

# Vital steps for enabling private investments in hydrogen ecosystem in India

Part -5 (Hydrogen ecosystem development and identification of key future market growth clusters in India)

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## Understanding upstream environment for hydrogen -steps required to realize private sector investments in India

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**Several governments have launched hydrogen specific programmes to fund R&D in technologies across the entire hydrogen value chain**

### **UPSTREAM INVESTMENT REQUIRED**

The future success of hydrogen will hinge on innovation. Today, low carbon hydrogen is more costly than unabated fossil fuel-based hydrogen, which undermines its uptake. Multiple end-use technologies at early stages of development cannot compete in open markets, in part because they have not yet realised the economies of scale that come with maturity. Governments play a key role in setting the research agenda and adopting policy tools that can incentivise the private sector to innovate and bring technologies to the market. Programmes to foster hydrogen innovation are not yet flourishing, although some positive signals are emerging and several

governments have launched hydrogen-specific programmes to fund R&D in technologies across the entire hydrogen value chain. However, current public R&D spending on hydrogen is below levels dedicated in the early 2000s during the last wave of support for hydrogen technologies. Further, integrated efforts will be required to avoid bottlenecks along the value chain.

Government and industry cooperation is critical to ensure the implementation of robust innovation programmes. With more than EUR 1 Billion in funding provided since 2008, the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) is a prime example of a public private partnership to support R&D and technology demonstration. Building on its success, European commission launched the Clean Hydrogen for Europe Joint Undertaking at the end of 2021, with matching budgets of EUR 1 Billion from public funding and private investment until 2027.

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Hydrogen and Fuel Cell (HFC) programme in India focuses to develop transformational technologies that reduce the cost of hydrogen production, distribution & storage, diversify the feedstock available for economic hydrogen production, enhance the flexibility of the power grid and reduce emissions through novel uses of low-cost hydrogen

– Hydrogen Research Initiative, India

## India and the GCC are natural energy partners and have huge potential for extending cooperation in cleaner fuels like hydrogen

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Indian government has also been supporting broad research development and demonstration programme on hydrogen energy and fuel. Projects are supported in industrial, academic and research institutions to address challenges in production of hydrogen from renewable energy sources, its safe and efficient storage, and its utilization for energy and transport applications through combustion or fuel cells. With respect to transportation, major work has been supported to Banaras Hindu University, IIT Delhi, and Mahindra & Mahindra. This has resulted in development and demonstration of internal combustion engines, two wheelers, three wheelers, and mini-buses that run on hydrogen fuel. Two hydrogen refuelling stations have been established (one each at Indian Oil R&D Centre, Faridabad and National Institute of Solar Energy, Gurugram).

The Government of India has allotted Rs 25 crore in the Union Budget 2021–22 for the research and development in hydrogen energy and intends to produce three-fourths of its hydrogen from renewable resources by 2050. Further, the government of India identified pilot projects, infrastructure and supply chain, research and development, regulations and public outreach as broad activities for investment with a proposed financial outlay of INR 800 crores for the next three years. India, aims to leverage the country's landmass and low solar and wind tariffs to produce low-cost green hydrogen and ammonia for export to Japan, South Korea and Europe. In this regard, there are immense possibilities for India to collaborate with the Gulf Cooperation Council (GCC) countries that have also invested significantly in developing hydrogen as a future source of energy. Geographical proximity and robust trade ties in conventional energy calls for proactive measures by India to collaborate with GCC countries especially Saudi Arabia, UAE and Oman for research and development pertaining to hydrogen energy.

India and the GCC are natural energy partners and have huge potential for extending cooperation in cleaner fuels like hydrogen. India has signed MoUs on renewable energy with most of the GCC countries. India's largest pure-play solar platform Acme Solar Holdings Ltd plans to invest US\$ 2.5 billion to manufacture green ammonia and green hydrogen in Duqm and signed an MoU with the Oman Company for the Development of the Special Economic Zone. The manufacturing facility will supply green ammonia to Europe, America and Asia region and will produce 2,200 metric tonnes (mt) of green ammonia per day.

## With the advent of hydrogen giga-scale projects , hydrogen production costs can continue to fall

India is looking at developing Hydrogen collaboration with Bahrain and even invited Bahrain to participate in the Hydrogen Roundtable when Bahraini foreign minister Dr Abdullatif bin Rashid Al-Zayani visited New Delhi in April 2021. The two countries agreed to engage more in renewable energy capacity-building and focus on cooperation between their governments as well as the private sector, particularly in the field of solar, wind and clean hydrogen.

Selected active hydrogen R&D programmes globally and investments

Country	Programme	Funding	Duration
<b>Australia</b>	ARENA's R&D Programme	AUD 22 mln (~USD 15 mln)	5 Years
	CSIRO Hydrogen Mission	AUD 68 mln (~USD 47 mln)	5 Years
<b>European Union</b>	Clean Hydrogen for Europe	EUR 1 bln (~USD 1. bln)	10 Years
<b>France</b>	PEPR Hydrogen	EUR 80 mln (~USD 91 mln)	8 Years
<b>Germany</b>	National Innovation Programme for Hydrogen and Fuel Cell Technology	EUR >250 mln (~USD 285 mln)	10 Years
	Wasserstoff – Leitprojekte	EUR 700 mln (~USD 800 mln)	N/A
<b>Japan</b>	NEDO Innovation Programmes	JPY 699 bln (~USD 6.5 bln)	10 Years
<b>Spain</b>	Missions CDTI	EUR 105 mln (~USD 120 mln)	3 Years
<b>United Kingdom</b>	Low Carbon Hydrogen Supply	GBP 93 mln (~USD 119 mln)	N/A
<b>United States</b>	H2@Scale	USD 104 mln	2 Years
	M2FCT – H2New Consortia	USD 100 mln	5 Years
	DOE Hydrogen Program	USD 285 m/yr	
<b>India</b>	Hydrogen & Fuel Cell Programme	INR 250 Million	3 Years
	Renewable & Clean Hydrogen Programme	INR 800 crore	3 Years

## Few bilateral agreements between governments to co-operate on hydrogen development , 2019-2021

Countries	Objective
Germany-Australia	Formulate new initiatives to accelerate development of a hydrogen industry, including a hydrogen supply chain between the two countries. Focus on technology research and identification of barriers
Germany- Canada	Form a partnership to integrate renewable energy sources, technological innovation and co-operation, with a focus on hydrogen
Germany- Chile	Strengthen co-operation in renewable hydrogen and identify viable projects
Germany-Morocco	Develop clean hydrogen production, research projects and investments across the entire supply chain (two projects have already been announced by the Moroccan agencies MASEN and IRESEN)
Germany-Saudi Arabia	Co-operate on the production, processing and transport of hydrogen from renewable energy sources
Netherland-Chile	Establish a structured dialogue on the development of import-export corridors for green hydrogen, aligning investment agendas and facilitating collaboration among private parties
Netherland-Portugal	Co-operate to advance the strategic value chain for producing and transporting renewables-based hydrogen, connecting the hydrogen plans of the two countries
Japan-UAE	Co-operate on technology development, regulatory frameworks and standards to create an international hydrogen supply chain
Japan-Argentina	Strengthen collaboration on the use of clean fuels and promote investments to deploy large-scale hydrogen production from renewable energy sources
Japan-Australia	Issue a joint statement highlighting the commitment already in place between the two countries and recognising the importance of co-operation on an international hydrogen supply chain
India- GCC	Collaboration to manufacture green ammonia and green hydrogen and engage more in renewable energy capacity building through government & private player's cooperation
India-EU	EU to partner with India through investments in green hydrogen
India-US	Collaboration to achieve affordable hydrogen solutions. The key vision is to enhance energy security and resilience by scaling up low or zero-carbon hydrogen technologies and deployment
Singapore-New Zealand	Boost collaboration on establishing supply chains for low-carbon hydrogen and its derivatives, and strengthen joint R&D, networks and partnerships

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