

target. The policy aims to facilitate the transmission of clean power for hydrogen production between states, addressing the connectivity issues that have stifled the circulation of solar and wind energy in the past. It also offers support for setting up manufacturing units across the country.

The building blocks of the hydrogen economy

Hydrogen is the most abundant chemical element in the universe, but it's not found in its pure form in nature. It has to be extracted from compounds such as gas, biomass or water, through electrolysis. When this process is powered by clean energy such as solar, hydrogen is entirely pollution-free, because it doesn't emit carbon when used.

"The production of green hydrogen is fairly uncomplicated," says Kashish Shah, analyst at the Institute for Energy Economics and Financial Analysis (IEEFA). Currently, he explains, **producing green hydrogen in India costs around US \$7 per kg**, while grey and blue hydrogen, produced using fossil fuels, cost less than \$2 per kg. Lowering the price of green hydrogen is possible, and "it's going to happen through reduction in prices of renewable energy and reduction of prices in the cost of electrolyzers".

A hydrogen map of India

But a hydrogen market is yet to be established, and its applications are not as broad as those of other sources of clean energy. For one, the gas is very flammable, which means it's difficult to move around and is better used where it is produced. **A future hydrogen map of India will look very different to a solar one**, with plants located within the industrial clusters where the fuel will be used.

Developer Acme Solar has already set up what it believes to be the world's first integrated solar to green hydrogen to green ammonia plant, with a capacity of 5 tonnes per day, in the desert state of Rajasthan, and is planning another one in solar-radiation-rich Oman.

Delhi think tank The Energy and Resources Institute (TERI) said that demand for hydrogen, which is **currently around 6 million tonnes per year in India and comes mostly from the fertiliser and refinery industries, could increase fivefold by 2050**. Despite the optimism, green hydrogen's potential mass applications are still unclear.

"We need to create a market for green hydrogen," says Hemant Mallya, who leads the think tank Council on Energy Environment and Water's (CEEW)'s work on hydrogen and is cooperating with the government on its development strategy. Currently, most of the hydrogen produced in the country comes from fossil fuels, but **India hopes to replace it over time with green hydrogen**. Unexpectedly, the conflict in Ukraine could speed up the process, as higher gas prices are making green ammonia and hydrogen comparatively cheaper.

"This time we can't miss the boat, like we did with the solar trajectory," Mallya says, referring to China's unshakable dominance in the sector. "Having said that, we'll have to see how users respond, because it's not just about supplying [the fuel], the end user needs to be willing to invest as well [to set up the adoption infrastructure]," he says. **"Consumer attitudes will inform us on whether we can domestically build capacity or not."**

Sandeep Kashyap, ACME Group's chief operating officer, says that while the company appreciates the first policy steps taken by the government, going forward "it will be important to come up with policy measures for demand creation, **for example through green hydrogen and ammonia purchase obligations**", which would require target users to purchase a minimum percentage of the clean fuel for their operations.

Global ambitions

The idea, Mallya says, is to make India a green hydrogen hub able to export electrolysers as well as green hydrogen derivatives such as ammonia, something that the aviation and maritime industries are considering as low-carbon fuel.