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On Point

Scaling hydrogen production in India - Enabling right policy framework and gap assessment

Part -3 (Scaling policy, support infrastructure and trade opportunities for hydrogen in India with technology and policy comprehensive roadmap)

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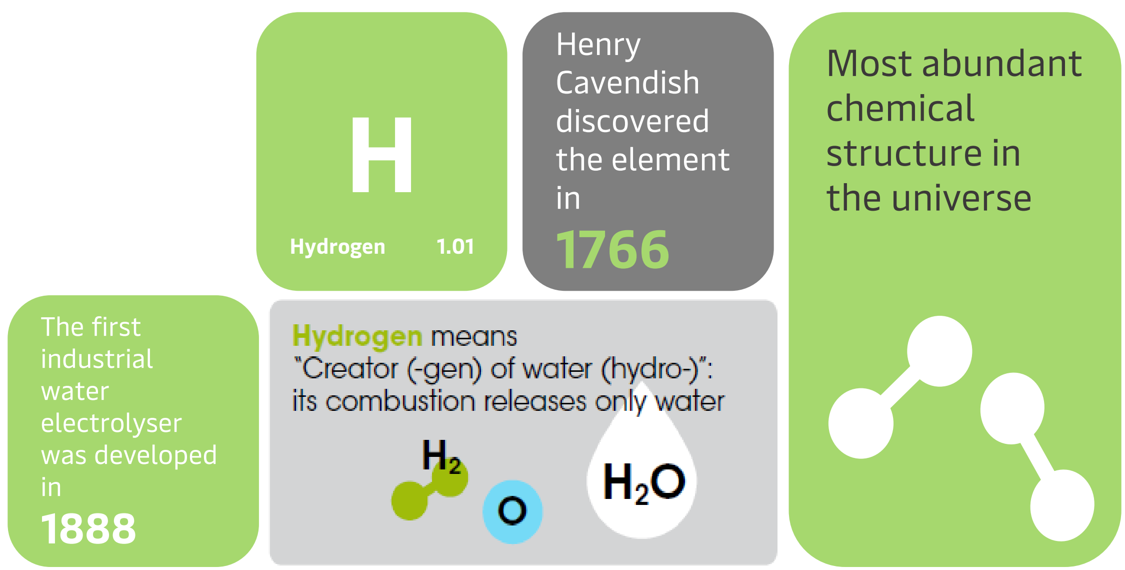
Regulations & policy framework examination for hydrogen scale up in India

Hydrogen: Status, Drivers & Barriers

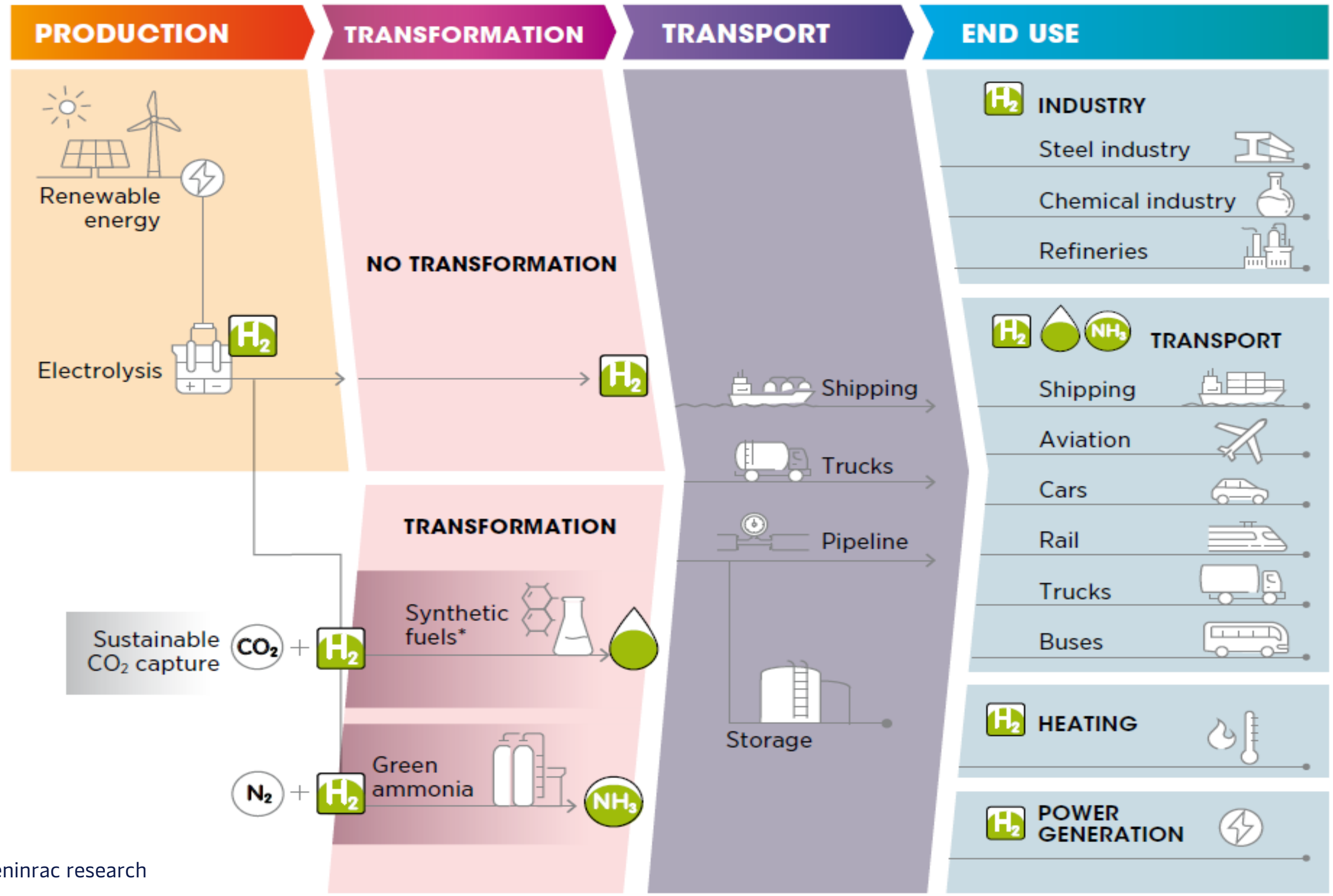
HYDROGEN LANDSCAPE

Green hydrogen is an energy carrier that can be used in many different applications. However, its actual use is still very limited. Each year around 120 million tonnes of hydrogen are produced globally, of which two-thirds are pure hydrogen and one-third is in a mixture with other gases (IRENA, 2019). Hydrogen output is mostly used for crude oil refining and for ammonia and methanol synthesis, which together represent almost 75% of the combined pure and mixed hydrogen demand.

Today's hydrogen production is mostly based on natural gas and coal, which together account for 95% of production. Electrolysis produces around 5% of global hydrogen, as a by-product from chlorine production. Currently, there is no significant hydrogen production from renewable sources: green hydrogen has been limited to demonstration projects.



Green hydrogen production, conversion and end uses across the energy system



Source: IRENA, eninrac research

** The term synthetic fuels refers here to a range of hydrogen-based fuels produced through chemical processes with a carbon source (CO and CO2 captured from emission streams, biogenic sources or directly from the air). They include methanol, jet fuels, methane and other hydrocarbons. The main advantage of these fuels is that they can be used to replace their fossil fuel-based counterparts and in many cases be used as direct replacements – that is, as drop-in fuels. Synthetic fuels produce carbon emissions when combusted, but if their production process consumes the same amount of CO2, in principle it allows them to have net-zero carbon emissions.*

Drivers of the New Wave of Hydrogen

There have been several waves of interest in hydrogen in the past. These were mostly driven by oil price shocks, concerns about peak oil demand or air pollution, and research on alternative fuels. Hydrogen can contribute to energy security by providing another energy carrier with different supply chains, producers and markets; this can diversify the energy mix and improve the resilience of the system. Hydrogen can also reduce air pollution when used in fuel cells, with no emissions other than water. It can promote economic growth and job creation given the large investment needed to develop it as an energy carrier from an industrial feedstock.

As a result, more and more energy scenarios are giving green hydrogen a prominent role, albeit with significantly different volumes of penetration. The drivers for green hydrogen include:

1. **Low variable renewable energy (VRE) electricity costs**: The major cost driver for green hydrogen is the cost of electricity. The price of electricity procured from solar PV and onshore wind plants has decreased substantially in the last decade. In December 2020, solar power tariff touched a all time low of ₹1.99 per kWh, this came within a month of SECI tender in Rajasthan auction wherein a tariff of ₹2 per kWh was quoted. Further, in March 2021, onshore wind tariff in India witnessed a low of ₹2.77 per kWh. Globally, the same trend have been witnessed as in 2018, solar energy was contracted at a global average price of 56 USD/MWh, compared with 250 in 2018. Onshore wind prices also fell during that period, from 75 USD/MWh in 2010 to 48 in 2018. New record-low prices were marked in 2019 and 2020 around the world: solar PV was contracted at USD 13.12/MWh in Portugal (Morais, 2020) and USD 13.5/MWh in the United Arab Emirates (Abu Dhabi) (Shumkov, 2020); onshore wind was contracted at USD 21.3/MWh in Saudi Arabia (Masdar, 2019) while in Brazil, prices ranged between USD 20.5 and 21.5/MWh. With the continuously decreasing costs of solar photovoltaic and wind electricity, the production of green hydrogen is increasingly economically attractive.

2. **Technologies ready to scale up:** Many of the components in the hydrogen value chain have already been deployed on a small scale and are ready for commercialization, now requiring investment to scale up. The capital cost of electrolysis has fallen by 60% since 2010 (Hydrogen Council, 2020), resulting in a decrease of hydrogen cost from a range of USD 10-15/kg to as low as USD 4-6/kg in that period. Many strategies exist to bring down costs further and support a wider adoption of hydrogen. The cost of fuel cells for vehicles has decreased by at least 70% since 2006.

Drivers of the New Wave of Green Hydrogen

While some technologies have not been demonstrated at scale yet (such as ammonia-fuelled ships), scaling up green hydrogen could make those pathways more attractive as production costs decrease.

3. **Benefits for the power system:** As the share of VRE rapidly increases in various markets around the world, the power system will need more flexibility. The electrolysers used to produce green hydrogen can be designed as flexible resources that can quickly ramp up or down to compensate for fluctuations in VRE production, by reacting to electricity prices (Eichman, Harrison and Peters, 2014). Green hydrogen can be stored for long periods and can be used in periods when VRE is not available for power generation with stationary fuel cells or hydrogen ready gas turbines. Flexible resources can reduce VRE curtailment, stabilise wholesale market prices and reduce the hours with zero or below zero electricity prices (or negative price), which increases the investment recovery for renewable generators and facilitates their expansion. Finally, hydrogen is suitable for long-term, seasonal energy storage, complementing pumped-storage hydropower plants. Green hydrogen thus supports the integration of higher shares of VRE into the grid, increasing system efficiency and cost effectiveness.

4. **Government objectives for net-zero energy systems:** By mid-2020, seven countries had already adopted net-zero GHG emission targets in legislation, and 15 others had proposed similar legislation or policy documents. In total, more than 120 countries have announced net-zero emissions goals. Among them is the People's Republic of China (hereafter "China"), the largest GHG emitter, which recently pledged to cut its net. carbon emissions to zero within 40 years. While these net-zero commitments have still to be transformed into practical actions, they will require cutting emissions in the "hard-to-abate" sectors where green hydrogen can play an important role.

5. **Broader use of hydrogen:** Previous waves of interest in hydrogen were focused mainly on expanding its use in fuel cell electric vehicles (FCEVs). In contrast, the new interest covers many possible green hydrogen uses across the entire economy, including the additional conversion of hydrogen to other energy carriers and products, such as ammonia, methanol and synthetic liquids. These uses can increase the future demand for hydrogen and can take advantage of possible synergies to decrease costs in the green hydrogen value chain.

Drivers of the New Wave of Green Hydrogen

Green hydrogen can, in fact, improve industrial competitiveness, not only for the countries that establish technology leadership in its deployment, but also by providing an opportunity for existing industries to have a role in a low carbon future. Countries with large renewable resources could derive major economic benefits by becoming net exporters of green hydrogen in a global green hydrogen economy.

6. **Interest of multiple stakeholders:** As a result of all the above points, interest in hydrogen is now widespread in both public and private institutions. These include energy utilities, steel makers, chemical companies, port authorities, car and aircraft manufacturers, shipowners and airlines, multiple jurisdictions and countries aiming to use their renewable resources for export or to use hydrogen to improve their own energy security. These many players have also created partnerships and ongoing initiatives to foster collaboration and co-ordination of efforts.

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