Sustainable Energy Showdown: Green Hydrogen in Comparative Focus

written by King Stubb & Kasiva | November 22, 2023

India is currently facing a significant challenge in the field of energy security, as its current reliance on imported oil and gas makes it difficult to achieve energy security. To address this challenge, India needs to transition to more sustainable and self-sufficient energy sources. Over the past decade, India has made significant progress in developing its solar and wind power sectors. This transformation not only resulted in an excess of power generation, but it also represented considerable progress towards meeting the goals set by the Paris Agreement.

Solar and wind energy, particularly, have played an important role in leading India towards cleaner energy sources. Nonetheless, it is critical to acknowledge the limitations that these sources have in meeting the country’s wide and diverse energy needs. Electricity is only a small part of our total

energy consumption, but we need to take more comprehensive measures to reduce greenhouse gas emissions. In the global quest to achieve net-zero emissions, hydrogen has emerged as a viable competitor.

Green hydrogen, an innovative substance produced through the electrolysis of water utilizing renewable electricity, is one prominent fuel. This holds great potential to decarbonize complex industrial sectors by properly using the capabilities of the available renewable resources. Since the 1970s, India has recognized the relevance of green hydrogen and has made strides in adopting hydrogen technology programs. Nonetheless, India has significant challenges in its efforts to develop a resilient hydrogen economy. However, recent government efforts, such as allocating funds and introducing a national hydrogen energy mission[1], reveal a considerable commitment to fostering the long-term growth of green hydrogen.

This article aims to undertake a comparative analysis of green hydrogen with other alternative renewable energy sources in the following manner:

- Understanding Green Hydrogen and its Application
- Introducing Other Renewable Energy Sources
- Comparative Analysis
- Conclusion and the Road Ahead

Understanding Green Hydrogen and its Applications

Green hydrogen is created by electrolysis, a method that separates water into oxygen and hydrogen without producing greenhouse gases. Hydrogen produced from sustainable sources such as solar or wind energy is turned into green hydrogen.

- Green hydrogen is an environmentally friendly energy source that emits no carbon dioxide. In India, practical implementation includes decarbonization of vital sectors such as transportation, industry, and electricity generation.
- Green hydrogen, in addition to its environmental benefits, successfully mitigates the difficulty of intermittent energy supply associated with renewable sources, providing dependable and consistent power provision that is critical for energy storage.
- It has the potential to replace traditional hydrogen derived from fossil fuels, also known as grey or brown hydrogen, in industrial applications, effectively lowering carbon emissions.
- Green hydrogen provides sustainable options for road, air, and maritime transportation, helping to minimize the transportation sector’s carbon footprint.
- Green hydrogen’s decarbonization capabilities in sectors such as steel, cement, and coal demonstrate its adaptability and position it as a critical contributor to India’s efforts towards a more sustainable and ecologically friendly future.

Introducing Other Renewable Energy Sources

As the world seeks a more sustainable future, a variety of renewable energy sources are leading the charge to produce environmentally friendly energy.

- Using photovoltaic cells to harness **solar energy** yields higher efficiency than newer technologies, making it a cost-effective alternative despite the initial investment necessary for installation.
- **Wind energy** is well-known for its cost-effectiveness because it converts kinetic energy into electrical power while accounting for land use and potential environmental implications.
- Despite their high efficiency, **hydroelectric** facilities require considerable initial investments, which have a negative impact on adjacent ecosystems.
- While responsibly generated **biomass energy** is relatively inexpensive, its combustion emits greenhouse gases.
- Despite its high initial costs, **geothermal energy** has long-term economic appeal due to its low carbon footprint.
- Because of its low environmental effect, early commercial development of **tidal and wave energy** is promising.

Every source has its own set of advantages and factors to consider, emphasizing the need to pursue a diverse strategy and encouraging continued innovation to move towards more sustainable energy sources around the world.

Comparative Analysis

Factor	Green Hydrogen	Solar Energy	Wind Energy	Hydroelectric Energy	Biomass Energy	Geothermal Energy	Tidal and Wave Energy
Efficiency	Over 60%[2]	15-22% (PV cells), up to 30% with tandem solar cells[3]	Up to 40%[4]	85-90%[5]	20-80%, depending on the technology[6]	Upto 21%, depending on locations[7]	20-40%[8]
Cost	High initial production cost, but low operating costs	High initial installation cost, but low operating costs	Cost-effective, especially in regions with consistent wind	High initial construction cost, but low operating costs	Relatively cheap, but depends on the availability of organic materials	High initial cost, but low operating costs in the long run	High cost, as the technology is still in the early stages of commercial development
Environmental Impact	Clean and sustainable fuel, produces no greenhouse gas emissions when burned	Low emissions and land-use impacts, but the production of solar panels involves some environmental pollution	Low emissions and land-use impacts, but wind farms can impact local wildlife	Can alter river flows and impact local ecosystems	Produces greenhouse gas emissions during combustion	Low emissions and land-use impacts, but can cause subsurface land degradation and water pollution if not managed properly	Generally low environmental impact, but local ecosystem disturbances can occur
Other Considerations	Can be stored and transported	Can be stored and transported	Can be stored and transported	Requires a large amount of land and water	Can be produced from a variety of organic materials, but needs to be sourced responsibly	Requires specialized infrastructure to produce, store, and transport	Requires specialized infrastructure to produce, store, and transport

Conclusion

The comparative analysis highlights green hydrogen as a potential player in the global effort to switch to sustainable energy. Green hydrogen's transport and storage capabilities, with an impressive efficiency of over 60%, establish it as a multifunctional and ecologically benign fuel, which is especially important in the quest to decarbonize complex industrial sectors. It is distinguished by the fact that it is a sustainable fuel that does not generate emissions during combustion, thus presenting a viable answer to the overall challenge of reducing carbon footprint.

The energy sector will require strategic integration of various renewable sources in the future, taking into account the respective strengths and factors to be considered. Green hydrogen can be used together with solar, wind, and hydroelectric power to provide a reliable and sustainable energy supply. Continuous collaboration, research, and innovation are required to fully realize its capabilities. To achieve environmental sustainability in the future, informed decisions, enabling policies, and a collective commitment to exploiting the revolutionary potential of green energy alternatives are required.

FAQs

What is green hydrogen’s efficiency percentage and how does it compare to other sources?

Green hydrogen has an approximate efficiency of over 60%, which positions it competitively alongside other sources such as solar, wind, hydroelectric, etc.

What is the cost comparison of green hydrogen with other sources?

Green hydrogen has high initial production costs but has the potential for cost competitiveness, which aligns it with the initial installation challenges faced by solar and wind energy.

How is green hydrogen different from other sources in terms of environmental impact?

Green hydrogen is a clean and sustainable fuel that does not emit greenhouse gases during combustion. This sets it apart from most other renewable sources that involve some sort of emissions or environmental pollution.

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[1] https://www.india.gov.in/spotlight/national-green-hydrogen-mission.

[2] https://www.csis.org/analysis/hydrogen-key-decarbonizing-global-shipping-industry.

[3]

https://www.theguardian.com/environment/2023/jul/06/revolutionary-solar-power-cell-innovations-break-key-energy-threshold.

[4] https://www.epa.gov/sites/default/files/2019-08/documents/wind_turbines_fact_sheet_p100il8k.pdf.

[5] https://www.usbr.gov/power/who/hydropwr.html.

[6] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA-ETSAP_Tech_Brief_E05_Biomass-for-Heat-and-Power.pdf.

[7] https://www.geothermal-energy.org/pdf/IGAstandard/NZGW/2012/46654final00097.pdf.

[8] https://www.sciencedirect.com/science/article/abs/pii/S0360544222028195?via%3Dihub.

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