Green Hydrogen for a Green Planet – Opportunities and Challenges

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Dr Rupesh Goel & Dr Sumesh Nair, Australian Institute of Business

Introduction

The fourth Industrial revolution presents unprecedented opportunities for disruptive innovations of technologies in all walks of life. Though most of these technological breakthroughs are related to digital technologies ranging from artificial intelligence to quantum computing, there are excellent prospects for the planet earth as the world is committed to zero-emission standards by 2050. One such sustainability opportunity is in the form of green hydrogen. Hydrogen, especially green hydrogen, is widely considered a significant alternative renewable energy source, hence a critical path to zero-emission targets.

Why green hydrogen?

Hydrogen is a colourless and odourless gas. However, colours are used to indicate the type of hydrogen generation method and disposal of its associated emissions. For instance, black, brown, and grey hydrogen production result in greenhouse gas (GHG) emissions, and hence are not candidates for sustainable goals, whereas blue hydrogen production involves the use of natural gases. Therefore, GHG emissions are less of a concern for blue hydrogen. However, green hydrogen, produced from renewable energy, is ideal for a sustainable future. Green hydrogen is made through a decarbonised process of electrochemical water electrolysis – splitting water into the hydrogen and oxygen atoms. Electricity is required for the electrolytic reaction to succeed in this energy-intensive method. However, renewable energy sources such as wind, solar, hydro and geothermal can be used to generate electricity for this process.

Green hydrogen – opportunities and challenges

Green hydrogen is touted as a panacea to save us from many ills emanating from fossil fuels and to propel the fourth industrial revolution. However, the requirement of water and renewable energy sources for green hydrogen presents interesting opportunities and challenges. Firstly, even though the freshwater requirement is not huge, it may not be sufficiently available everywhere to generate green hydrogen economically. The use of seawater instead of freshwater as fuel for electrolysis provides great hope, although cost and chlorine chemistry may be an issue, which is partially offset by a new method from Sun and his associates. The location of the hydrogen production plant near the sea is a blessing in disguise, with some of the renewable energy sources for powering the green hydrogen reaction being generally available in coastal areas (e.g., wind power).

In many countries like Australia, the availability of purified water on the mainland is an issue and poses a challenge, hence the preference of coastal locations of the plants. The alternate sources, recycled wastewater and stormwater, can also be harnessed for the desalinated water transported through pipes. Besides being expensive, desalination is an energy-intensive process. The above discussion suggests that the water choices are rather limited outside the coastal areas and areas with tailwater. Therefore, water availability and renewable energy sources might pose challenges for producing green hydrogen.

Solar and wind power are available in the deserts, which are expected to vanquish the water availability challenges. The solar PV battery banks powered from such arid areas can be utilised as the renewable energy reserve to power the essential grid-support services. These can be used in isolation for powering the electrolytic reaction towards the green hydrogen production efforts. Geothermal, nuclear, and hydroelectric are the other renewable energy sources to consider. While geothermal is not rife, hydroelectric and nuclear power command a 26% share in global electricity production and together contribute only 11% to the global energy supply. The small modular nuclear reactors (SMR) offer an exciting opportunity to produce renewable energy almost anywhere. However, it must be said that investing in nuclear reactors attracts enormous resistance from many quarters for fear of safety and misuse.

Generally, the factor that significantly affects the uptake of green hydrogen is the cost of production, storage, and transportation. Specifically, the high outlays stem from the cost of electricity and water, electrolyser investments and other operational expenses. As indicated above, the electrolyser cost component is high; however, advanced technology allows replacing electrolyser with solar power. The projected cost of producing green hydrogen across different estimates sits around $2 per Kg by 2030 compared to $1.80 for blue hydrogen. However, investing in green hydrogen is critical in achieving the Sustainable Development Goals (SDGs) of the United Nations (Goal seven). Subsequently, wide adoption and standardisation of green hydrogen production would bring the cost down even further, achieving the UN SDG seven that will "ensure access to affordable, reliable, sustainable and modern energy for all."

Green hydrogen can revolutionise GHG reductions through its extensive uses in industry, transport, heating, and power generation. The energy-intensive heavy industry (including the steel industry), chemical industry (including cement and concrete production) and the refineries (including the zinc refineries) can be taken off the fossil-fuelled grid to a considerable extent. Transportation could be another industry that could gain from green hydrogen. However, the industry seems to be still in favour of electric-powered vehicles.

To illustrate, the compact-sized hydrogen fuel cell electric vehicles (FCEV) seem to have lost out to the plugin hybrid electric vehicles (PHEV) and the battery electric vehicles (BEV) due to extremely efficient lithium-ion batteries. Even the FCEV is primarily an electric car powered by hydrogen fuel cells. However, the fact remains that the hydrogen fuelling times are substantially lower than electric charging. The prospect of using green hydrogen is better for trucks, trains, ferries, coaches, bigger cars and even for the short-haul aircrafts. The use of green hydrogen for residential heating offers attractive decarbonising opportunities. However, considering the current technology, the power generation from green hydrogen is still not an economically viable option as the round trip of power to gas to power efficiency is found to be just 45%.

Conclusion

The experts anticipate that hydrogen meeting a significant part of global energy demand is critical in limiting GHG emissions levels to net-zero. The 24% global energy demand required can be achieved with the expected sectoral contributions of 30% each for power sector and industry, 25% from the transport sector and the balance from buildings. However, cynics dismiss green hydrogen as a serious prospect, reasoning that it would only be a viable option for places where wind and solar power supply are insufficient. As a matter of fact, the prices of solar and wind energy have been dropping significantly while fossil fuel-generated power prices are continuously rising. Lower renewable energy prices can drive down the input costs for green hydrogen, resulting in increased adoption of green hydrogen. This in so many ways will be major contributor to a greener planet.

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Dr. Kavita Goel

Discipline Leader, Australian Institute of Business

Dr Kavita Goel is the Discipline Leader in Finance at the Australian Institute of Business. She is a passionate academic with extensive teaching experience across three continents – Australia, Asia and Africa. She is a qualified Cost and Management Accountant with Doctorate (PhD) in the Finance area.

Dr. Sumesh Nair

Senior Lecturer, Australian Institute of Business

Dr Sumesh Nair is a Senior Lecturer in Marketing at the Australian Institute of Business. Dr Nair has been working in Australian higher education institutions in the last 14 years. He previously worked at Monash University and Murdoch University before joining the Australian Institute of Business.