

Role of Green Hydrogen for Sustainable Future in Basic Science: A review

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ABSTRACT

Hydrogen is the most abundant gas in the universe and is classified by the World Energy Organization as the cleanest fuel in the world compared to other energy products. Therefore, the hope hangs upon it in achieving the zero fuel emissions strategy, which adopted by the largest countries in the world. Also, it is believed that by 2050, hydrogen consumption will represent 24 % of the global energy sector, with investments estimated at 2.5 trillion dollars, compared to only 139 billion dollars at present. There are three types of hydrogen (gray, blue and green) classified based on their production methods and carbon content. Gray hydrogen is usually produced by burning natural gas at high temperatures and once the carbon is removed or captured, the gray hydrogen turns into blue hydrogen. As for green hydrogen with zero emissions, it is produced through the electrolysis of water or by using renewable energy sources such as solar cell, wind energy, etc. to avoid any emissions during the production stages. Despite the efficiency of green hydrogen compared to other types, its price remains a major obstacle in the promotion and marketing, which is estimated at 3.5 Euro/kg, compared to 1.5 Euro/kg for blue hydrogen. In addition to some other obstacles related to infrastructure and raw materials used in the production stages. Recently, and in order to remove all these obstacles, the leading countries in the energy sector pumped more investments to study all these obstacles and assess the current hydrogen market, which in turn leads to the acceleration of the up scaling of hydrogen production. In this context, this research was developed to study all these current and future challenges.

Keywords: hydrogen, sustainable energy, zero fuel emissions, renewable energy.

I. INTRODUCTION

Hydrogen is a clean alternative to methane, also known as natural gas. It's the most abundant chemical element, estimated to contribute 75% of the mass of the universe. Here on earth, vast numbers of hydrogen atoms are contained in water, plants, and animals, of course, humans. But while its present in nearly all molecules in living things, it's very scarce as a gas – less than one part per million by volume. Hydrogen can be produced from a variety of resources, such as natural gas, nuclear power, biogas and renewable power like solar and wind. The challenge is harnessing hydrogen as a gas on a large scale to fuel our homes and businesses.

1. Hydrogen important as a future clean energy source

A fuel is a chemical that can be 'burnt' to provide useful energy. Burning normally means that chemical bonds between the elements in the fuel are broken and the elements chemically combine with oxygen (often from the air). For many years, we've used natural gas to heat our homes and businesses, and for power stations to generate electricity. In the UK, 85% of homes and 40% of the country's electricity currently relies on gas; in the US, 47% of households rely on natural gas and 36% on electricity. Methane is the main constituent of 'natural gas' from oil and gas fields. We've continued to use natural gas because it's a readily available resource, it's cost effective and it's a cleaner alternative to coal – the dirtiest fossil fuel that we historically relied on for heating and to generate electricity. When natural gas is burnt, it provides heat energy. But a waste product alongside water is carbon dioxide, which when released into the atmosphere contributes to climate change. Burning hydrogen does not release carbon dioxide. India's deep commitment to aspirational

Climate Goals has been widely acknowledged in the comity of nations. Our achievements have matched our ambition. India has the fastest growing Renewable Energy capacity in the world. India has also emerged as one of the most attractive destinations for investments in Renewable.

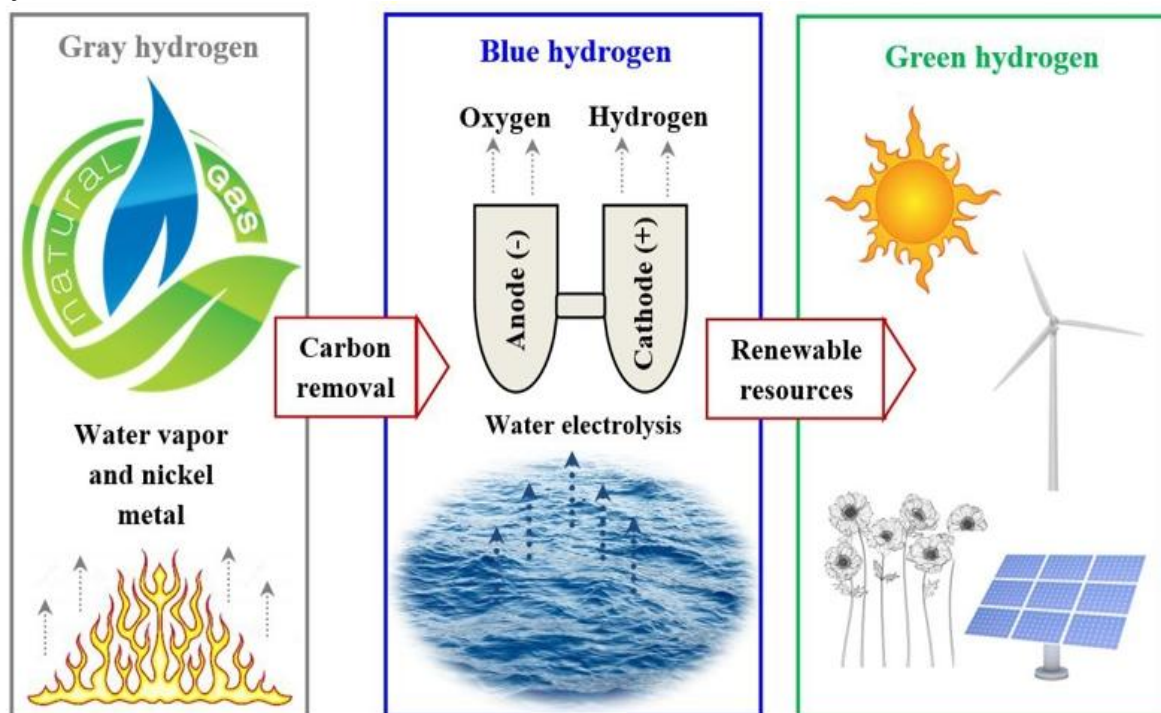
2. National Green Hydrogen Mission

India has set its sight on becoming energy independent by 2047 and achieving Net Zero by 2070. To achieve this target, increasing renewable energy use across all economic spheres is central to India's Energy Transition. Green Hydrogen is considered a promising alternative for enabling this transition. Hydrogen can be utilized for long-duration storage of renewable energy, replacement of fossil fuels in industry, clean transportation, and potentially also for decentralized power generation, aviation, and marine transport. The National Green Hydrogen Mission was approved by the Union Cabinet on 4 January 2022, with the intended objectives of:

- Making India a leading producer and supplier of Green Hydrogen in the world
- Creation of export opportunities for Green Hydrogen and its derivatives
- Reduction in dependence on imported fossil fuels and feedstock
- Development of indigenous manufacturing capabilities
- Attracting investment and business opportunities for the industry
- Creating opportunities for employment and economic development.

TYPES OF HYDROGEN BASED ON EXTRACTION METHODS

Depending on the nature of the method of its extraction, hydrogen is categorised into three categories, namely, Grey, Blue and Green. But my review report on green hydrogen, Green Hydrogen: It is produced using electrolysis of water with electricity generated by renewable energy.



Highlights

- Production technologies of gray, blue and green hydrogen were presented.
- The challenges of up scaling of hydrogen production were presented.

- The current global demand of hydrogen and its prices was discussed.

3. Hydrogen production

Hydrogen is produced through several methods and the most used method is by burning natural gas in the presence of water vapour and nickel metal, and here the output is either gray or blue hydrogen. Blue if the carbon dioxide produced

by this process is blocked (Fig. 1). The other way is through renewable energy (such as electrolysis of water, solar, wind energy, etc.), which produces green hydrogen. Some advances techniques like fermentation.

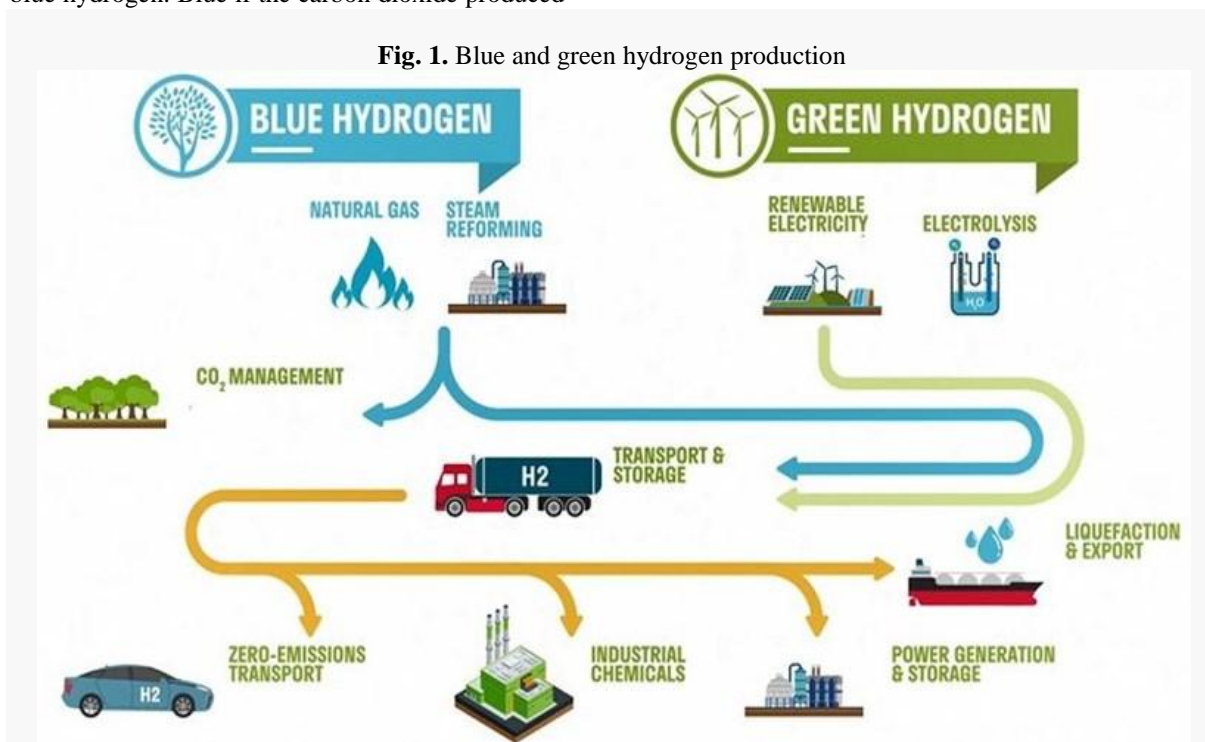


Fig. 1. Blue and green hydrogen production

4. Hydrogen transportation and utilization

Hydrogen is an excellent fuel for long-distance transportation from so-called fuel cells, which makes it a future choice for trucks, ships and airplanes. Hydrogen is easy to transport by converting it into alumina, and its transport speed in this way is three times that of natural gas. The benefits of hydrogen are not only environmental, but also economic, as hydrogen has wide uses, the most important of which is oil refining and chemical industries, such as the production of fertilizers, or in industries that require high temperatures, such as steel and glass, which are industries in which electricity cannot be used. It can also be used as fuel for power plants or even as a source of heat for heating.

5. Global demand

Hydrogen use is expected to reduce emissions by about 30 % by 2050. Also, this is in line with the strategy of reducing carbon emissions to zero and shifting to a circular and green economy, which is supported by most countries of

the world. At present, the global demand for hydrogen represents 4 % of the global demand for energy, with expectations of an increase in demand to 24 % of global demand by 2050. Currently, there are 85 countries that require hydrogen, which suggests that there is a large market for hydrogen. And projections indicate that the hydrogen market is valued at \$ 136 billion, with expectations that it will reach \$ 2.5 trillion in 2050. Some estimate much higher than that.

6. Research and development

Recently, many of the leading countries in the energy production sector around the world have allocated large budgets in the hydrogen sector in order to study obstacles in the development and follow-up opportunities. For example, the European Union has launched a hydrogen strategy, with investments amounting to 400 billion euro's, until 2030. In addition to Germany's approval of the National Hydrogen Strategy, with investments amounting to 9 billion euro's. Australia has also set up a \$ 300 million fund to finance hydrogen

projects. In the Arab region, Saudi Arabia signed an agreement to establish the largest hydrogen plant in the world, in addition to establishing a hydrogen transmission line between it and Japan. The UAE also directed ADNOC to explore and pursue opportunities in the hydrogen sector, so it launched the first green hydrogen project in the world of its kind in the region. Recently, China planned to produce hydrogen at 12 government-owned companies.

7. Hydrogen unit pricing

It is expected that there will be several types of hydrogen based on the color. Hydrogen has been priced based on several calculations across the production room. The conventional cost of hydrogen has been estimated at 1.5 euro/kg, while green is estimated at 3.5 euro/kg. This excludes the cost of transportation and storage. Currently, there are no markets for hydrogen trading, but with the lower cost price, the prices are expected to drop. This will provide more transparency to help the market develop. Currently, we are in a stage witnessing many projects through which it is possible to know whether it was possible to raise the efficiency of hydrogen production, as there are many projects between Saudi Arabia and Japan to find out the cost of transportation. Also, global markets are currently resorting to hydrogen very quickly compared to the example of natural gas, which took nearly a decade to produce it, but hydrogen markets may witness much faster growth due to the energy and marketing of decarbonisation and the role of hydrogen in the energy future.

8. The economic viability of hydrogen production

Hydrogen is a long-term future investment opportunity because the cost of its production is currently somewhat high. But we must remember that the same thing happened with us when the renewable energy star exploded twenty years ago, and at that time the production of solar energy or wind energy was a very costly affair. At the time, most of the hydrogen production facilities are small and there are efforts in some countries to increase their size, but the volume of investments in hydrogen must be visited to make it more sustainable and economically. We are talking here about blue and green hydrogen, which does not cause harmful emissions. At the beginning of renewable energy, there was support from governments. The same support had to be found

with hydrogen. Also, in important issues, a carbon cost has to be found, and the hydrogen investment may be difficult to grow. There are some regions that enjoy benefiting from the hydrogen revolution, for example, if you have low-cost gas, such as the Middle East and America, and then blue hydrogen can be produced at a competitive cost. But we must remember that extracting hydrogen requires bad energy from fossil fuels or renewable energy, and therefore there is a cost for this energy, and this matter makes hydrogen more expensive than other types of energy, which needs support from governments.

9. The expectations of hydrogen production

The Middle East is in a position to allow it from the hydrogen market due to its infrastructure and quantities of natural gas, and according to international energy data, the Middle East, next to China, is one of the most productive areas in China. China will likely go to green hydrogen and America to blue, as green needs growth in renewable energy production, and blue needs gas and infrastructure in the Middle East.

II. CONCLUSION

In this work, Hydrogen holds potential for India and its goals of decarbonisation and the challenges of a hydrogen fuel production and promotion were discussed. It could play a vital role in supporting renewable energy and also help to decarbonise hard-to-abate sectors. The government and the industry have already taken their first steps toward building a hydrogen economy. The most pressing need is to sustain the momentum through coordinated action going into the future. There is a need to create synergies on the supply side, with greater focus on investment and commitments by the government and the industry, as well as demand side support through guaranteed markets and subsidy schemes promoting the adoption of hydrogen. The study concluded that hydrogen production began to grow very quickly as a result of the largest investments that were pumped by the major countries. Also, burning technology is often used. The increase in green hydrogen prices, many countries have begun to encourage investors and researchers to find new solutions and methods of production. Hydrogen has also become a market in more than 85 countries around the world. So it can be considered that hydrogen is the next bright star in the clean energy train.

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