UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Progress by innovation

A2D Accelerate to Demonstrate Facility

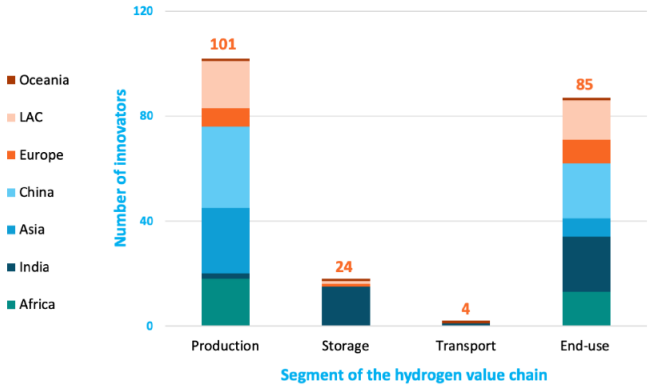
MARKET ASSESSMENT ON CLEAN HYDROGEN INNOVATION IN DEVELOPING COUNTRIES

Climate change requires accelerated worldwide action. The involvement of developing nations in the adoption of clean hydrogen solutions is important to achieve global decarbonisation targets. This is why initiatives such as the "Accelerate-to-Demonstrate Facility" (A2D) play a key role in supporting these efforts by facilitating technology uptake and investment.

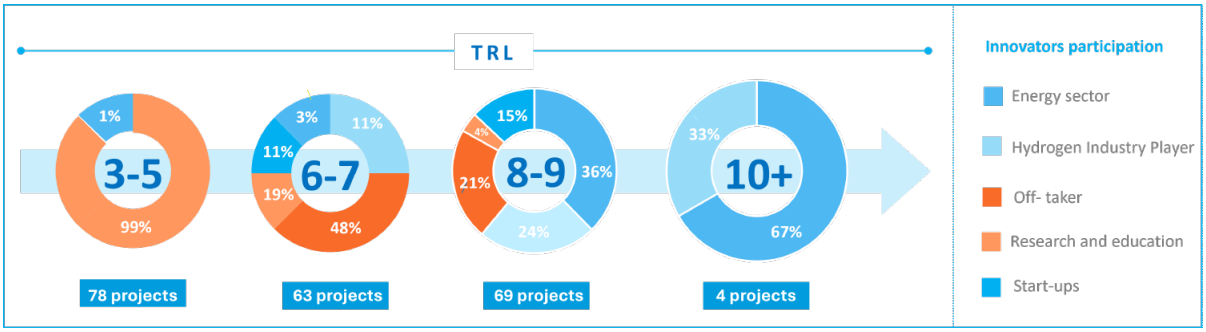
The market assessment undertook a comprehensive analysis of all the actors and enablers for the deployment of clean-hydrogen projects in developing countries. This included challenges, opportunities, stakeholders, initiatives, innovators, and financing mechanisms, with a particular focus on early mover projects and countries with established policy ambitions and national strategies.

Clean hydrogen technologies are being developed by innovators across 35 developing countries

The following graphics show the number of innovators by region and segment of the clean hydrogen value chain, as well as their distribution according to the Technology Readiness Level (TRL) of the projects. Additionally, they provide key insights, such as:



- Over 110 hydrogen projects are in late-stage planning across 35 developing countries.
- Most of the innovators, 101 of 214 (47%), are working on clean hydrogen production technologies.
- They focus on adopting technologies at TRLs 6 to 9.
- 77 of 78 (99%) of the projects in TRLs 3-5 are led by universities and research institutes, while 51 of 63 (81%) of the projects in TRLs 6-7 are led by the industrial sector.



However, the main barriers faced by innovators in developing countries are: accessing materials, technologies, equipment, insufficient infrastructure, technical expertise and training, local off-takers, and funding.

Appropriate funding, delivery mechanisms and the involvement and funding from international stakeholders are essential to drive forward initiatives in developing countries.

Existing funding initiatives prioritise the production of clean hydrogen, but there is a pressing need to boost demand as well.

Provision of an enabling environment for innovation → **Development and adoption of innovative technologies** → **End use applications of clean hydrogen and derivatives**

Government entities

- Policies development for R&D and innovation, enabling regulatory frameworks and grants.
- Establishment of hydrogen regulatory sandboxes and safe testing environments.
- Attraction of international investment.

Innovators

- Adaptation of clean hydrogen technologies to country-specific conditions.
- Advance innovative solutions to commercial stages.
- Foster market-driven knowledge and skills.

Off-takers

- Ensuring demand.
- Off-take agreements to facilitate developers requesting for funds.

Academia

- Centres and networks for interdisciplinary collaboration.
- Laboratory environment and expertise on R&D.

Financing Institutions

- Funding mechanisms and financial instruments for capital-intensive stages.

International Stakeholders

- Establishment of initiatives to support innovation: knowledge sharing, capacity building, technical assistance, financial support, and market creators.

Hydrogen Associations

- Bridge between industry, academia and government.
- Integration and synergies between players along the value chain.
- Industry perspective

Case studies:
Government Initiatives

$2.4 billion	India's National Green Hydrogen Mission.
$1 billion	Namibia's Sustainable Development Goals (SDGs) One Fund.
	Colombia's FENOGE[1] Fund.

Case studies:
Development Finance

$200 million	KfW[3]'s concessional financing for clean H_2 in Africa.
$3 billion	World Bank's loan to India for clean H_2 market.
	IDB[4]'s technical assistance for Latin America and the Caribbean.

Case studies:
Private Investments

+$425 million	Singapore Capital Ventures to Semarak Renewable Energy in Malaysia.
$25 million	SBI Ventures[2]' private equity to Hygenco in India.

Case studies:
Research & Development Funding

- Governments are providing research grants and creating centres of excellence.
- Private sector is granting funds for innovation hubs and forming partnerships with universities.

1. Fondo de Energías no Convencionales y Gestión Eficiente de la Energía (in English, Non-Conventional Energy and Efficient Energy Management Fund)
2. SBI Ventures Limited is a wholly owned subsidiary of State Bank of India.
3. Kreditanstalt für Wiederaufbau (in English, Credit Institute for Reconstruction)
4. Inter-American Development Bank

Most initiatives aimed at advancing clean hydrogen are national or international, with fewer regional initiatives

- National initiatives focus on public policy and regulatory development, such as hydrogen roadmaps.
- Regional initiatives promote collaboration and knowledge exchange.
- International initiatives consist in funding and technical assistance.

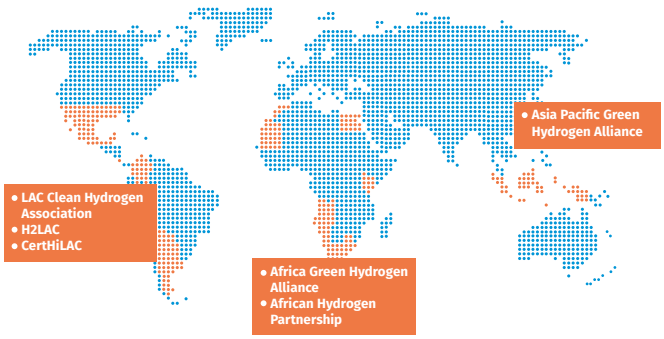
Developing countries with a national hydrogen strategy or roadmap

Algeria, Argentina, Bhutan, Brazil, China, Colombia, Costa Rica, Ecuador, Egypt, India, Indonesia, Kazakhstan, Kenya, Malaysia, Mauritania, Morocco, Namibia, Panama, Paraguay, Peru, South Africa, Sri Lanka, Tunisia, Türkiye, Ukraine, Uzbekistan, Vietnam

- As of November 2024, 27 out of 141 countries (19%) have published a national hydrogen strategy, with only 20 of these (14%) mentioning innovation support and 18 (13%) referencing R&D programs.
- Also, 28 of 141 (20%) have a National Hydrogen Association.
- More than 15 developing countries have the ambition to create domestic hubs.

Regional alliances and initiatives

There are 6 regional clean hydrogen initiatives:



Global clean hydrogen initiatives that include developing countries

- In developing countries, international cooperation is often directed toward common objectives, such as establishing regulatory frameworks and providing technical assistance.
- Critical areas for technology innovation remain unaddressed: R&D funding, lack of laboratories and materials, educational resources, and hydrogen security protocols.

Developing countries with the highest participation in international clean hydrogen initiatives

Argentina, Brazil, China, Colombia, Costa Rica, Egypt, India, Indonesia, Kenya, Mauritania, Mexico, Morocco, Namibia, South Africa

Supporting high-impact projects in developing countries can boost the clean hydrogen industry

High-impact projects represent those with a significative and lasting effect in the country's economy.

Key success factors for projects in developing countries

- Existence of an offtaker.
- Government support and favourable policies.
- A strong innovation ecosystem.
- Access to co-funding opportunities.

Recommended project types

- Initiatives focusing on production and end-use, with attention to the local conditions.
- Projects aimed at optimising the Levelised Cost of Hydrogen (LCOH) by improving plant design and integrating renewable energy sources.

Developing countries leading clean hydrogen development

In these 16 countries, clean hydrogen ecosystems are rapidly taking shape and investing in them could have a catalytic effect:

Argentina, Brazil, Colombia, Costa Rica, Egypt, India, Indonesia, Kenya, Malaysia, Mexico, Morocco, Namibia, South Africa, Türkiye, Ukraine, Vietnam

The existence of demonstration projects of innovative clean hydrogen solutions, a national hydrogen strategy or roadmap, and a hydrogen association, are key drivers for a country to develop a competitive ecosystem for clean hydrogen. Only 47 out of 141 developing countries meet at least one of the mentioned criteria.

Besides, by evaluating 5 key aspects: projects and innovation, financing mechanisms, hydrogen associations, hydrogen roadmaps and international partnerships, 16 countries were identified as pioneers in clean hydrogen innovation, from the initial list of 141 countries.

Across regions, there are various opportunities to enhance and advance progress toward SDGs, but all face challenging barriers

	Africa	Asia	Latin America and the Caribbean
What are the main areas of focus?	30% Clean hydrogen production 22% Mobility 13% Chemicals	46% Clean hydrogen production 27% Mobility 9% Blending	35% Clean hydrogen production 22% Mobility 21% Ammonia
What are the key advantages they each have?	■ Proximity to European markets. ■ Significant domestic demand potential in the mobility sector. ■ Off-grid fuel cell projects targeting communities with limited access to energy.	■ Proximity to off-takers in Japan, Singapore, and South Korea. ■ Domestic industrial demand for clean hydrogen applications. ■ Clean hydrogen production projects in the late stages of planning.	■ Export potential to European markets. ■ 60% of the electricity generation mix is from renewable sources. ■ High domestic demand in the fertilizer sector.
Which barriers need to be addressed?	■ Non-industrialised countries, limited energy and technology access. ■ High dependence on fossil fuels. ■ Infrastructure deficits. ■ Political and economic instability.	■ Varying levels of infrastructure and technology access through the region. ■ High dependence on fossil fuels.	■ Lack of technical expertise. ■ Infrastructure limitations. ■ Potential resistance with local communities.
Towards which SDGs are they progressing? Clean hydrogen has the potential to contribute mainly to SDGs 1, 7, 9 and 13. Examples of some countries' initatives are given for each region.	**Kenya** Green ammonia will boost fertiliser industry and food security. **Namibia** Green hydrogen industry is projected to add $4.1 billion to GDP by 2030, driving economic growth and sustainable industrialisation.	**India** Creation of 600,000 green jobs by 2030 and $48 million allocated to R&D. **Malaysia** Rural electrification to be boosted by remote and off-grid hydrogen fuel cells.	**Costa Rica** By 2050, green hydrogen could reduce GHG emissions by 6 to 13 million tons of CO2 equivalent per year. **Brazil** Pecém Port and Industrial Complex will stimulate economic development in a low-income state, contributing to poverty alleviation.

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Download the entire executive report here:

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