectives of this AOA.

Article 14 Duties of the Secretariat

1. The Secretariat shall have the duty to operate GHIAA by undertaking and performing certain activities, including but not limited to, preparing and holding the General Meeting and managing GHIAA's webpage and the Members.

2. The Secretariat shall have the right to request any Members' participation and assistance necessary to operate GHIAA, including but not limited to, contributing to events held by GHIAA as a speaker, providing related materials.

3. The Secretariat shall use reasonable commercial efforts to support any Member's request for assistance for their activities concerning the vitalization of the hydrogen industry, including but not limited to, contributing to events held by any Members as a speaker, providing related materials.

4. The Chair and the Secretariat shall represent GHIAA concerning the requests for assistance from other institutions or organizations or matters needed to be decided upon or the activities required to be conducted in the name of GHIAA; provided, however, that if such requests and matters are materially important for both the Members and GHIAA, the Chair and the Secretariat shall call a General Meeting to pass resolutions in relation to such requests and matters to represent the interests of GHIAA.

Article 15 Composition of the Secretariat

1. The Member that serves as the Secretariat shall appoint a secretary general and at least two officers who support the secretary general.

2. The Members shall appoint at least one in-house staff for dealing with matters concerning GHIAA and the Secretariat shall collect and manage the list of such staff.

CHAPTER 5 SUPPLEMENTARY PROVISIONS

Article 16 Enactment of Addendum

The Chair shall have the authority to determine the matters with regard to the operation of GHIAA that are not stipulated in this AOA, including but not limited to, creating official forms of GHIAA, by virtue of its authority. However, the Chair shall enact an addendum to the AOA, which shall be approved by a resolution passed by the General Meeting, to decide on matters important for the operation of GHIAA or if there is a Member request.

Article 17 Confidentiality

The Members shall hold the information obtained during the course of conducting their duties under this AOA in strict confidence and not disclose, copy, reproduce, or distribute any of it or otherwise make it available to any third party.

Article 18 Amendment

This AOA may be amended or modified only by the resolution of the General Meeting with the consent of two-thirds (2/3) of the Representatives.

GHIAA Operation Terms of Reference

1. Chair and Vice-Chair

There shall be one (1) Chair and two (2) Vice-Chair and the term of office shall be two (2) years.

The Chair will be appointed by the Vice-Chair for the continuity of the activities of GHIAA.

The representative of H2KOREA, the chairman Mr Jaedo Moon, will be appointed as the first Chair to fulfil the founding purpose of GHIAA.

2. Convening of the General Meeting

The Regular General Meeting shall be convened once every half a year. The first Regular General Meeting shall be convened by the Secretariat and the other can be held under discussion to cooperate with other occasions such as international events.

3. Operation of the Secretariat and Memberships

In the initial stage of establishment, membership fees are borne by the Secretariat, in principle, but if necessary, the Members contribute financially under the Member's consent.

4. Others

The Secretariat shall publish and circulate a report once a year for information sharing among Members.

Appendix II. Joint Statement for the COP27



The Global Hydrogen Industrial Association Alliance (GHIAA) call on COP27 for more dedicated action

The Global Hydrogen Industrial Association Alliance (GHIAA) actively supports COP 27 in Egypt to overcome the global climate crisis and urges participants and other stakeholders to support and invest in the hydrogen industry to achieve Net-Zero targets and secure clean energy supplies.

Hydrogen is an essential element of decarbonization and is an infinite clean energy source that can be produced. It has the potential to reduce carbon emissions in several industrial sectors, including transportation, heating and heavy industry. In addition, it can be shipped and traded worldwide as a clean fuel for both liquefaction forms and derivatives (such as ammonia).

Therefore, the world is currently paying attention to hydrogen as an important means of solving the climate crisis and energy security, and more than 40 countries are surveyed to have hydrogen strategies.

According to the Hydrogen Insights 2022 of the Hydrogen Council, hydrogen investment worth about \$700 billion by 2030 is needed to get on a carbon-free economy by 2050, but only 3% of the total cost is currently being spent. Therefore, we should quickly and boldly increase investment to build a hydrogen ecosystem.

For the rapid transition to the global hydrogen economy, the international cooperation is essential. Through this, opportunities for the growth of the global hydrogen industry and the expansion of the hydrogen market will be created with mutual cooperation. GHIAA will actively support this and play the role of a bridge.

The associations include the H2KOREA, the Hydrogen Europe, the Fuel Cell & Hydrogen Energy Association (FCHEA), the Canadian Hydrogen and Fuel Cell Association (CHFCA), the Asociación Chilena de Hidrógeno (H2CHILE), the France Hydrogène (AFHYPAC), the UK Hydrogen and Fuel Cell Association (UK HFCA), the Asociación Española del Hidrógeno (AeH2), the Nederlandse Waterstof en Brandstofcel Associatie (NWBA), the Norsk Hydrogenforum (NHF), the International Hydrogen Fuel Cell Association(IHFCA), the Hydrogen and Fuel Cell Association of Singapore (HFCAS), the Australian Hydrogen Council (AHC), the Asociación Colombiana del Hidrógeno, the H2ar Consortium, the Brintbranchen (Hydrogen Denmark), the Vätgas Sverige (Hydrogen Sweden), the Deutsche wasserstoff- und brennstoffzellen-verband(DWV), the Hungarian Hydrogen Technology Association(HH2), and the Japan Hydrogen Association(JH2A).

3rd November, 2022

Jaedo Moon, the Chair of GHIAA, sends this mail on behalf of 20 associations



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Statement for COP27

GHIAA which is organized by 20 hydrogen industry associations around the world called on COP27 participating nations and parties to support investment and technology development and to expedite international cooperation and collaborations for action on the hydrogen economy to implement a net zero target.

1. We, members of GHIAA, collectively welcome that more governments have been recognizing hydrogen as an essential component for achieving carbon neutrality and tried their best to transform their visions into actions as shown in the appendix.
2. Notwithstanding these positive developments, it goes without saying that there are still a lot of challenges to be done by private and public entities. To solve this problem, it is necessary to maximize hydrogen utilization technology, develop clean hydrogen production technology, expand scale-up and infrastructure, and establish an international system for hydrogen trade. It is also urgent to raise funds for continuous investment to address these issues.
3. In order to realize their strategies into action, we call on governments to establish an inclusive policy framework, e.g. to set clear targets for clean hydrogen to decarbonize every sector of the economy as much as possible, establish public hydrogen financing scheme as practically as possible, invest in infrastructure for hydrogen supply chain, and apply globally recognized standards. These certification schemes aim to promote the international trade of clean hydrogen as fairly and transparently as possible.
4. Accordingly, we commit that GHIAA will work closely together to enhance multilateral private cooperation in the dissemination of best practices, technology transfer, and mutual investment.

Appendix. Examples of Countries actions in 2022

- The world is now facing an energy supply chain crisis caused by the protracted Russia-Ukraine war and lingering climate issues.
- In May, the European Commission announced a "REPower EU" strategy aimed at reducing Europe's dependence on Russian gas. Particularly, the Commission aims to achieve 10 million tons of domestic green hydrogen production capacity and 10 million tons of hydrogen imports by 2030 in the EU.
- In August, U.S. president Biden signed a bill, the Inflation Reduction Act, into law, that includes significant support for hydrogen, including a subsidy plan of up to \$3 per kilogram for green hydrogen production. The U.S. DOE has released a Funding Announcement as part of the Infrastructure Investment and Jobs Act (IIJA)'s 8 Billion dollars for regional clean hydrogen hubs (H2Hubs). These initiatives strive to develop a hydrogen sector to as part of broader



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decarbonization efforts.

- Germany announced support measures worth 9 billion euros with the aim of securing 5GW of electrolysis capacity by 2030 and is pushing forward to secure green hydrogen production capacity at home and abroad.
- Korea revised the Hydrogen Act in 2022 to specify the strategy for establishing the hydrogen industry ecosystem. Currently, about 26,000 fuel cell electric vehicles (FCEVs) are operating nationwide, and about 190 hydrogen refueling stations (HRSSs) have been built and are operated nationwide. The hydrogen fuel cell power plant is in operation at 800MW, and separately, it is expected to expand the power plant that directly or mixed combusts hydrogen to achieve carbon neutrality. Moreover, Korean government held an international forum in May 2022 and is reaching out to the international community to enact a clean hydrogen certification system for international trade in clean hydrogen.
- The Netherlands has set targets to have 3 to 4 GW electrolysis capacity and further accelerates offshore wind energy generation towards 70 GW in 2050. Financial stimuli are diverse and cover the entire value chain, and with use of the Import Project of Common European Interest (IPCEI) facility, at least 1.385 billion Euro is available for these projects. The NWBA will focus on creating, sharing and consolidating knowledge across the value chains in industry, mobility and the built environment.
- In 2022, the UK has seen a doubling of the Government's low carbon hydrogen production target to 10 GW by 2030, with a commitment that at least 50% is from renewable hydrogen. As part of plans to support both capex and opex of hydrogen production, the first electrolytic hydrogen production funding call for both capital development and operation, with initial funding of £100 (more calls planned) million, was launched. The UK's Low Carbon Hydrogen Standard was set at 20g CO₂e/MJLHV. On the demand side, £60 million was made available for industrial emissions savings and decarbonisation, and ~£480 million for demonstration and deployment across trucks, buses, maritime and associated refuelling infrastructure. Government published a Sector Development Plan covering aspects such as supply chain development and skills, and has taken the first steps to develop a business model for hydrogen transportation and storage infrastructure.
- After launching the Colombian Hydrogen Roadmap with ambitious goals by 2030, as well as the Energy Transition Law that gives tax benefits for investment in Hydrogen projects, in March of 2022 the first two industrial pilot projects were inaugurated. One of the pilots is on using green hydrogen in the refinery process in Cartagena, and the other one is on analyzing a blend between natural gas and hydrogen. In terms of regulation, in July of 2022, the Government of Colombia issued a national decree that establishes the institutional framework and assigns responsibilities to different ministries to develop the hydrogen ecosystem. In parallel, via the Renewable Energy Fund FENOG, financial funds were assigned to 10 hydrogen projects for the development of prefeasibility studies.
- Last year, the Economic Development Agency of Chile (CORFO) auctioned a fund of US\$ 50 million for the development of hydrogen projects, where 6 projects were awarded. Furthermore, Chile has signed MoUs with different Ports to position its green hydrogen and its derivatives



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including the Port of Hamburg, the Ports of Rotterdam, and Antwerp-Bruges. There are also additional agreements with South Korea and Singapore for the technical and commercial viability of supply routes. In August 2022, the Government of Chile created the Green Hydrogen Committee to support the implementation of the National Green Hydrogen Strategy, manage public activities and programs, propose innovation R&D guidelines, support the creation of promotion tools on financing, productive innovation, and the development of local supply chain.

- Major Achievements: 2021 1st HRS opened in Budapest (at present in test operation). 2022 1st 2,5MW industrial H₂ electrolyzer and H₂ gas motor methane blending project is ongoing-name: Akvamarin, 2022 Evaluation of EU IPCEI projects for the Ministry of Technology and Industry such as: 1. Creating electric system flexibility with H₂, seasonal storage, and pyrolyzer from biogas), 2. Petrochemical greening, 660MW PV park, electrolyzer, storage, 14500t H₂ as the first step), 3. Underground H₂ storage at Öcsöd empty gasfield, 4. airport services H₂ transformation, H₂ airplane fuel development, 5. H₂-algae production plant, heavy truck filling station, 6. waste burning, enriched syngas, H₂, and liquid CO₂ selling, 7. PV-elektrolyzer-H₂ storage- filling station
- In march , China published the “Medium and Long-term Plan for Hydrogen Energy Industry Development (2021-2035)”. The plan proposes four goals for the development of China’s hydrogen energy industry to 2025: Increase the quantity of hydrogen Fuel Cell Vehicles (VFC) to 50,000, Build-up hydrogen refueling station networks, Hydrogen production from renewable energy to reaching 100,000-200,000 tons/year, Carbon dioxide emission reduction of 1-2,000,000 tons/year.

In August, “Science and Technology Support the Carbon Neutralization Implementation Plan (2022-2030)” was announced, clearly proposing ten major actions, including technological support for energy green and low-carbon transformation, and technological breakthroughs in low-carbon and zero-carbon industrial process reengineering.

- In August, Canada and Germany signed a Joint Declaration of Intent urging the two countries to collaborate in the export of clean Canadian hydrogen to Germany. The Canada–Germany Hydrogen Alliance 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. In addition, the province of Nova Scotia set a target to offer leases for five gigawatts of offshore wind energy by 2030 to support its budding green hydrogen industry.
- Norway invested heavily in the development of a domestic hydrogen infrastructure. In 2022, Enova has increased the support with 1,8 bn NOK, of which 669 million was allocated to the establishment of 5 hydrogen production facilities along the Norwegian coast and 451,3 million was allocated to 7 ground-breaking hydrogen- and ammonia-powered vessels. In addition, two research centers on hydrogen and ammonia were established in October 2022. The Norwegian government also supports the establishment of a full-scale value chain for carbon capture, transport and storage in the North Sea and has allocated 16.8 bn NOK to the Longship project. Further CO₂ storage capacity has been installed both in the Barents and North seas in 2022. This shall enable large-scale production of very-low emission hydrogen with CCS.
- With ambitious goals of hydrogen production and economic development, Spain presented its



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hydrogen roadmap in 2020. It plans to commission 4 GW of electrolyzers, which is around 10% of Europe's production target. Furthermore, the Spanish government approved a Strategic Project for the Recovery and Economic Transformation (PERTE) of Renewable Energies, Renewable Hydrogen, and Storage (ERHA) that will provide 16.37 billion euros of funding.

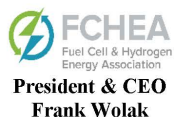
- Japan announced “The Clean Energy Strategy Interim Report” which shows a roadmap for economic growth and energy transition. Striving towards building a Hydrogen / Ammonia supply chain, and rapid expansion and commercialization, a detailed study will be conducted to advance support measures based on differential cost of conventional fuels in terms of production, transportation and storage together with development of common infrastructures such as storage tanks and pipelines.
- France has an ambitious national strategy to reduce greenhouse gas emissions by 6 million tons of CO₂ annually in 2030. Backed by €9 billion from the French government, one of the strategy's main targets is 6.5 GW of installed electrolyzer capacity by 2030, which will enable France to produce clean hydrogen on a large scale. French companies, with the support of the French government, will invest in the construction of gigafactories to manufacture electrolyzers, fuel cells, tanks and vehicles with a twofold objective: both to drive down costs and to make France and the European Union self-sufficient in manufacturing key equipment. As an important milestone in 2022, the first ten industrial projects have been launched in France and approved by the European Commission involving public and private investment of €2.1 billion and €3.2 billion respectively – directly leading to the creation of 5,200 jobs.
- Denmark has set out a government target of 4-6 GW of installed electrolyzer capacity in 2030 – and Industry as even greater ambitions aiming for between 14 and 17 GW installed capacity in 2030. All to be powered by renewable energy, mainly from offshore wind, in the recognition that Green Hydrogen as well as fuels based on green Hydrogen are key components in a successful green transition. Denmark will also establish a domestic Hydrogen infrastructure aiming to inaugurate the first pipelines already in 2026 and to establish export opportunities for green Hydrogen by connecting the domestic Hydrogen infrastructure to the wider European network by 2030. This will enable the utilization of the renewable resources in the North and Baltic Seas and the creation of hubs across the country for the production and refining of green Hydrogen for domestic as well as export needs.



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This statement was co-signed by the following GHIAA members.



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Appendix III. Joint Declaration in Seoul



Joint Declaration at the 4th GHIAA General Meeting in Seoul

We firmly recognize that the world has entered a new era of implementing action plans based on the vision and strategy for the development of a hydrogen economy. This year, many countries have announced revised plans, reflecting technological development and geo-economic changes. Although details of the strategies differ depending on each country's economic circumstances, the central theme revolves around establishing an ecosystem centered on clean hydrogen. Political leaders have been actively involved in executing such plans, showing growing confidence and determination for the future of the hydrogen economy.

However, more time is needed for hydrogen to be recognized as a mainstream energy source, replacing fossil fuels like coal, oil, and gas, paving the way towards carbon neutrality. Despite the increased expectations for hydrogen's role in future energy solutions, soaring energy prices and increasing government's financial deficits resulted from the COVID-19 pandemic and the War in Ukraine have significantly discouraged efforts to promote corporate investment.

Nevertheless, various developments are evident in the global hydrogen market. There is a broad acceptance of the necessity for a standardized 'clean hydrogen certification' scheme, categorizing hydrogen based on carbon dioxide emissions. This will solve the issue of ambiguously classifying hydrogen according to its color. We are also taking note of a growing acceptance of the role of various hydrogen production technologies such as blue hydrogen and nuclear hydrogen and its derivatives such as clean ammonia, considering some of the main concerns in the early stage of hydrogen industry, such as high level of financing and costs required to produce green hydrogen and the maturity of the hydrogen industry itself. In the meantime, there is growing consensus on the urgency to actively engage and invest in the clean energy transition to decarbonize hard-to-abated sectors utilizing clean hydrogen, including long-haul transport, chemicals, steel, and more.

Being fully aware of these issues and concerns, the Global Hydrogen Industry Association Alliance (GHIAA) was established with the recognition that international cooperation in the private sector is essential and urgent to promote policies to respond to climate change and expand the hydrogen economy. Being constantly aware of these goals and visions and striving to create jobs and opportunities around the world today, all members of the GHIAA hereby agree to make the following declarations:



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1. For the hydrogen economy to develop in the future, investment in hydrogen technologies, expansion of appropriate infrastructure, and mobilization of necessary financing through strengthened partnership between the government and the private sector are essential. Global cooperation between countries and various entities is vital for its achievement. In order to facilitate and expedite these actions by governments, the GHIAA will cooperate and collaborate to collect information and share best practices with members through documentation and seminars and strengthen dialogues with governments.
2. As the hydrogen economy aims to overcome the geographical bias of fossil fuels, sharing information and technologies among countries is especially crucial. In this sense, we firmly welcome various programs from the international community to support the hydrogen industry in underdeveloped areas. To ensure the success of these programs and related policies, the GHIAA will strengthen partnership with international communities and relevant international organizations through various means.
3. We urge governments to accelerate efforts to establish a global hydrogen ecosystem by clearing technical barriers and facilitating international trade of hydrogen. Relevant measures include the introduction of a clean hydrogen certification scheme and the harmonization of technical regulations and standards. In order to support the government's initiatives, the GHIAA will continue to collect and provide relevant information to various individuals and organizations participating in the clean hydrogen movement.

This statement was agreed by the following GHIAA members on September 14th, 2023.



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