



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION



GLOBAL PROGRAMME
GREEN HYDROGEN IN INDUSTRY
Innovative | Decarbonized | Inclusive

Promoting Green Hydrogen to support Industrial Development and the Paris Agreement

UNIDO's Programme
for Green Hydrogen
in Industry and its
Global Partnership



I. INTRODUCTION

This document addresses the role of Green Hydrogen (GH2) in supporting countries to achieve net zero industrial growth and fulfil their commitments under the Paris Agreement. It presents UNIDO's Global Programme for GH2 in Industry focusing on its key pillar, which is the Global Partnership for Hydrogen in Industry.

Today, approximately 98% of global hydrogen production is produced from fossil fuels (accounting for 6% of global natural gas and 2% of global coal). This is collectively responsible for carbon dioxide emissions of around 830 million tonnes per year¹.

To accelerate the clean energy transition from fossil fuels, the potential of GH2, produced from renewable energy (e.g., solar or wind), is gaining momentum. With significantly decreasing costs for renewable electricity and technology advancements, GH2 is expected to expand rapidly and is predicted to cover 21% of the world's total final energy consumption by 2050².

GH2 offers a viable option for 'hard-to-abate' industrial sectors (e.g., refining, chemicals, iron, steel and cement). These sectors, together with aviation, trucking and shipping, emit 20% of global carbon dioxide emissions. Local production and application of GH2 in these sectors will help countries to decarbonize these sectors, develop their industries accordingly and achieve their climate targets.

Through UNIDO's Global Partnership for Hydrogen in Industry, the Organization aims to assist Member States in accelerating the deployment of hydrogen resources in line with their climate and industrial policies. Paving the way for GH2 application in industry will not only provide the foundation to reduce emissions, but also create jobs, mobilize investments and build pathways towards inclusive industrialization.



II. GH2 – OPPORTUNITIES FOR INDUSTRIAL DEVELOPMENT

As a key element in global decarbonization strategies, GH2 creates new opportunities for industrial development, particularly in countries that have abundant renewable power potentials and sources, such as solar and wind.

Developing countries and transition economies collectively account for more than half of the world's GHG emissions. GH2 could be produced and used locally to achieve climate targets through decarbonisation of key sectors. Simultaneously, both national energy systems and an industrial market can be developed.

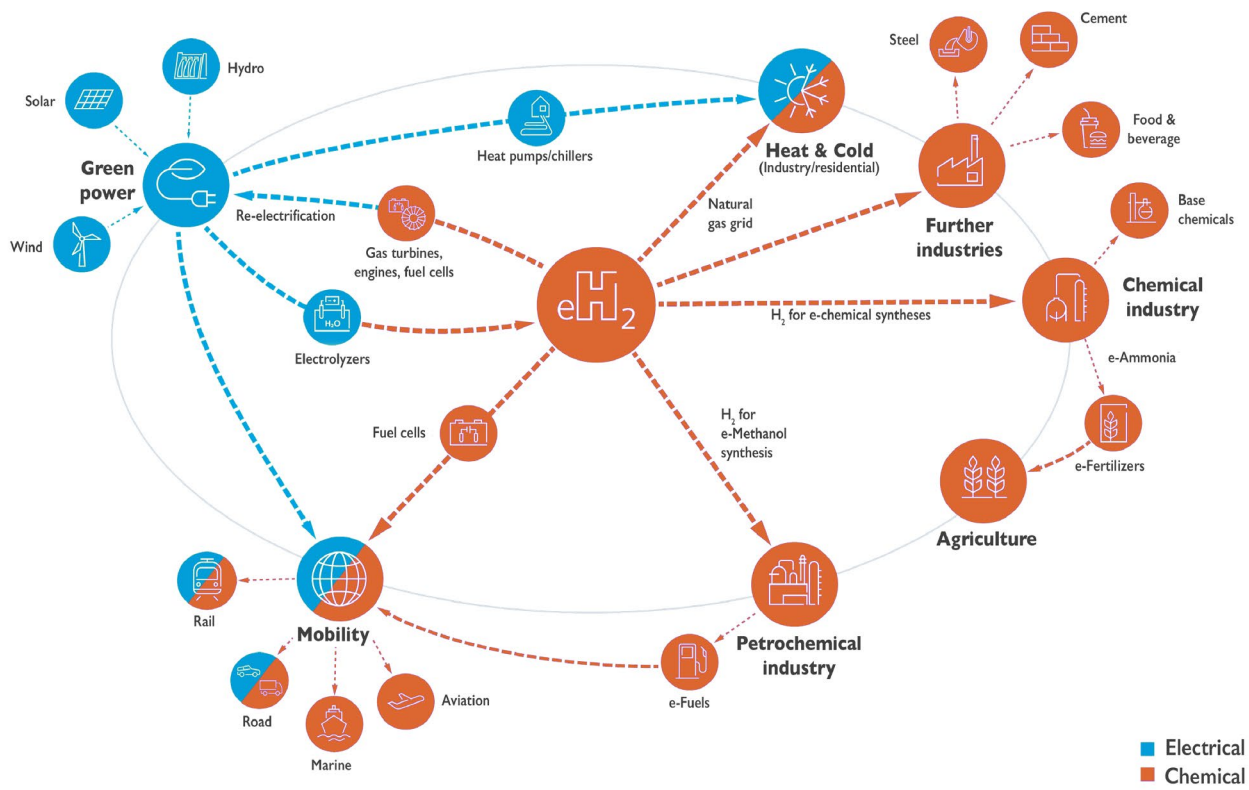
Countries have the opportunity to exploit the growing market for hydrogen-based technologies (e.g., fuel cell technology, green steelmaking technologies and synthetic fuels) and exports.

Adapting advanced innovation systems and industry technologies can support countries in overcoming cost barriers and inefficiencies associated with GH2 production. The costs of wind and solar resources deployed in electric power systems are significantly decreasing. It is thus expected that GH2 costs will become cost competitive between 2025 and 2030³.

1. IEA (2019), The Future of Hydrogen, IEA, Paris <https://www.iea.org/reports/the-future-of-hydrogen>

2. IRENA (2021), World Energy Transitions Outlook: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi.

3. IRENA (2020) Global Renewables Outlook: Energy transformation 2050. <https://www.irena.org/publications/2020/Apr/Global-Renewables-Outlook-2020>

Figure 1. The industrial linkages of renewable power and GH2 (eH2)


Source: Siemens Energy (edited).



III. UNIDO'S APPROACH

UNIDO is at the forefront in globally promoting GH2 and driving sustainable industrial development and SDG 9. The Organization has long-standing experience in working with developing countries and transition economies in the deployment of renewable energy for productive use. The Organization has a range of global networks and programmes including: the Global Network of Regional Sustainable Energy Centres, UNIDO Field Offices, Programmes for Country Partnership, the Industrial Deep Decarbonisation Initiative and the Industrial Energy Accelerator. These UNIDO initiatives aim to accelerate energy, climate and industry transformation, trigger access to finance and provide policy advisory services.

UNIDO's vast experience, expertise and partnerships confirm its strategic role in the global promotion of GH2 application in industry.

In 2021, with the support of the governments of Austria, China, Germany and Italy, UNIDO launched its Global Programme for GH2 in Industry. It stimulates the accelerated uptake and deployment of GH2 in industries of developing countries and transition economies. It aims to build partnerships for knowledge and technology transfer and cooperation. It focuses on industrial decarbonization of emission-intensive industries ('hard-to-abate' sectors) to support countries in fulfilling their commitments under the Paris Agreement and achieving net-zero goals.

Figure 2. The two pillars of the Global Programme for GH2 in Industry



The Global Programme for GH2 in Industry foresees two main pillars of work: (01) the establishment of a Global Partnership for Hydrogen in Industry; and (02) the Technical Cooperation Programme for GH2 in Industry. Both pillars are closely interlinked and supported by the International Hydrogen Energy Centre in Beijing sponsored by China.



IV. GLOBAL PARTNERSHIP FOR HYDROGEN IN INDUSTRY

The Global Partnership presents a platform for Member States, industries, private sector, investors, research and academic institutions. It provides opportunities for policy dialogue, awareness-raising, knowledge sharing, technical standards and certifications development. It also aims to assist Member States in developing hydrogen resources in line with their climate and industrial policies, thereby, boosting innovation and job creation.

One of the key objectives of the Partnership is to stimulate joint project development and cross-sector cooperation. Participants in the Partnership will be invited to collaborate in the development and implementation of UNIDO’s Technical Cooperation projects. The Partnership also aims to provide dedicated support to countries that require early assessment for GH2 production and application in industry.

The Global Partnership offers the following:



1. **Fostering policy dialogue** amongst partners on GH2. By aligning climate and industrial development targets of countries, the Partnership aims to scale-up production and application of GH2 in industry.



2. **Facilitating joint project development and pooling of expertise** to assist countries and regions in building-up and mobilizing investments for GH2 projects, industrial clusters and value chains.



3. **Creating knowledge products** (e.g., guidelines, training manuals, best practices) on innovative GH2 technologies and uses in hard-to-abate sectors and sector coupling, technical and safety standards, business models and enabling policies.



4. **Organizing global awareness raising and capacity building** for different stakeholders to address social, economic and climate impacts of GH2 in industry.



V. TECHNICAL COOPERATION FOR GH2 IN INDUSTRY

Within the framework of UNIDO's Global GH2 Programme, the Partnership supports the Technical Cooperation (TC) Programme.

The TC Programme cooperates with governments in developing countries and transition economies to design country-specific GH2 projects in industry.

As a key element, UNIDO developed a three-stage GH2 industrial cluster model to accelerate application of locally produced GH2 in industrial zones, clusters and parks. Its objective is to assist in early-stage development and deployment of GH2, thereby, catalysing investments and partnerships for the accelerated uptake of GH2.

The cluster model aims to serve as a roadmap for countries to decarbonize industries and thereby achieve their climate and industrial development goals. Furthermore, one of its objectives is to create job opportunities and generate innovation and social and economic gains for the respective region/country. Additionally, this model foresees assistance in working on policy frameworks and incentives to create a conducive environment for applying GH2.

UNIDO intends to further develop tailored interventions. In line with the respective industrial development policies, projects will be facilitated for decarbonisation of priority hard-to-abate sectors.

More information on the GH2 Industrial Cluster Model is included in **Annex 1**.



VI. JOINING THE PARTNERSHIP

In view of the above, it is evident that GH2 presents a wide range of opportunities for industrial development. It is a key pillar of the global energy transition.

UNIDO will play a strategic role in accelerating the development and deployment of GH2 in industry and support decarbonization of hard-to-abate sectors. The Partnership will align climate and industrial development targets and stimulate policy dialogue. It will provide advisory services and cooperation opportunities for Member States.

To pave the road for engagement of Member States in the Global Partnership, UNIDO will commence an interactive Development Dialogue in March 2022. This will help to gather and echo the needs and priorities of Member States in the further development of the Partnership.

The Dialogue will also prepare the first meeting of the members of the Global Partnership that is scheduled to take place in April 2022. Member states and other entities that have expressed interest will be invited. This meeting will discuss the organizational structure and coordination mechanisms of the Partnership. It will also debate and approve the work plan of the Partnership.



ANNEX 1. UNIDO'S GH2 INDUSTRIAL CLUSTER MODEL

As part of its Global Programme for Green Hydrogen in Industry, UNIDO developed a GH2 industrial cluster model to accelerate application of locally produced GH2 in industrial zones, clusters and parks. This model aims to serve as a roadmap for countries to decarbonize industries and thereby achieve their climate and industrial development goals. Furthermore, its goal is to assist governments in early-stage development and deployment of GH2, thereby, catalysing investments and partnerships for the accelerated uptake of GH2.

The three-phase model (**Table 1**) provides guidance for government and industries in: the (1) preparation; (2) implementation; and (3) up-scaling of GH2 industrial clusters. It focuses on the decarbonization of hard-to-abate industries (e.g., refining, chemicals, iron, steel and cement) and the creation of value-chain and eco-wide synergies. One of its important objectives is to create job opportunities and generate innovation and social and economic gains for the respective region/country.

This model specifies a set of criteria to define the potential for developing a GH2 industrial cluster. These criteria cover composition of hard-to-abate industries, scale of electrolysis capacity and sector coupling potential.⁴ Furthermore, the criteria consider availability and potential of renewable energy to produce GH2 on-site as well as infrastructure for production and transmission of GH2 and synthetic fuels.

4. Sector coupling refers to the idea of integrating the energy consuming sectors - buildings (heating and cooling), transport, and industry - with the power producing sector. With a high share of renewable energy, the production of green hydrogen could have a significant role in the context of decarbonizing the end-use sectors beyond electricity generation. The production of hydrogen can provide significant flexibility for the power system, as well as seasonal storage of renewable electricity by blending hydrogen into natural gas grids.

Table 1. The three phases of the GH2 Industrial Cluster Model

	<u>Work Packages</u>
Phase 1: Preparation of GH2 clusters	<ul style="list-style-type: none"> • Awareness raising and capacity building • Stakeholder engagement • Feasibility studies, including sector coupling potential • Finance and investment planning • Addressing technical and policy gaps
Phase 2: GH2 application	<ul style="list-style-type: none"> • Production of GH2 • Adaptation of industrial processes for the application of GH2 • Utilization of GH2 in industrial processes • Sector coupling • Innovation hubs • Monitoring and continuous improvement
Phase 3: GH2 upscaling	<ul style="list-style-type: none"> • GH2 project/programme upscaling • Global GH2 network development

Identifying and addressing key challenges and enablers is another key element of this model.

Policy: There is a lack of policies, financial and policy incentives, including GH2 standards and certification, for stimulating local production and use of GH2 in industry. Through targeted awareness raising, stakeholder involvement and capacity building a conducive political environment will be created.

Financing: High capital investment is required for GH2 infrastructure and development of GH2 energy systems. Through early-stage technical and policy support and stakeholder engagement, innovative business models, investments and strategic partnerships will be triggered.

Technology and Capacity: Limited technical expertise on GH2 production, storage, transport and usage technologies might negatively affect local GH2 production and utilization. To counter-act this risk, feasibility studies to identify technology and skills requirements of the local industrial sectors will be undertaken. This will allow to develop targeted capacity building and facilitates technology analysis, transfer and adaptation.

In view of the above, UNIDO's GH2 model is a comprehensive approach to supporting countries to decarbonize industries through local deployment of GH2. This will enable them to achieve their climate and industrial development goals.