



Green Hydrogen - Substitute to Fossil Fuel

This editorial is based on "[Hydrogen Mission needs solid implementation](#)" which was published in The Hindu Business Line. It discusses Green Hydrogen and how green hydrogen can substitute fossil fuels.

For Prelims: Green Hydrogen, Green Ammonia, Renewable Energy.

Mains: National Green hydrogen Mission and Related Challenges.

Under the highly ambitious [National Green Hydrogen Mission](#), India intends to be "**the Global Hub for the Production, Use, and Export of Green Hydrogen**" and "**to assume technology and market leadership.**" The mission's goal is to **generate 5 million tonnes of green hydrogen for domestic use.**

Green hydrogen is a **clean energy source produced through the electrolysis of water using renewable energy sources such as wind, solar, and hydro power.** It has the potential to become a key player in the transition to a **carbon-free economy** and can help mitigate climate change. The hydrogen produced can be stored and used as a fuel for transportation, industry, and agriculture.

What are the Reasons to Develop Green Hydrogen?

- **Reducing Greenhouse Gas Emissions:**
 - The primary reason for developing green hydrogen is to **reduce greenhouse gas emissions and mitigate climate change.** The use of **fossil fuels for transportation and electricity generation is a major contributor to global emissions.**
 - Green hydrogen, produced from renewable sources, emits zero greenhouse gases, making it a sustainable and environmentally friendly energy source.
- **Energy Security and Independence:**
 - **Fossil fuels are a finite resource,** and their **prices can fluctuate** due to global supply and demand. By developing renewable energy sources like green hydrogen, **countries can become more energy-independent and less vulnerable to price shocks** and supply disruptions.
- **Creating New Industries and Jobs:**
 - The development of green hydrogen can create new industries and jobs, particularly in the renewable energy sector. The production, storage, and distribution of green hydrogen require specialized expertise and infrastructure, which can generate employment opportunities.
 - According to the [International Renewable Energy Agency \(IRENA\)](#), the **renewable energy sector employed 11 million people worldwide in 2018** and is expected to create more than 42 million jobs by 2050.
- **Decarbonizing in Sectors which are Difficult-to-Decarbonize:**

- The potential to substitute fossil fuels with green hydrogen is significant, especially in sectors that are difficult to decarbonize, such as heavy industry and aviation. These sectors contribute significantly to global emissions, and the use of green hydrogen can help reduce their **carbon footprint**.
- **Technological Advancements:**
 - The development of green hydrogen can drive technological advancements and innovations in various sectors. The production, storage, and distribution of green hydrogen require new technologies and infrastructure, which can spur the development of new materials, processes, and systems.

What are the Applications of Green Hydrogen?

- **Agriculture Sector:**
 - **Green Hydrogen as Replacement to Fossil Fuel in Agriculture:**
 - Green hydrogen has the potential to replace traditional fertilizers in agriculture through the **production of ammonia using renewable energy sources**.
 - **Ammonia is a key ingredient in the production of fertilizers**, and the current production process relies on natural gas, which is a fossil fuel and contributes to greenhouse gas emissions.
 - **Green ammonia** produced with help of green hydrogen is carbon-free, green ammonia has other benefits over traditional fertilizers, including improved efficiency and reduced soil acidity.
 - However, the production of green ammonia at scale will require significant investment in infrastructure and the development of new technologies. Currently, the production of green ammonia is more expensive than traditional ammonia production, which may limit its adoption in the short term.
 - **Green Hydrogen-Powered Farm Machinery:**
 - Farm machinery like tractors, harvesters, and irrigation systems require a lot of energy to operate. **Green hydrogen-powered farm machinery can significantly reduce greenhouse gas emissions** while still delivering the power required to carry out essential farm tasks.
 - **Green Hydrogen for Water Management:**
 - Water is a precious resource, and managing it efficiently is critical for sustainable agriculture. Green hydrogen can be used to power desalination plants that convert saltwater into freshwater, reducing our reliance on scarce freshwater resources.
- **Transport Sector:**
 - **Hydrogen Fuel Cell:**
 - A hydrogen fuel cell is a device that converts the **chemical energy of hydrogen and oxygen into electricity, water and heat**.
 - **Hydrogen fuel cell vehicles produce zero emissions**, making them an attractive **alternative to gasoline and diesel-powered vehicles**. They have a longer range than battery electric vehicles and can be refuelled in minutes, making them more convenient for long-distance travel.
- **Industrial Sector:**
 - **Cost Savings:**
 - The production of green hydrogen can be done using excess renewable energy that is produced during off-peak hours. This excess energy can be used to produce **green hydrogen, which can then be stored and used when the energy demand is high**. This can help to **reduce the cost of energy and promote sustainable development**.
 - **Reliable:**
 - Green hydrogen can be **produced and stored on-site, making it a reliable and consistent source of energy for industrial processes**. This can help to reduce the dependence on the electricity grid and promote energy independence.
 - **Reduction in Waste:**
 - Green hydrogen production can be done using waste materials like **municipal solid waste and agricultural waste**. This can help to **reduce waste and promote sustainable development**.

- **Increase in Energy Efficiency:**
 - Green hydrogen can be used to power fuel cells, which are more energy-efficient than traditional combustion engines. This can help to reduce energy consumption.

What are the Difficulties in Green Hydrogen Implementation?

- **Cost:**
 - The cost of green hydrogen is **currently high compared to traditional fossil fuels**. The production, storage, and distribution of green hydrogen require specialized equipment and infrastructure, making it more expensive than conventional fuels.
 - However, with **advancements in technology and scaling up of production, the cost of green hydrogen is expected to decrease over time**.
- **Infrastructure:**
 - The widespread adoption of green hydrogen requires the **development of a robust infrastructure for its production, storage, and distribution**.
 - The infrastructure must be developed in a way that is **compatible with existing energy infrastructure to facilitate the transition to green hydrogen**.
- **Energy Storage:**
 - Green hydrogen production is dependent on renewable energy sources like wind, solar, and hydro power. However, these sources are intermittent, **meaning that their output can fluctuate over time**. The **development of effective energy storage solutions** is critical to enable the widespread adoption of green hydrogen.
 - Energy storage solutions like **batteries and hydrogen storage can store excess energy produced by renewable sources and provide a constant supply of green hydrogen**.
- **Safety:**
 - Green hydrogen is a **highly flammable gas that requires special handling and storage**.
 - The development of proper safety protocols and regulations is crucial to ensure the safe handling and storage of green hydrogen.
- **Public Acceptance:**
 - The public acceptance of green hydrogen is crucial to its adoption. **The public must be educated about the benefits of green hydrogen and its role in mitigating climate change**.

What are India's Initiatives to Promote Green Hydrogen?

- India has recognized the potential of green hydrogen to decarbonize its economy and achieve its climate goals. The country has launched several initiatives and policies to promote the production, utilization and export of green hydrogen.
- **Some of the key initiatives are:**
 - **National Hydrogen Mission:**
 - The mission was announced in the Union Budget 2021-22 and aims to make India a global hub for green hydrogen and its derivatives.
 - The mission will also facilitate demand creation, pilot projects, R&D, skill development, standards and regulations, and policy framework for green hydrogen.
 - **Green Hydrogen Consumption Obligations:**
 - The **Ministry of New and Renewable Energy (MNRE)** has proposed to introduce **green hydrogen consumption obligations** for fertilizer and the petroleum refining industry, like the renewable purchase obligations for electricity distribution companies.
 - The obligations will require these industries to consume a certain percentage of green hydrogen in their total hydrogen consumption.
 - **Green Hydrogen Hubs:**
 - The **MNRE** has identified regions that can support large scale production and/or utilization of green hydrogen and develop them as green hydrogen hubs.

What Should be the Way Forward?

▪ **High Cost of Production and Utilization:**

- Green hydrogen is currently more expensive than conventional hydrogen produced from fossil fuels or other low-carbon sources, **such as nuclear or blue hydrogen**. So, to address this issue, there is a need to develop efficient technologies that can reduce the production cost of green hydrogen.
 - One promising approach is to use **more efficient electrolysis systems that require less energy to produce the same amount of hydrogen**. This can be achieved using advanced materials for the electrodes or the use of more efficient catalysts.
 - Another approach is to **integrate green hydrogen production with other renewable energy technologies such as wind or solar farms**. This can **reduce the cost of electricity used in the electrolysis process**, making green hydrogen more competitive with conventional hydrogen.

▪ **Implement Regulatory Incentives:**

- The government can play a key role in promoting the adoption of green hydrogen by implementing **regulatory incentives, such as tax credits and subsidies**, to encourage the production and use of this technology.

▪ **Lack of Adequate Infrastructure and Supply Chain:**

- Green hydrogen requires dedicated infrastructure and supply chain for its production, storage, transport and distribution.
 - The existing infrastructure and supply chain for conventional hydrogen are not sufficient or compatible for green hydrogen, efficient and cost-effective supply chain must be developed.

▪ **Coordination Among Various Stakeholders and Sectors:**

- Green hydrogen involves multiple stakeholders and sectors across the value chain, such as renewable energy producers, electrolyser manufacturers, hydrogen producers, transporters, distributors and end-users.
 - There is a need for coordination among these stakeholders and sectors to ensure alignment of policies, standards, regulations, incentives and markets for green hydrogen.

▪ **Awareness and Capacity Building among Potential Users and Producers:**

- Green hydrogen is still a developing technology that requires awareness and capacity building among potential users and producers.
- There is a need to demonstrate the benefits, safety and feasibility of green hydrogen in various applications and sectors.
- There is also a need to develop skills and competencies for green hydrogen production and utilization.

Drishti Mains Question

Green Hydrogen is emerging as a promising source of clean energy. Analyze the potential of Green Hydrogen to mitigate climate change and its prospects in India.