



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

SUSTAINABLE
DEVELOPMENT
GOALS



BUILDING A SUSTAINABLE AND INCLUSIVE HYDROGEN ECONOMY

Spearheading Net-Zero Industrial Development

October 2025



Global Context

Alignment with the Paris Agreement & the SDGs

To align with the Paris Agreement and to limit global warming, systemic change is urgently required.

CO₂ emissions need to be reduced by 45% by 2030 (compared to 2019 levels), but are instead currently projected to increase by almost 20% by the mid-2040s (IEA (2021), Net Zero by 2050). This holds particularly in emerging markets and developing economies where energy demand is rising and where industrial production in the **hard-to-abate industrial sectors**, such as steel, cement, chemicals, and heavy transport is expected to increase significantly. These sectors already account for more than 20% of global CO₂ emissions. Meeting such growing energy demand will require innovative clean energy technologies at scale by 2030.

One of the most promising solutions is **low-emission hydrogen**. To stay on a 1.5 °C pathway, global demand for low-emission hydrogen would need to grow from negligible levels today to nearly 523 million tonnes by 2050 (IRENA (2024), World Energy Transitions Outlook 2024: 1.5°C Pathway)

The transition to low-emission hydrogen can help countries meet their climate pledges by reducing fossil fuel use and contribute to the achievement of Sustainable Development Goals.





For countries with abundant renewable resources, **low-emission hydrogen**¹ presents a unique opportunity to drive sustainable and inclusive industrialization. It can support economic development, enabling domestic value creation across its entire value chain: from renewable electricity generation to electrolysis and equipment manufacturing, new fuels, and industrial feedstocks. It also provides new opportunities for participation in global trade.

Aligning hydrogen with national development goals can drive decarbonization of hard-to-abate industries (chemicals, iron, steel, cement), enhance national energy security, create new jobs, strengthen skills, and mobilize investments. As a result, it can help build diversified, knowledge-based and competitive economies, and provide a springboard for establishing local green industries (such as low-emission ammonia fertilizer production).

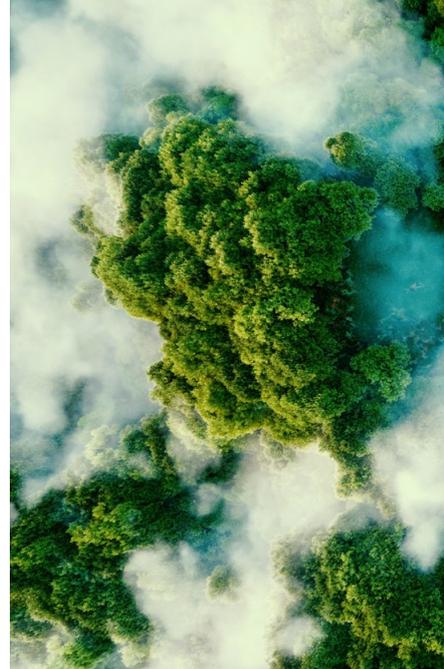
Currently, the low-emission hydrogen market is under development and requires overcoming **significant challenges**. Despite the potential, progress remains slow due to limited policy and regulatory frameworks, weak quality infrastructure and standards, insufficient financing, skills gaps, lack of affordable innovation, and weak stakeholder coordination.



¹ Low-emissions hydrogen refers to production methods that significantly reduce greenhouse gas emissions, such as renewable electrolysis or fossil-fuel reforming with CCUS, compared to conventional methods (IEA). This publication also refers to renewable or “green” hydrogen, which is produced exclusively from renewable energy sources.



Addressing the Challenge



UNIDO and its partners work to address key challenges and develop targeted solutions that promote local hydrogen production and offtake in developing countries², while fostering inclusive and fair participation in the hydrogen trade. The ultimate goal is to ensure a sustainable and just transition that places social and environmental considerations at the core.

- **Conducive policies and regulations.** Policies are essential to promote a hydrogen ecosystem that underpins investor and market confidence, and accelerates hydrogen projects. While hydrogen has great potential to boost developing countries' economies, market forces alone are not sufficient to drive a rapid transition. Policies must address these barriers and create an enabling environment for mobilizing investment.
- **Standards and certification.** Hydrogen characteristics currently vary across countries, including how emissions from production and transportation are accounted for. Establishing globally agreed technical standards and regulations is critical for hydrogen production, use, and trade. Developing countries need to be part of international standard-setting processes, while also building their own technical infrastructure and conformity-assessment systems to participate effectively in hydrogen markets.
- **Financial instruments.** Developing countries need enhanced access to international assistance and financing mechanisms to attract large-scale public-private investments in hydrogen projects. The IEA estimates that USD 50 billion per year will be needed until 2030, to align with the

Net Zero Emissions by 2050 Scenario³. These investments are vital to scale up infrastructure, lower production costs, foster innovation, and increase hydrogen uptake. Yet despite many project announcements in recent years, only 4% of low-emission hydrogen projects have reached final investment decisions⁴.

- **Skills and know-how.** Hydrogen production, storage, distribution, and use require specialized skills to ensure efficiency, safety, and security across the value chain. Developing countries with ongoing or planned projects will need competent workforces (including managers, engineers, technicians, and operators) aligned with national hydrogen strategies. Current studies show a mismatch between industry needs and academic training offers, which must be addressed.
- **Innovation.** Accelerating hydrogen uptake requires accessible and affordable innovation across the value chain. This includes modelling systems, developing prototypes, and implementing on-site pilot demonstrations of hydrogen technologies, equipment, and infrastructure in developing countries.
- **Coordination** between key stakeholders at the national, regional, and global level is crucial to effectively resolve the challenges identified, given the extent and complexity of the low-emission hydrogen value chain.

² For the sake of readability, the term developing countries is used in this publication to refer collectively to developing and transitioning economies.

³ A normative pathway for achieving net-zero CO₂ emissions by 2050 in the global energy sector, aligned with SDGs and the 1.5 °C target. (IEA Global Hydrogen Review 2024)

⁴ EU Hydrogen Bank



- **Sustainability and inclusiveness.** To ensure producing countries benefit properly, it is essential to carefully consider socio-economic and environmental factors. A just and inclusive approach safeguards water and land, shares benefits with local communities, creates decent working conditions, ensures fair and equal job opportunities for all, and improves access to essential resources. These measures are key to strengthening social acceptance, long-term stability, and the overall sustainability of hydrogen projects.





UNIDO's Role and Approach

The Global Programme for Hydrogen in Industry (GPHI)

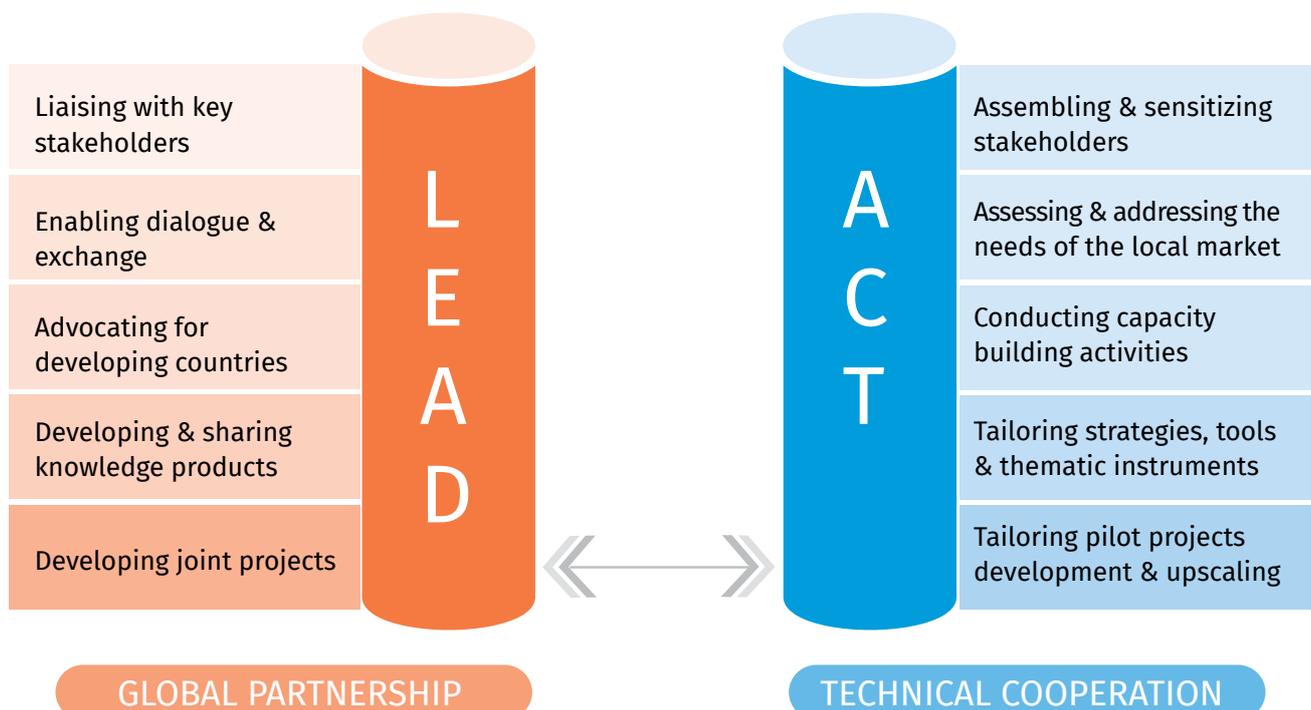
Launched in 2021, UNIDO's Programme seeks to shape the development of a just hydrogen economy by influencing policies, standards, skills, financing instruments, innovation, stakeholder coordination, and sustainability strategies. A central focus is on promoting local projects that accelerate the uptake of low-emission hydrogen and its derivatives in industries of developing countries and transitioning economies.

The Programme is built around two mutually reinforcing pillars, each drawing on and contributing to the other's resources, expertise, and networks.

As shown in Figure 1, these pillars are:

- **The Global Partnership** for Hydrogen in Industry
- **The Technical Cooperation** with country-specific tailored interventions

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



Through the Global Partnership component, UNIDO engages regularly with key stakeholders by organizing regional and global dialogue sessions with Member States and partners. These dialogues explore developing countries' needs while enabling information exchange and learning. The insights gained allow UNIDO to articulate these needs and advocate for them in global fora such as COP, G7, G20 and the Clean Energy Ministerial (CEM).

Building on the outcomes of these dialogues, UNIDO works with renowned knowledge partners to co-develop innovative tools and solutions. This includes designing and implementing policies, regulations, standards, financial instruments, investment promotion and innovation programmes, as well as sustainability guidelines. Exchanges with stakeholders also often lead to ideas for joint project development.

UNIDO's Technical Cooperation complements this global work by adapting and applying knowledge and tools to country-specific contexts. In close collaboration with governments and industries in developing and transition economies, UNIDO shares best practices, and develops tailored strategies, trainings, and tools. It provides guidance on policies, standards, financing, and investment mobilization. Assistance also includes assessing local market needs, reviewing institutional and technical capacities, and conducting capacity development where gaps exist. It also conducts feasibility studies and technical assessments for local production, and application of low-emission hydrogen and its derivatives.

UNIDO promotes its green hydrogen industrial cluster model, which applies a co-location approach to hydrogen production, storage, transport, and end-use, and supports related pilot projects.

UNIDO has identified low-emission ammonia fertilizer as a key focus of the Global Programme for Hydrogen in Industry. Fertilizer production is responsible for around 2% of global greenhouse gas emissions, making it a critical sector for transformation as well as a promising industrial use case for clean hydrogen. UNIDO's work promotes sustainable and decentralized production models that reduce reliance on fossil fuels while improving local access, affordability, and resilience.





Partnerships

Strategic Partners (non-exhaustive list)

- International Renewable Energy Agency (IRENA)
- International Organization for Standardization (ISO)
- Hydrogen Council
- Hydrogen Europe
- Clean Hydrogen Mission of Mission Innovation
- German Engineering Federation / Machinery and Equipment Manufacturers Association of Germany (VDMA)
- OCP Group
- Slovene Enterprise Fund
- International Hydrogen Energy Centre (IHEC)
- International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)
- International Hydrogen Fuel Cell Association (IHFCA)
- Women in Green Hydrogen (WiGH)
- Dii Desert Energy
- John Hopkins University School of Advanced International Studies
- The World Bank
- Organisation for Economic Co-operation and Development (OECD)
- United Nations Environment Programme (UNEP)



Member States/public institutions



Industries & private sector associations



Financial institutions



International organisations



Research & academic institutions

Examples of ongoing and past cooperation

Standards. UNIDO collaborates with the International Organization for Standardization (ISO) to help developing countries participate more effectively in standard-setting, and address challenges related to quality infrastructure and conformity assessment. In November 2023, UNIDO hosted the ISO Technical Committee 197 “Hydrogen Technologies” meeting in Vienna. Together with partners, UNIDO also developed the Guide to ISO/TS 19870 to make this standard more accessible to practitioners, industry professionals, and policymakers.

Financing and investment. To improve access to finance, UNIDO works to design innovative assistance mechanisms. In cooperation with the UK Hydrogen Breakthrough Agenda, the World Bank, and the International Renewable Energy Agency (IRENA), UNIDO carried out a mapping of financing and technical assistance initiatives.

UNIDO works with a wide range of partners to address challenges faced by developing countries (in line with Global Partnership pillar). With many of these partners, UNIDO has signed Joint Declarations or Memoranda of Understanding to strategically strengthen cooperation.

Global coordination. UNIDO enhances Member States engagement through regular dialogues. It also serves as coordinator of the International Hydrogen Trade Forum (IHTF), established under the Clean Energy Ministerial Hydrogen Initiative (CEM HI). The IHTF provides an intergovernmental platform to stimulate international hydrogen trade, reduce barriers, and foster productive market conditions. In this role, UNIDO facilitates cooperation among governments and industry leaders while ensuring that the perspectives of developing countries and transition economies are represented.

Skills and know-how. Together with Hydrogen Europe and GIZ, UNIDO developed a skills map for hydrogen-related jobs to help build capacity in developing countries. UNIDO has also conducted in-country assessments in Egypt and Tunisia to identify skills gaps and support upskilling and reskilling of the workforce.

Innovation. In cooperation with the UK Government through the Clean Energy Innovation Facility, UNIDO supports the acceleration of clean hydrogen innovations in developing countries, helping technologies move from demonstration to commercial scale. UNIDO also collaborates closely with the International Hydrogen Energy Centre in China to advance and promote innovative solutions, and it supports the Centre's international award.

Policies and regulations. To advance enabling frameworks for hydrogen market creation in developing countries, UNIDO worked with IRENA and the German Institute of Development and Sustainability (IDOS) to develop a Policy Toolkit for Green Hydrogen for Sustainable Industrial Development.

Sustainability and inclusiveness. UNIDO places sustainability and inclusiveness at the core of its activities. Together with partners including United Nations Environmental Programme, the United Nations Economic Commission for Europe, the African Development Bank, the German Institute of Development and Sustainability, the Just Energy Transition Green Hydrogen Portfolio of South Africa, and the MENA Hydrogen Alliance, alongside contributions from United Nations Trade and Development, the International Renewable Energy Agency and the International Labour Organisation, UNIDO has developed sustainability guidelines. These guidelines are intended to support the assessment of social and environmental impacts and serve as a practical resource for policymakers and financial decision-makers involved in new low-emission hydrogen projects.

UNIDO also considers gender equality an important element of sustainability and inclusiveness. In partnership with Women in Green Hydrogen, UNIDO co-organizes webinars and events that raise the visibility of women working in the hydrogen sector.



International Hydrogen Energy Centre located in Beijing, China.



Technical Cooperation Portfolio

Today, the Programme's technical cooperation portfolio spans **13 countries** and is supported by a wide range of donors. Current hydrogen-related initiatives include:

- **Global Clean Hydrogen Programme** (funded under GEF-8)
- **International Hydrogen Energy Centre** (China)
- **Green Hydrogen Energy Integrated Demonstration Application Project** (China, funded by GEF-8)
- **Hydrogen Readiness Programme** (Morocco and South Africa, funded by GCF)
- **Net Zero Global Pipeline Development for Investment-Ready Proposals** (hydrogen is one of the core components), including:
 - » Brazil-UK Hydrogen Hub
 - » Hydrogen Project Implementation Assistance Facility
- **Accelerate-to-Demonstrate Facility** (hydrogen is one of the thematic focuses)
- **Low-Emission Ammonia Fertilizer Initiative** (LEAFI)

Several initiatives are described below.

Global Environment Facility (GEF)

GEF-8 GLOBAL CLEAN HYDROGEN PROGRAMME

Developed under GEF-8 (approved in June 2025), this Programme aims to reduce global greenhouse gas emissions by promoting hydrogen technologies as a clean energy solution in developing countries and economies in transition. It includes **nine country-specific** projects (Algeria, Ecuador, Egypt, Malaysia, Namibia, Nigeria, Pakistan, the Philippines, and South Africa) as well as **one global project**.

Strategically aligned with global climate goals and national commitments, the Programme contributes to the decarbonization of hard-to-abate sectors such as chemicals, iron and steel, and heavy transport.

At the global level, the Programme focuses on strengthening institutional capacities, creating enabling policies and regulatory environments, and facilitating knowledge-sharing to ensure effective technology transfer and coordination.



At the country level, interventions are tailored to local needs. Planned activities include the development of national hydrogen standards, capacity-building for production and use of low-emission hydrogen, demonstration projects in industrial clusters, and innovative financial mechanisms to attract investment. The Programme also prioritizes inclusivity, with targeted training for women and youth.

Overall, it is expected to achieve cumulative greenhouse gas emission reductions of approximately 9 million tonnes of CO₂ equivalents, enhancing energy security, generating employment, and supporting sustainable economic growth.

Looking ahead, UNIDO is already in advanced discussions with additional countries interested in joining the Programme under GEF-9.

GEF-8 CHINA

Approved in November 2024, the project “*Green Hydrogen Energy Integrated Demonstration Application*” in China supports industrial decarbonization through the use of low-emission hydrogen. Closely linked to the GEF-funded Global Clean Hydrogen Programme, it aims to catalyze renewable hydrogen production and utilization to advance the energy transition in Ningdong, Dalian, and Shenyang.

The project focuses on developing policies, standards, regulations, and an information platform to promote a hydrogen-integrated supply chain. It also supports the demonstration of renewable hydrogen applications in industries and heavy-duty transport. In addition, the project promotes capacity-building, knowledge sharing, and international cooperation.

Over its five-year duration, the project is expected to mitigate around 57 million tonnes of CO₂ and benefit more than 40,000 local inhabitants through the creation of green jobs.

Green Climate Fund (GCF)

UNIDO is implementing two Readiness Proposals in Morocco and South Africa.

Morocco. This initiative seeks to accelerate the adoption of renewable hydrogen, with a particular focus on decarbonizing the steel industry - a priority sector in Morocco’s efforts to cut greenhouse gas emissions by 45.5% by 2030, as outlined in its Nationally Determined Contribution (NDC). The project is fully aligned with Morocco’s Green Hydrogen Roadmap and national strategies, positioning the country to become a leading player in the global renewable hydrogen market. Project partner: Ministry of Energy Transition and Sustainable Development of Morocco.

South Africa. The GCF Readiness Programme for South Africa is designed to strengthen institutional capacity for coordinating and implementing renewable hydrogen initiatives under the Hydrogen Society Roadmap (HSRM). It is aligned with South Africa’s broader national strategies, including the Green Hydrogen Commercialization Strategy and the Just Energy Transition Implementation Plan (JET-IP), and is implemented in close coordination with the Department of Science, Technology and Innovation (DSTI). A key objective is to prepare the ground for the establishment of the South African International Hydrogen Energy Centre (SA-IHEC), envisioned as a platform to unlock new industries, enhance local industrial competitiveness, and boost manufacturing capacity.

The United Kingdom Funds

Net-zero global pipeline development for investment-ready proposals

With support from the United Kingdom Department of Energy Security and Net Zero (DESNZ) and partners, the project aims to support emerging economies in driving decarbonization solutions and low-emission hydrogen uptake.

The initiative aims to accelerate the deployment of low-emission hydrogen by:

- Developing a pipeline of investment-ready hydrogen projects in targeted member states
- Enhancing technical and institutional capacities of emerging economies
- Promoting innovation, technology collaboration and knowledge sharing
- Bridging financing and hydrogen off-take gaps

Brazil-UK Hydrogen Hub (H2 Hub)

A Brazilian country-led platform, in partnership with the UK government aims to mobilize and coordinate a programme of international development assistance to support the delivery of Brazil’s National Hydrogen Programme. UNIDO serves as a Secretariat of the Brazil-UK Hydrogen Hub, in consultation with relevant ministries and stakeholders.

Hydrogen Platforms & Hydrogen Project Implementation Assistance Facility (HPIAF)

Replicating lessons learned, UNIDO is leveraging Member States’ support for the establishment of country-led platforms in Mexico and South Africa. These country-driven initiatives in partner states aim to help countries prioritize low-emission hydrogen projects, assess promising initiatives, advance them toward bankability, and identify potential sources of financing.



CHINA

UNIDO-IHEC HYDROGEN FLAGSHIP DEMONSTRATION PROJECTS

UNIDO's Global Programme for Hydrogen in Industry is supported by the technical expertise of the International Hydrogen Energy Centre (IHEC) in Beijing, launched in 2021 by UNIDO and the Government of China. The Centre serves as an international hub for technology innovation in hydrogen energy, advancing R&D, application, and demonstration of key hydrogen technologies and supporting the development of hydrogen value chains. The IHEC aims to accelerate the global scale-up of industrial hydrogen use particularly in developing countries by mobilizing international R&D funding and promoting South-South and regional cooperation with key partners.

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

HFCV Demonstration during 2022 Beijing Winter Olympics (Completed)

During the 2022 Winter Olympics, IHEC collaborated with SinoHytec to carry out the world's largest demonstration of hydrogen fuel cell commercial vehicle. A total of over 850 commercial vehicles were deployed, utilizing 9 hydrogen refueling stations. These vehicles collectively traveled over 3.2 million

kilometers, resulting in a cumulative reduction of over 2000 tons of CO₂ emissions. This marked the first comprehensive demonstration of large-scale and high-intensity safe operation of hydrogen fuel cell vehicles in extremely cold and high-altitude regions, generating significant global impact.

Baotou International Hydrogen Demonstration in Chemical Industry and Metallurgy (Under Development)

IHEC, relying on the hydrogen industry know-how of Beijing Tsinghua Industrial R&D Institute and the global cooperation network of UNIDO, in cooperation with Mintal New Energy, is carrying out a large-scale hydrogen demonstration project in the field of chemical industry and metallurgy.

The project has two phases, and the annual ammonia output is 400,000 MTPA for each. For phase 1 of the project, the dynamic project plant has a capacity of 1800 MTPD, and yields 400,000 MTPA. The corresponding hydrogen plant is 750MW, consisting of 148-156 ALK electrolyzers. The renewable energy is 1.9GW with wind and solar combined.

Site leveling of phase 1 of the project started early 2023 and is expected to commission by 2027.





Key Achievements

UNIDO has been recognized as a leading UN agency on hydrogen. The Global Programme for Hydrogen in Industry has established a broad portfolio of ongoing and pipeline projects. Within this framework, UNIDO has delivered extensive analytical and policy advisory services, developed a wide range of knowledge products, and carried out targeted studies to help address critical challenges in advancing the hydrogen economy.

The key publications

- [Guidelines For Sustainable Hydrogen Projects In Developing Countries](#) (2025)
- [Low-Emissions Hydrogen Industry Development in Emerging Market and Developing Economies](#) (2025)
- [Green Hydrogen for Sustainable Industrial Development: A Policy Toolkit](#) (2024)
- [Mapping of Financial and Technical Assistance of Clean Hydrogen](#) (2024)
- [Guide to ISO/TS 19870](#) (2024)
- [Green Hydrogen Industrial Clusters Guidelines](#) (2023)
- Several new publications are currently under development.

The opinion pieces

- [Green Hydrogen: Fuelling industrial development for a clean and sustainable future](#)
- [Industrial and innovation policy can speed up the Green Hydrogen transition](#)
- [Achieving a Green Hydrogen transition built on equity and consensus](#)
- [Mobilizing investment in green hydrogen](#)
- [Strategies for hydrogen transport infrastructure](#)
- [Embracing a dual GH2 strategy: domestic use and trade](#)

The dedicated online platform

- <https://hydrogen.unido.org/>





UNIDO has positioned itself as a key global convener on low-emission hydrogen by hosting Member State development dialogues, expert groups, technical committee meetings (such as ISO TC 197 on Hydrogen Technologies), and high-level roundtables at CEM, G20 and IHTF. These efforts have contributed to shaping standards and policies, advancing skills development, supporting global trade corridors, and mobilizing partnerships. UNIDO was requested by COP29 Presidency to design and negotiate a Hydrogen declaration for its [COP29 Presidency Action Agenda](#), which gathered the support of 62 parties and 47 non-state actors (as of September 2025).

“ We are dedicated to advocating for the Global South, assisting developing and transitioning economies in overcoming challenges on the path to energy transition, and ensuring that no one is left behind.

Petra Schwager





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