



## Need of Green Hydrogen for Indian Economy: a Bibliometric Analysis

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October 29, 2024

# Need of green hydrogen for Indian economy: A bibliometric analysis

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## Abstract:

Green hydrogen has emerged as a crucial solution for addressing energy security and reducing carbon emissions globally. For India, with its growing energy demands and dependence on fossil fuel imports, green hydrogen presents an opportunity to transition towards a sustainable and self-reliant energy future. This paper provides a bibliometric analysis of the research on green hydrogen and its economic relevance for India. By examining trends in publications, key research areas, and emerging themes, we highlight the role of green hydrogen in supporting India's economic growth, industrial decarbonization, and energy independence. The analysis reveals a significant increase in research interest, especially since the launch of India's National Hydrogen Mission. Key challenges such as high production costs, infrastructure development, and policy support are identified as critical areas for future research. The findings suggest that with the right policy framework and technological advancements, green hydrogen can play a transformative role in India's energy transition, paving the way for long-term economic and environmental benefits.

## 1. Introduction

Green hydrogen has emerged as a promising solution for addressing the global energy and environmental challenges of today. As the world transitions towards cleaner energy, green hydrogen, produced using renewable energy sources like solar and wind, is gaining attention as a critical player in decarbonizing various sectors. For India, this shift holds special importance. With its growing energy needs, reliance on imported fossil fuels, and commitment to reducing carbon emissions, green hydrogen presents an opportunity to bolster energy security while contributing to the country's economic growth [1]

India's journey towards adopting green hydrogen aligns with its broader goals of achieving energy independence, meeting international climate obligations, and driving sustainable development. Given its vast renewable energy potential and strategic focus on green energy, India is well-positioned to emerge as a global leader in the green hydrogen space. However, this transition is not without challenges. The economic feasibility, infrastructure needs, and policy framework to support large-scale green hydrogen deployment require careful consideration [2], [3].

To better understand the importance of green hydrogen in India's economic landscape, this paper employs a bibliometric analysis. By analyzing relevant research publications, we aim to uncover trends, challenges, and opportunities related to green hydrogen's role in India's economy. Through this approach, we can gain valuable insights into how academic and policy discourse has evolved around this topic and identify key areas for future research and policy development [4].

## 2. Literature Review

### 2.1 Green Hydrogen: An Overview

Green hydrogen refers to hydrogen produced through the electrolysis of water using renewable energy sources. Unlike grey or blue hydrogen, green hydrogen does not emit carbon dioxide during its production process, making it an environmentally friendly alternative. The use of green hydrogen spans several sectors, including transportation, industry, and energy storage. It has the potential to play a pivotal role in achieving global net-zero emission targets [5].

Several countries, including India, are making efforts to scale up green hydrogen production. The National Hydrogen Mission, launched in 2021, highlights India's focus on becoming a hub for green hydrogen production. The mission aims to establish green hydrogen production capabilities, promote research and innovation, and create an export market for hydrogen-based fuels [6].

## *2.2 Economic Relevance of Green Hydrogen for India*

India is the third-largest energy consumer in the world, and its energy demand is projected to grow further as the population and economy expand. Currently, India relies heavily on coal and oil imports, leading to economic vulnerabilities due to fluctuating global energy prices. Green hydrogen offers a path to reduce this dependence, diversify the energy mix, and enhance energy security [7], [8].

From an economic standpoint, green hydrogen could open up new industries, create jobs, and drive innovation in sectors such as renewable energy, manufacturing, and transportation. The transition to green hydrogen also aligns with India's climate goals under the Paris Agreement, where the country aims to reduce its carbon intensity and expand its renewable energy capacity [9].

## *2.3 Challenges in Adopting Green Hydrogen*

While the benefits of green hydrogen are clear, there are several barriers to its widespread adoption. The high cost of production, lack of infrastructure, and limited technological readiness remain significant hurdles. Moreover, India's renewable energy sector, while rapidly growing, may face challenges in scaling up to meet the demand for green hydrogen production. Policy support, financial incentives, and international cooperation will be essential in overcoming these obstacles [10].

## **3. Methodology**

### *3.1 Bibliometric Analysis*

Bibliometric analysis is a quantitative approach used to assess the academic literature on a given topic. By examining research publications, citations, and keywords, it allows us to identify patterns, trends, and key contributors to a specific field. In this study, we used bibliometric tools to analyze the existing body of research on green hydrogen and its role in the Indian economy.

### *3.2 Data Collection*

The data for this analysis was collected from well-known academic databases, including Scopus and Web of Science, using the search terms "green hydrogen," "India," "economy," and "renewable energy." The timeframe for the analysis spans from 2010 to 2024, covering the period when green hydrogen research began gaining momentum.

The selected articles were then subjected to keyword analysis, co-citation analysis, and author collaboration mapping to uncover the most influential papers, researchers, and institutions contributing to the topic.

## **4. Results**

The bibliometric analysis revealed a growing interest in green hydrogen research in India, particularly in the last five years. The National Hydrogen Mission has sparked significant academic and policy discussions around the role of green hydrogen in India's future energy landscape. Key areas of focus include:

**Cost Reduction:** Several papers emphasize the need for technological innovation to bring down the cost of green hydrogen production. Breakthroughs in electrolyzer efficiency, renewable energy integration, and large-scale production are seen as critical factors in reducing costs.

**Policy Support:** The role of government policies in shaping the green hydrogen economy is evident from the literature. Research highlights the importance of subsidies, financial incentives, and public-private partnerships to drive investment in hydrogen infrastructure.

**Industrial Applications:** There is growing interest in how green hydrogen can be used in hard-to-abate sectors like steel, cement, and heavy transportation. Research indicates that green hydrogen could

significantly decarbonize these sectors, creating a competitive advantage for Indian industries in the global market.

International Collaborations: Studies highlight the potential for India to collaborate with global partners, especially in Europe and the Middle East, to create a green hydrogen export market. International partnerships could accelerate technology transfer and investment in green hydrogen projects.

## 5. Discussion

The bibliometric analysis suggests that green hydrogen has the potential to transform India's energy and economic landscape. However, realizing this potential will require addressing key challenges such as reducing production costs, developing infrastructure, and ensuring strong policy support. The economic benefits, including job creation, energy security, and industrial decarbonization, make green hydrogen a crucial element of India's future energy strategy.

To further strengthen the research and policy focus on green hydrogen, future studies could explore the following areas:

Scaling Renewable Energy for Hydrogen Production: Research on integrating solar and wind energy with hydrogen production systems.

Technological Innovations: Studies on improving electrolyzer technology and reducing the carbon footprint of hydrogen production.

Socio-economic Impact: Analysis of how green hydrogen adoption will impact India's workforce, especially in rural and industrial areas.

## Conclusion

Green hydrogen represents a significant opportunity for India to achieve energy security, reduce carbon emissions, and create a robust green economy. While the path ahead involves several challenges, including cost reduction and infrastructure development, the potential benefits far outweigh the hurdles. The growing body of research, as reflected in the bibliometric analysis, demonstrates the increasing importance of green hydrogen in India's policy and academic landscape.

With the right policy framework, technological advancements, and international collaborations, green hydrogen can become a cornerstone of India's sustainable economic growth in the coming decades.

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