

UGC CARE group I Journal



VOL-X ISSUE-V NO. XVIII MAY 2020



ज्ञान-विज्ञान विमुक्तये
UGC

University Grants Commission
Approved Journal



Impact Factor

Significance of Hydrogen for Replacement of Fossil Fuel

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The discussion about utilization of hydrogen as a fuel has taken place since the 1970s but its prohibitive cost was a big stumbling block. By now mankind is well versed with the use of Hydrogen, at present it is in use in a wide variety of sectors like petroleum refineries and fertilizers plants. But, would it become a mainstream energy source like fossil fuel? The focus on renewable energy as a tool to fight the global environment crisis has again brought focus on hydrogen as a fuel. It is a clean fuel and has potential to gain the spot of mainstream energy sources. The fate of hydrogen is tied to other renewable sources because the energy required to generate hydrogen through electrolysis would be derived from wind and solar power.

Renewable energy

Renewable energy will remain the focus of governments in the decades to come because the protection of the environment cannot be compromised. The three following promising technologies as per its economic viability are as follows;

1. Solar and Wind
2. Lithium ion batteries
3. Hydrogen

Solar and wind are successfully competing against conventional energy sources and are now cheaper to install at many places than conventional energy sources. For example, in India, the cost of generation of renewable energy is falling continuously and it has reached the parity level with conventional energy. In the recent round of auction in India, ReNew power quoted Rs 2.9/kWh for a 400 MW project. It was a first ever round the clock (RTC) bid. The company can set up a hybrid energy farm with solar and wind. It can also set up any form of energy storage. The tariff is allowed to be increased annually for a 15 years period and price would reach upto Rs 3.6/kWh. This is close to the average annual thermal power tariff of Rs3.38/kWh generated by National Thermal Power Station (NTPC). As a result the share of renewable energy in India's overall power generation mix increased to 36.2 percent at the end of first quarter of 2020.¹

Lithium ion batteries have changed the perception of conventional energy. It has become extremely competitive with the conventional in sectors like automobile and energy storage due to drastic drop in the prices in the last decade. The electric vehicles are getting popular and in few countries like Norway, they have already overtaken in sales over the conventional cars. In the

sector of energy generation they have become potential threats to thermal and natural gas based power generation. In the energy sector, lithium ion batteries in many projects have become a choice of peaker devices scoring over natural gas based energy generators. They have also become a booster for solar and wind as a grid level energy storage device. With the prices of lithium ion batteries to fall further and its efficiency likely to increase with new battery chemistry, it is likely to revolutionize the energy sector.

Hydrogen is on the similar cusp of solar and wind energy which is competitive at certain places and sectors but is awaiting a technological push to gain a place in mainstream energy streams. It is expected that Hydrogen will make a much higher impact around 2035 as it would get the desired technological edge. It is predicted that there would be about 500,000 Fuel Cell Electric Vehicle (FCEV) by 2032. The Internal Combustion Engine (ICE) cars would be reduced to 50 percent of global market share by 2030 and about 10 percent by 2050.² It is at this point renewable energy infrastructure would develop and be able to facilitate a holistic Hydrogen economy. The Hydrogen economy will largely rise on excess renewable energy from wind farms, solar and hydro which will produce hydrogen. It is also expected that significant technological advancement will take place in the hydrogen generation and fuel cell technology.

The Promise

The biggest advantage is its abundant and universal availability. Once, the global energy is shifted to Hydrogen, there will be no geopolitical tension over energy as is observed in today's times of fossil fuel. Hydrogen is uniformly spread across the globe. This will be boon for countries like India which is highly dependent on import of hydrocarbons. Today India imports over two third of its energy needs across the globe. India is also highly dependent on hydrocarbons from the Middle East as a result any geopolitical tension in the region leaves a deep scar on the Indian economy. India suffered its worst oil shock in 1991 during the Gulf war. The impact of shock was very strong and India brought a complete reform in its economy to tide over the shock. The economy suffered another shock in 2008 when the international crude oil prices reached its peak price of \$148 per barrel leaving high inflationary pressure.

The other big advantage is that it has high calorific value, as a result it can replace hydrocarbons easily and it does not emit greenhouse gases. It is expected that hydrogen as fuel can reduce global greenhouse gas emission by 34 percent by 2050. Shipping industry is one of the sectors where hydrogen as a fuel can be applied. This industry significantly contributes towards global pollution as there are around 50,000 ships going around the globes which contribute around 900 million metric tons of CO₂. It is also estimated that the world's 15 largest container ships cause more pollution than all the cars on the earth put together.³ Shipping industry can adapt hydrogen easily because it can be generated on the high seas with wind turbines. Hydrogen, on these high seas farms can be stored and large floating storage facilities where ships can refill hydrogen on its voyages. Ships, thus, will not compete with any land based

resources. It will also save a lot of space on the land which is at present utilized for energy production and its storage for ships.

In the automobile segment, it offers facilities to replicate hydrocarbon models of fast refueling. Hydrogen can be filled in tanks like other usable products like petrol, diesel or natural gas. It scores over battery driven electric vehicles which need hours of charging. Even the fast charging takes much longer than filling up other forms of fuels. Though battery electric vehicles have appeared to be ever dominating now, they will be replaced by hydrogen fuel cells subsequently. There are some big built in negatives in battery electric vehicles which fuel cells will remove from electric vehicles. It will also reduce the need for a vast battery production. It will save the globe from side effects of large amounts of batteries dumped after its life cycle is over.

Today the cost of hydrogen appears to be higher for small transportation vehicles like two and three wheelers, cars and small transportation vehicles. However, the cost of production is continuously falling. The technology improvisation in electrolyses has already brought hydrogen generation by 40 percent in the last five years. With such a competitive price it will be cheaper to run on vehicles on hydrogen by 2030 in comparison to diesel. Hydrogen could further be competitively produced within the range of \$7.4/MMBtu by 2050.⁴

The Projects

Now countries like the Netherlands, Portugal and Australia have started investment in hydrogen technology. In other European Union countries, investors and politicians are pushing the country toward hydrogen. Commercial projects are set up like a steel mill utilizing hydrogen as a fuel in its production in Sweden. In Germany, a train running on hydrogen fuel cell completed its 180,000 kilometers of operations and has successfully completed 530 days of operations. Alstom was awarded a project of Cardio iLint units for hydrogen fuel cell trains in November 2017 by the German transport authority. The train has a roof mounted hydrogen tank with a range of around 1000 km with a speed of 140 km/h. These Cradio iLint hydrogen fuel cell units will start commercial operation in 2022.⁵ A train was also powered by hydrogen in the United States.

The use of hydrogen in a furnace in a steel plant located in Sweden has brought a new perspective in pollution created by the steel production. The steel industry was struggling with energy efficiency and has improved the overall energy efficiency by 60 percent in steel production since the 1960s. Energy is a major cost of steel production with shares as high as 40 percent. Traditional steel makers use coal as an energy source. As per by the World Steel Association (WSA), use of coal causes around 9 percent of global fossil fuel emissions as per the date provided. In Sweden natural gas was used as an environmentally friendly option. The price

of natural gas is falling at a faster pace than coal at the international level and it is scoring over coal because there are lower impurities in the gas and it is emission free.

However, the use of hydrogen in a blast furnace is the next step towards cleaner fuel in Sweden. The use of hydrogen is restricted up to melting of steel scrap and production of base products. Beyond this stage, hydrogen is not utilized and takes over by natural gas in the rolling mills. However, with its limited use hydrogen provides a renewable and environmentally friendly energy source.⁶The use of hydrogen would bring huge benefit both financially and environmentally. In the time to come the lower production cost of hydrogen would make it suitable to be used in niche applications like refineries or fertilizers as a fuel.

As mentioned earlier, hydrogen has a limited role in small passenger and cargo vehicles because of its cost but it is competitive for heavy vehicles like long distance trucks and buses. In the recent past many companies have come forward to produce trucks running on hydrogen as fuel. Nikola Motors of the United States is in the forefront of hydrogen trucks building. The company unveiled its trucks in April 2019 with 1,000 horsepower and 2000 pound feet of torque. This hydrogen truck is expected to cut transportation fleet carbon emission by 18 percent. Along with the hydrogen truck, Nikola Motors also unveiled plans to supply hydrogen fuel to customers with a network of 700 hydrogen fuel stations in the United States.⁷ The traditional truck makers also disclosed their plans to develop trucks running on hydrogen fuel. Daimler and Volvo, the world's two largest heavy trucks makers have announced a joint initiative to develop hydrogen fuelled trucks.

Conclusion

As mentioned elsewhere, hydrogen is on the cusp of renewable energy. Solar and wind were struggling to get into the mainstream during 2000-05 period. The environment and enthusiast lobby was pushing the government toward more and more investments in solar and wind energy resources even if it did not make economic sense immediately. The efforts now seem to be paid off after ten years. Hydrogen too will need similar ten to fifteen years of time lapse before coming into mainstream. It is expected that the cost of hydrogen would come down with the greater use of and more investments in infrastructure. The best use today is found in industrial applications. The potential use of hydrogen in the industrial sector might not completely replace conventional fuel immediately but it could be merge as a suitable alternative. In the transportation sector, hydrogen will slowly find its place. Above all, hydrogen as a mainstream fuel will definitely contribute towards the improvement of the environment.

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