



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION



UNIDO AND HYDROGEN IN INDUSTRY

UNIDO Directorate of SDG Innovation and Economic Transformation

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Global Context

Industrialization provides a foundation for economic growth and supports countries in achieving **an inclusive sustainable development**. At present, systemic change is required to reduce emissions to near zero by 2050 in line with the Paris Agreement and keep global warming to no more than 1.5°C. CO₂ emissions need to be reduced **by 45% by 2030, but they are projected to grow by almost 20% by mid-2040**, particularly in emerging markets and developing economies with growing energy

demands. The hard-to-abate industrial sectors such as steel production, cement, chemicals, and heavy transport, are responsible for **more than 20% of global CO₂ emissions**. Industrial production from these industries is expected to increase significantly in emerging and developing economies. With such growing energy demands, **innovative clean energy technologies** in these industries need to be at scale by 2030.



Green hydrogen, produced from renewable energy sources, and low-carbon hydrogen, have **emerged as the fuel of the future with the potential to decarbonize the hard-to-abate industrial sectors**. According to the International Renewable Energy Agency (IRENA), to achieve the 1.5°C scenario, annual production and usage of mostly green hydrogen would need to reach 614 million tons (Mt) annually by 2050. Notably, **94% of hydrogen consumption is expected to come from renewables**, indicating an increased reliance on clean energy sources. At present, 95% of global hydrogen is produced using fossil-fuel sources, such as natural gas and coal (“grey hydrogen”). The annual demand for industrial hydrogen has grown more than threefold since 1975, reaching over 94 million tons in 2021. As a consequence, **the production of hydrogen is responsible for 830 million tons of CO₂ emissions annually**.

The transition to green hydrogen can help countries meet their climate pledges by reaching substantial reductions in fossil fuel usage. Demand is emerging for key new hydrogen applications, growing to about 40 thousand tons in 2022, a **60% increase from 2020 levels**. However, several obstacles and challenges currently hinder developing countries in creating a sustainable hydrogen economy, ranging from the market to technical, political and social uncertainties. Such challenges prevent actors from taking advantage of the opportunities hydrogen offers.



Addressing the challenge



Green hydrogen offers unique opportunities for net-zero industrial development in developing countries with abundant renewable power potential. Developing countries can leapfrog to **green and low-carbon hydrogen as a clean energy solution**, creating local value addition and wealth generation. Green and low-carbon hydrogen could further become the springboard for the establishment of green industries in UNIDO's partner countries.

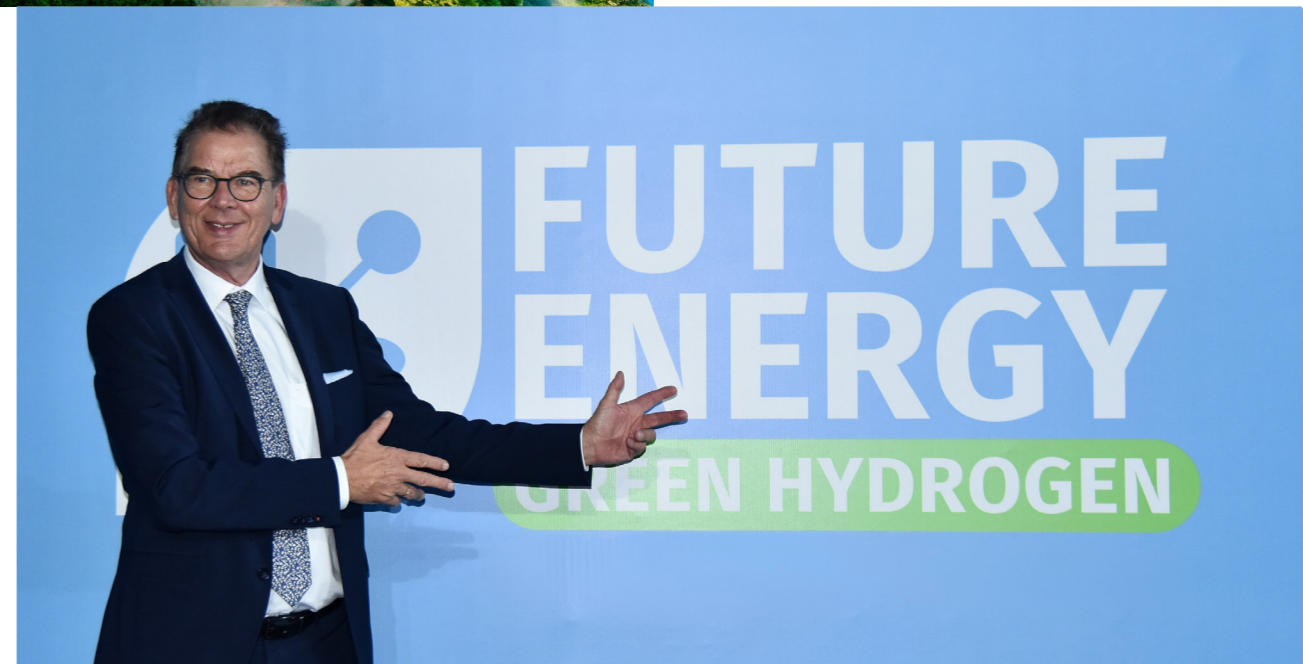
It can pave the way for **job creation, skills upgrading, investment mobilization, energy security and participation in global hydrogen trade**. Green hydrogen can reinforce developing countries' overall resilience and drive the development of a diversified and knowledge-based economy. Many countries with an already existing gas infrastructure can pursue the goals of net-zero industrialisation through the concurrent application of low-carbon hydrogen and green hydrogen.

Based on the above, there is a notable need to provide concrete solutions to support developing countries in harnessing the full potential of green and low-carbon hydrogen and to achieve a just hydrogen transition that puts social and environmental aspects in focus. A just transition implies **greening the economy in an inclusive manner by creating decent work opportunities and also improved access to resources**, e.g. electricity and water. A wide array of solutions to take into account:

- » Conducive **policies and regulations** for promoting a hydrogen ecosystem to underpin investor and market confidence and accelerate hydrogen projects. Despite the great potential for boosting developing countries' economies, market-driven factors are still not conducive for a speedy GH2 transition. This requires the use of policies to skillfully redress these factors and create a conducive climate for investment mobilization.
- » **Standards**. Currently, the criteria and thresholds for hydrogen standards and certifications vary

across countries, requiring individual agreement on how emissions from hydrogen production and transport should be accounted for. The establishment of commonly agreed global hydrogen technical standards and regulations will play a fundamental part in hydrogen production and usage, as well in enabling domestic and international trade. Developing countries need to be part of the discussion on international standards setting to develop their own competent technical infrastructure and provide the necessary proof of conformity assessment when hydrogen projects become operational.

- » **Financial instruments**. Developing countries require enhanced access to international assistance to incentivise investments and related support mechanisms to address obstacles in mobilising public-private financing at scale in hydrogen projects. An investment of USD 4.6 trillion is needed for green hydrogen and its derivative fuels until 2050 to align the current energy system with a 1.5°C pathway. Such investment is required to scale up hydrogen infrastructure, promote innovation and help lower production costs and promote the uptake of hydrogen.
- » **Skills and know-how**. Hydrogen production, storage, distribution and use require a set of specialized skills to guarantee the efficiency, safety and security of the value chain. Emerging economies and developing countries with ongoing and planned H2 projects require a competent workforce (managers, engineers, technicians and operators) to be adapted to their hydrogen strategies.



- » **Innovation**. Accelerating the uptake of green and low-carbon hydrogen in developing countries require innovative solutions across the value chain. Development of modelling of systems, prototype and onsite pilot demonstration of hydrogen technologies, systems, equipment and infrastructure must be accessible and affordable for developing countries.
- » **Coordination** between key stakeholders at the national, regional and global level to effectively resolve the challenges identified, given the extent and complexity of the green and low-carbon hydrogen value chain.





UNIDO's role

The Global Programme for Hydrogen in Industry (GPHI)

Through its Programme, UNIDO aims to influence and guide the **development of market policies, standards, skills, financing instruments, innovation and coordination** between key stakeholders that play an essential role in the development of a just hydrogen economy. Promoting tangible projects to accelerate the local uptake of green and low-carbon hydrogen in industries of developing countries and transition economies is a key element of the Programme. UNIDO has built its Global Programme around two pillars which draw on and feed into each other's resources, expertise and networks. As

depicted in Figure. 1, the Programme consists of: **The Global Partnership for Hydrogen in Industry and the Technical Cooperation Programme with country-specific tailored interventions.**

Through the **Global Partnership**, UNIDO regularly liaises with key stakeholders by conducting regional and global dialogue sessions with Member States to explore developing countries' needs and to enable dialogue and information exchange among them. These dialogues provide substantial material for UNIDO to articulate developing countries' interests

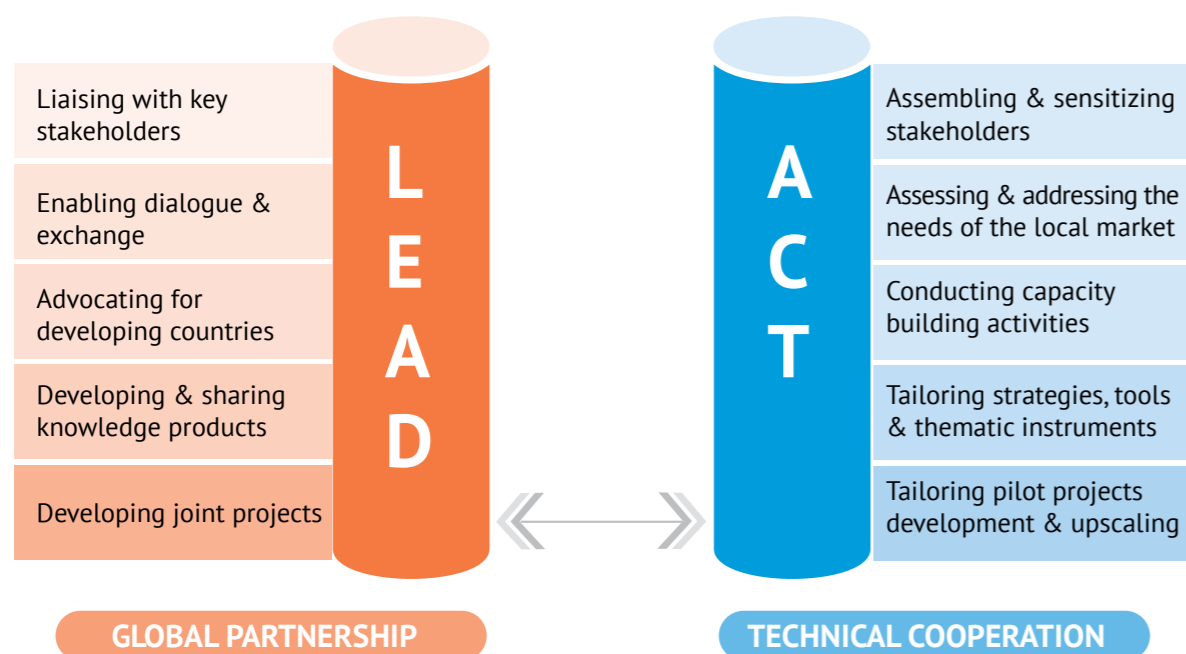
and needs and advocate for them in global fora (e.g. COP, G7, G20). Moreover, based on dialogues' outcomes, UNIDO joins forces with renowned knowledge partners to address countries' needs and to develop knowledge and innovative tools and solutions. These include designing and implementing policies, regulations, standards, financial instruments, investment promotion and innovation programmes. The exchanges with stakeholders also give rise to ideas for joint projects development.

UNIDO's **Technical Cooperation** adapts and applies knowledge and tools developed globally to country-specific interventions for green and low-carbon hydrogen in industry. This is done in close collaboration with the governments and industries of developing countries and transition economies. Such technical assistance entails sensitizing stakeholders, sharing best practices, as well as assessing local market needs and devising tailored strategies, trainings, tools and instruments. UNIDO reviews countries' institutional and technical capacities and conducts capacity development where gaps have been identified.

One key component of UNIDO's Technical Cooperation is its **green hydrogen industrial cluster model**, which is based on a co-location approach to local green or renewable hydrogen production, storage, transport and end-use. UNIDO supports the development of pilot projects, e.g. green hydrogen clusters, and makes recommendations on their upscaling. Through this pillar, UNIDO seeks **to foster and accelerate countries' innovation capacities while solving existing challenges** in green hydrogen production, storage, transport, and use. Within the framework of the Global Programme, UNIDO's interventions across the green hydrogen value chain are outlined below.

Along the hydrogen value chain, **UNIDO provides technical assistance and knowledge products on skills development, policies, standards, financing and investments and local innovation.** Furthermore, UNIDO supports feasibility studies and technical assessments for local production and application of green hydrogen and its derivatives, e.g. green ammonia.

FIGURE 1: "LEAD & ACT" – A TWO-PILLAR APPROACH





Partnerships

UNIDO is coordinating with partners to address the challenges encountered in developing countries in line with the key enablers of the Global Partnership.



Standards: UNIDO is collaborating with the **International Organization for Standardization (ISO)** technical Committee 197 “Hydrogen Technologies” to increase knowledge and insight in public-private sectors of developing countries and transition economies. The standard development process will inform developing countries on how to better participate in standard setting and address challenges on quality infrastructure to assess its conformity to hydrogen standards. In line with this effort, UNIDO aims to organize the Technical Committee 197 meeting in Vienna in November 2023.



Financing and investment: To scale and facilitate access to finance, UNIDO aims to create innovative finance assistance mechanisms following a mapping of finance and technical assistance initiatives with **UK Hydrogen Breakthrough Agenda, World Bank** and the **International Renewable Energy Agency (IRENA)**. UNIDO conducts a mapping of finance and technical assistance initiatives and will share the outcomes at the COP28.



Global coordination: UNIDO regularly enhances Member State engagement by organizing dialogues on annual basis. In addition, UNIDO is currently developing a global platform and expert database on hydrogen supported by the **German Agency for International Cooperation (GIZ)**. UNIDO also takes on the role of coordinator of the **International Hydrogen Trade Forum (IHTF)**, established under the Clean Energy Ministerial Hydrogen Initiative (CEMI). The IHTF is an inter-governmental platform to stimulate international hydrogen trade, reduce barriers and foster productive market conditions. In its coordinating capacity, UNIDO will facilitate cooperation among the government members and industrial leaders, and bring in the perspective and considerations of developing countries and transition economies.



Skills and know-how: UNIDO is cooperating with **Hydrogen Europe** and the **Machinery and Equipment Manufacturers Association (VDMA)** to develop a skills map of jobs for hydrogen to accelerate the capacity and knowledge of developing countries. UNIDO will conduct in-country assessments to identify skills gaps and promote an up-skilling and re-skilling workforce for green hydrogen in developing countries.



Innovation: In cooperation with the **Government of the UK** through the Clean Energy Innovation Facility, UNIDO aims to accelerate clean hydrogen-related innovations in developing countries from demonstration to commercial phase.



Policies and regulations: UNIDO aims to advance enabling policies and regulatory frameworks to stimulate market creation in developing countries with **IRENA** and the **German Institute of Development and Sustainability (IDOS)**. With partners, UNIDO will develop a policy toolkit for green hydrogen to launch at COP28.



Gender: UNIDO cooperates with the **Women in Green Hydrogen** to co-organize series of webinars and events to enhance visibility of women working in the green hydrogen sector.



National pilot programmes: Developing technical cooperation programmes are a core area of UNIDO’s work. UNIDO cooperates with the **World Bank, Global Environment Facility, Green Climate Fund** and other donors to enhance technological readiness and institutional capacity to attain the benefits of green and clean hydrogen application in industries.

International Hydrogen Energy Centre (IHEC)

UNIDO’s Global Programme for Hydrogen in Industry benefits from the technical support and know-how of the **International Hydrogen Energy Centre (IHEC)** in Beijing, launched by UNIDO and the Government of China in 2021. The Centre functions as a global technology innovation hub for hydrogen energy, supporting the creation of hydrogen value chains and focusing on R&D, application, and demonstration of key hydrogen technologies. The IHEC aims to enhance the global scale-up of hydrogen application in industry particularly in developing countries by attracting international R&D funding and promoting South-South and regional cooperation with key partners.

UNIDO-IHEC GREEN HYDROGEN FLAGSHIP DEMONSTRATION PROJECTS

The IHEC is engaging in a number of industrial demonstration projects for green hydrogen production and application, supported by UNIDO and in close cooperation with partners.

» **Metallurgical and chemicals industry:** The IHEC, together with the Shuimu Mingtuo Group and Hualu, aims to develop the world’s first comprehensive demonstration project on green hydrogen production and application for the metallurgical and chemicals industries. Construction of the industrial site started at the end of 2022 and will be in operation in 2025. A respective feasibility study report was developed in close cooperation with ThyssenKrupp

Technology (Shanghai), the General Electric Power Planning and Design Institute, and Aerospace Changzheng Chemical Engineering.

The research and engineering design of a green ammonia plant is under development in close cooperation with Rhine Technology (Shanghai), TÜV (Germany) and Hualu Engineering Technology. The demonstration project expects to produce an annual capacity of 300,000 tons of green hydrogen, derived from China’s largest 5 million KW wind power generation and 1.5 million KW photovoltaic power.

» **Hydrogen vehicles in the logistic sector:** IHEC is developing a demonstration project for the operation of hydrogen fuel cell vehicles utilized to decarbonize logistic routes. The Centre aims to develop the world’s largest green hydrogen refueling station which will be built in Daxing, Beijing, China.

The IHEC partnered with Beijing Sinohytec to support the development of the hydrogen commercial vehicle fleet in Zhangjiakou, China, with more than 850 hydrogen fuel cell buses, used to transport Winter Olympics 2022 athletes and officials. Nine green hydrogen refueling stations were built in the Hebei province, enabling the buses to operate over 3.2 million kilometers and resulting in approximately 2,000 tons of CO2 emissions reduction.



International Hydrogen Energy Centre located in Beijing, China.



TC Portfolio

Global Environment Facility (GEF)

GEF-8 GLOBAL CLEAN HYDROGEN PROGRAMME:

Through the GEF-8 funding cycle, UNIDO has developed a Global Clean Hydrogen Programme in cooperation with the World Bank. The Programme aims to enhance national institutional capacities, create enabling policy frameworks, improve technological readiness and financial mechanisms for the successful uptake of clean hydrogen in

developing countries to ensure their net-zero development with social considerations and benefits. UNIDO is engaging in advanced discussions with countries that are interested in participating in the programme such as; Algeria, Azerbaijan, Egypt, Nigeria, the Philippines, South Africa and Vietnam.

GEF-8 CHINA:

The project on 'Green Hydrogen Energy Integrated Demonstration Application' in China has been approved under the GEF-8. The project will proceed in cooperation with partners; Ministry of Industry

and Information Technology, Ministry of Science and Technology, the International Hydrogen Fuel Cell Association and IHEC represented from China.



Green Climate Fund (GCF)

Two Readiness proposals on green hydrogen for Morocco and South Africa have been submitted and are under final review.

- » Enhancing enabling environment to support the decarbonization of Moroccan steel production through the application of green hydrogen: The project proposal was developed in cooperation with the Research Institute for Solar Energy and New Energies (IRESEN) of Morocco.
- » Enhancing the institutional capacity of South Africa to coordinate green hydrogen activities of the Hydrogen Society Roadmap: The project proposal was developed in cooperation with the Department of Science and Innovation of South Africa.





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