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The Next Level

e-Edition

Factoring Water for GREEN HYDROGEN

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India to be World's Fastest Growing Startup Ecosystem

Metaverse for Innovative Marketing

Nurturing Grassroots Women Entrepreneurs

Taking HR to New Level

Helping SMEs to go Digital for Everyday Operations

Importance of Entrepreneurship Education

Trade Factoring for MSMEs

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Sometimes there's a trade-off between easy and clean, and government needs to pick the right side. It's critically important to making sure India meets its climate goals, and not just on paper. If we want to make sure we're supporting a truly green hydrogen and e-fuels industry, now is the time for the country to set us on the right path.

Factoring Water in Production of 'Green Hydrogen'

Green hydrogen production will consume 1.5 ppm of Earth's freshwater or 30 ppb of saltwater each year, an amount smaller than what is currently consumed by fossil fuel-based energy production and power generation. Then what is the journalistic concern about the consumption of water in production of green hydrogen? As per the Green Hydrogen Compact Catalogue of the United Nations "Businesses, countries and other stakeholders are encouraged to establish Energy Compacts that can help deliver 25 GW of green hydrogen capacity by 2026, towards 500-1000 GW required by 2030, in line with the UN Marrakech Partnership's Climate Action Pathway on Green Hydrogen for a 1.5-degree compatible energy sector by 2050."

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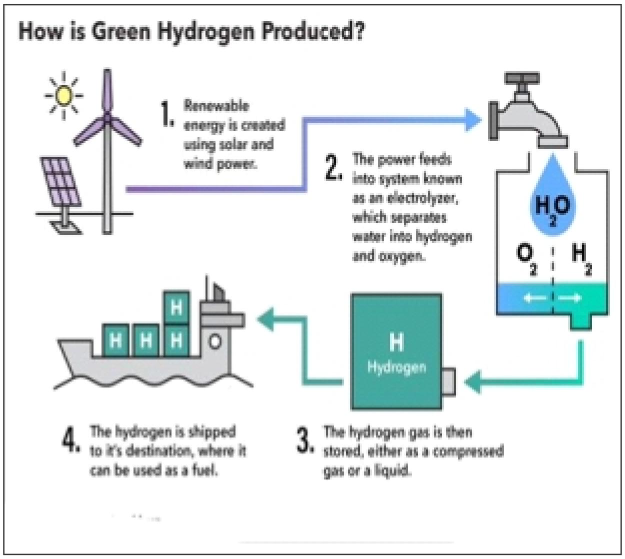
The Ministry of Power has notified a Green Hydrogen Policy for production of Green Hydrogen using renewable sources of energy (solar, wind, etc.). It has set a target of 5 million tonnes per annum of green Hydrogen production by 2030. National Hydrogen Mission (NHM), launched by



Government of India, aims at cutting down Carbon emissions and increasing the use of renewable sources of energy. It would aid the government in meeting its climate change adaptation and mitigation goals. Green Hydrogen can help achieve net zero Carbon dioxide emissions in energy intensive sectors like steel, chemical production, etc. It also looks at Hydrogen cooperation with GCC countries like Saudi Arabia, Oman and UAE. Hydrogen has emerged as an important source of energy, since it has zero Carbon content.

Uses of Green Hydrogen

Currently, Hydrogen is mainly used in transport sector and industrial sectors including Oil refining, Ammonia production, Methanol production, Steel production etc.

Hydrogen production requires secure, long-term access to water. The efficacy of Indian infrastructure to support scaling up to long-term, commercial scale Hydrogen production is contingent on domestic water resources (especially groundwater) and its sufficiency.

With time, green Hydrogen could be used to develop much more environment friendly fuel cell cars in order to complement the Electric Vehicle industry in India.

Rather than being directly consumed by endusers, the majority of water use today occurswithin the supply chains that serve each sectorof the economy. Most

existing industrial and transport activities have large water footprints, because of their dependency on hydrocarbonfuels and/or electricity generated by thermalpower plants. It is therefore important toconsider the impact on water use of switchingto renewable electricity and green hydrogen.

Accessible fresh water and wastewater can enable green hydrogen production, but electrolysers will need to use desalinated seawater in arid regions and at offshore wind/solar farms. Fortunately, the seawater resource on Earth is approximately 39 times greater than the fresh water resource. Together these respective amounts frame the water resources available for satisfying both established uses and the new demand associated with green hydrogen production.

An important question is: do we have enoughwater to satisfy our future demand for greenhydrogen? This is analogous to the longestablished, but no longer relevant, question asto whether we have enough oil and gas reservesto satisfy our future energy demand.The total mass of water on Earth is about1.4x10kg. Approximately 2.5% of this is freshwater, ofwhich only 9.3x10kg is classifiedas accessible surface water in lakes and rivers –glaciers and groundwater account for >99.7%of the fresh water resource. We currentlyuse about 4.6x10kg of water p.a. andestimates suggest that we produce about3.6x10kg ofwastewater p.a., which needs tobe treated before being returned to rivers orused for human consumption.

Interestinglythe current annual loss of glacier ice due toglobal warming is of as similar magnitude tothis, about 3.4x10kg.Accessible fresh waterand wastewater can enable green hydrogen production, but electrolysers will need to use desalinated seawater in arid regions and at offshore wind/solar farms. Fortunately, the seawater resource on Earth is approximately 39 times greater than the fresh water resource. Together these respective amounts frame the water resources available for satisfying both established uses and the new demand associated with green hydrogen production

Water Access for Hydrogen Production

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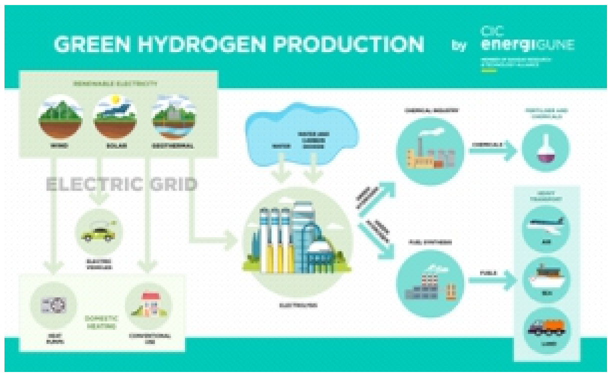

electrolysis process needs significant input of water. The water input required is around 9 liters/1 kg of Hydrogen produced.Large amount of water is also required for Hydrogen production using fossil fuels, with the current dominant technology of “steam reforming” using water for the reaction stage, process water and cooling water. There is a need to allocate some portion of ground water resources for Hydrogen production, with the consent of CGWA, NGT, etc.

Water is governed by different central and state rules and various acts for different regions.New acts, such as wetland rules, will redefine the availability of water and the sources that could be utilized.The economic / finance model for any Hydrogen production will have to include the following costs for water due to: Identified sources, Water management – technical and process, Recycle and reuse, Balancing environment impact / Net Zero - including stakeholders, ecology, and others.

Alternative Water Sources

Given the uncertainty of water availability in the country, desalination, recycled wastewater and storm water would need to be employed as alternatives to

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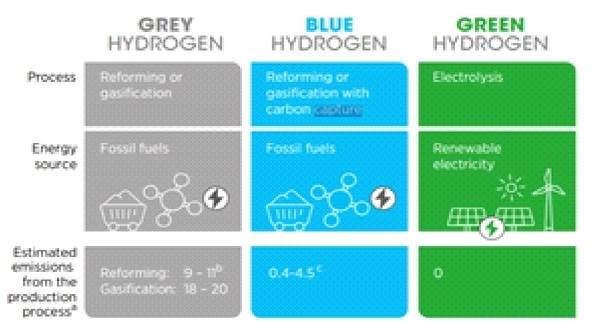
freshwater for Hydrogen production and other industrial applications. Desalination of groundwater as well as Brackish Groundwater (BGW) can be considered a viable alternative to secure water supply for Hydrogen production. Hydrogen producers may also consider establishing their ownbrackish groundwater desalination plants modeled along the lines of seawater desalination plants.Sewage system water and industrial waste effluents that get discharged to water bodies and pollute them, can be treated and used for Hydrogen production. There is then a definite need to locate Oxygen based treatment plants in the same location as the Hydrogen production facility areas, in order to improve the commercial viability of this type of projects.It is the rainwater that runs off the paved and non-paved surfaces in urban and sub-urban areas, unutilized. Its abundance, with due regard to treatment of pollutants can make this water an effective water source for Hydrogen production.

Optimizing Water Use for long term Sustainable production of green hydrogen

Energy is used in two forms (electrons and molecules) and it is now critical that both electricity and fuel are produced in an environmentally sustainable manner. If all existing fossil fuel use were switched to green hydrogen, the water requirement for electrolysis would amount to 1.8% of current global water consumption. This new demand would be counterbalanced by water

Figure 2.2 Selected colour-code typology of hydrogen production



Note: a) CO_{2-eq}/kg = carbon dioxide equivalent per kilogramme; b) For grey hydrogen, 2 kg CO_{2-eq}/kg assumed for methane leakage from the steam methane reforming process. c) Emissions for blue hydrogen assume a range of 98% and 68% carbon capture rate and 0.2% and 1.5% of methane leakage.

savings achieved by not having to produce fuels from petroleum or biomass and by reducing the use of conventional thermal power plant. Furthermore, when green hydrogen is oxidized by combustion equipment and fuel cells, the same amount of water that was originally consumed by electrolysis is released back into the environment. Therefore, in general, a massive deployment of electrolysis will have a relatively neutral impact on the global water resource.

The right choice of technologies (water treatment, cooling systems, water disposal), including assessment of hybrid solutions, will often vary on a project-by-project basis but all will be required to be addressed ultimately for projects to be successful. We can therefore expect that as the green hydrogen industry comes to fruition as part of our energy transition, water for hydrogen is and will become an increasingly important part of the water industry across the world.

The water required by electrolysers can be sourced from accessible fresh water, seawater and wastewater. In each case it must be purified and deionized prior to electrolysis. In dry regions, islands and offshore locations, electrolysers will rely mainly on the seawater resource and this must first be desalinated (either at scale or by integration within the electrolyser system). Accordingly, there are distinct opportunities for deploying electrolysers, ranging from decentralized hydrogen hubs at wastewater treatment plants to gigawatt-scale hydrogen production at offshore wind/solar farms.

Several additional benefits are obtainable for the water industry, including improving the provision of drinking water in developing countries and oxygenating hypoxic zones in lakes, rivers and coastal regions. Therefore, it is recommended that electrolysis should play a more central role in future policies concerning energy and water: achieving a multi-terawatt electrolyser capacity by mid-century would yield massive positive benefits.

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