Green Hydrogen : Zero Emission for Mobility

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16th February 2021

Climate Change & Global Warming

- Excessive growth in Fossil Fuels use led to increase of Green House Gases and heat trapping gases in atmosphere e.g. CO2, Methane, Nitrogen Oxide and Halocarbons etc.

- As per IPCC report of 2001, temp. rose by 0.6 degree celsius in 20th Century, 2/3rd of the increase happened in 1975-2000.

- Earth global surface temperature in 2019 was 0.98 degrees Celsius warmer than average of 1951 to 1980.

- With Business as Usual, the temperature rise would be upto 2-3 degrees Celsius.

Climate Change Impacts beyond the Planet
Health to Health of People

- Rise of Sea levels, melting of glaciers, increased frequency of hurricanes, cyclones, floods and droughts.

- Temperature rise will impact crop patterns and nutrition value of food.

- Hotter climate will increase certain infections, diseases like malaria, dengue fever and food borne infections.

Is COVID 19 a fallout of climate change
or a wake up call by nature ?

Meeting Energy Demand Amidst Climate Commitments

India in its **Intended Nationally Determined Contribution** submitted to UNFCCC pledged to curb GHGs by up to 35% from 2005 level by 2030

- **Copenhagen Accord** and its 2°objective had set goal of limiting global warming to a maximum 2° C.
- **Transport** sector has an important role to achieve this target;
  - Global transport sector contributed to ~25% of all anthropogenic CO2 emissions
  - NOX emissions from energy primarily arise in the transport sector accounting for almost 40% of the total, followed by the power sector (31%) and the industrial and transformation sectors (20%)- ***IEA, India 2020 Energy Policy Review***
- Vehicles besides their direct impact on CO2 emissions have impact on air pollutants (including Black carbon) causing health implications.

Shri Dharmendra Pradhan, Hon'ble Minister of PNG and Steel on Energy Transition

- *"India will chart its own course for energy transition in a responsible manner"*
- *"Let us vow to intensify our efforts to adopt a healthier mix of fuel to protect natural eco-sytems for a healthier and greener future".*
- *"India's massive bio-mass potential, expanding natural gas coverage, and push for renewable electricity offers a good opportunity to explore hydrogen for a decarbonized future".*

IEA: Clean Energy Investments to Rebound

Faith Barol, ED, IEA

- COVID-19 will impact 20 per cent investments with implications for energy security and cleaner energy investments.
- Right Govt. Energy Policies critical for quick rebound and to create jobs, boost economy and prepare for much cleaner, resilient and modern energy sector.
- Recovery packages should include investments not in electricity alone but also in Hydrogen, Carbon Capture and Storage.

Global Energy Leaders on Energy Transition Post COVID-19

- **BP boss Mr Looney hails 'resilient' renewable energy as oil price turns negative**

CEO Looney predicts sharper pressure for energy transition post-pandemic as consumers change habits

- **Shell boss Mr** Ben van Beurden says 'hard to say' if demand will return with transition and net-zero key to future investability

- BP, Shell, Total and Eni all reducing Hydrocarbon spending while their Energy Transition plans on Track.

India's Energy leaders on Transition to Clean Energy

Mukesh Ambani, C&MD, Reliance Industries

Mr Mukesh Ambani said recently:

"Instead of treating carbon dioxide (CO2) as liability, one can use it as raw material, by adopting technologies whereby we can complete the energy cycle" "There is a need to provide efficient, clean and affordable energy. And we have to do it in a responsible way. That's the business. We should not confuse that between clean and unclean"

Gautam Adani chairman and founder of the Adani Group

- **Mr Adani sees Covid-19 as opportunity for faster transition to clean energy**

The head of India's biggest infrastructure conglomerate Adani Group said many of the system operators in Europe, faced with falling demand, are learning to manage grids at a remarkably high level of renewables in the energy mix, often up to 70 per cent.

IndianOil Bets big on Hydrogen

S S V Ramakumar,
Director (R&D) IOCL

- *"We are the largest producer of hydrogen and our aim is to build the hydrogen economy and distribution network ".*
- **Indian oil bets on Hydrogen vehicle for self reliant future mobility.**

Hydrogen and fuel cells – Moving towards carbon free future

- Pathways for hydrogen production:

Fossil fuels:

- Coal – Gasification
- Natural Gas & Heavy Crudes:
  - Steam reforming
  - Auto-Thermal
  - Partial Oxidation

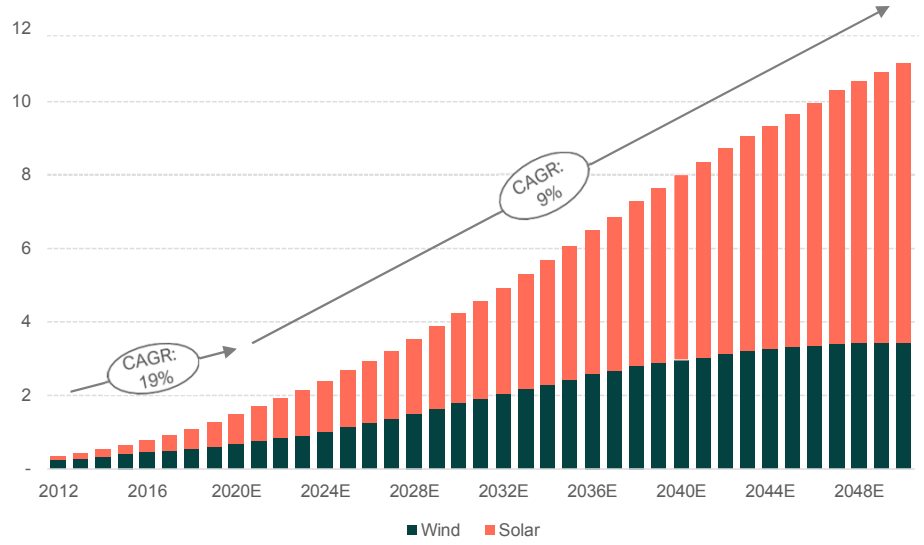
Renewable Source:

- Biomass Sources – Gasification
- Solar, Wind, Hydro, Geothermal – Electrolysis
- Photoelectrochemical Water Splitting

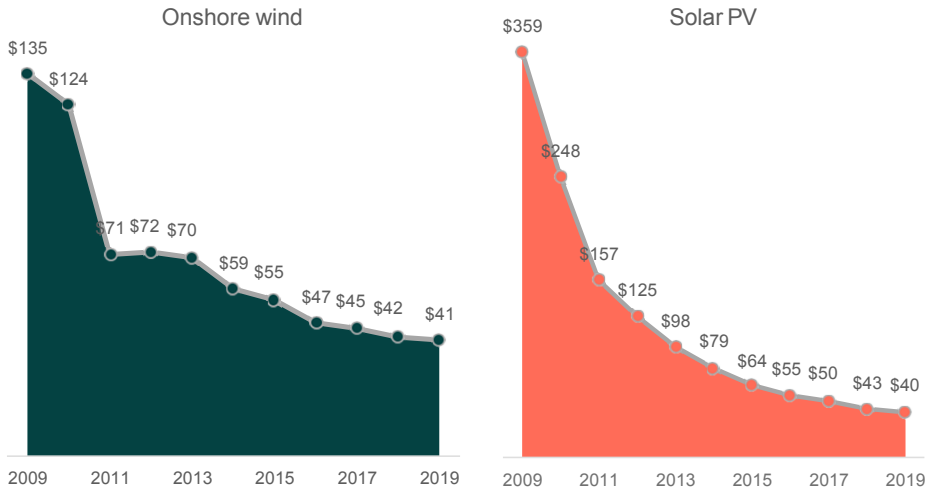
Renewable sources will provide Green Hydrogen but till such time these are fully developed, Brown Hydrogen or Blue Hydrogen (Hydrogen from fossil sources + CCUS) can supplement the hydrogen supply

…on the back of rapid growth in renewables

Growth in renewable power capacity (TW)



Declining cost of renewable power ($/MWh)*



We need hydrogen to utilize the growth in renewables…
…and the drop in renewable power prices has made green hydrogen more economical

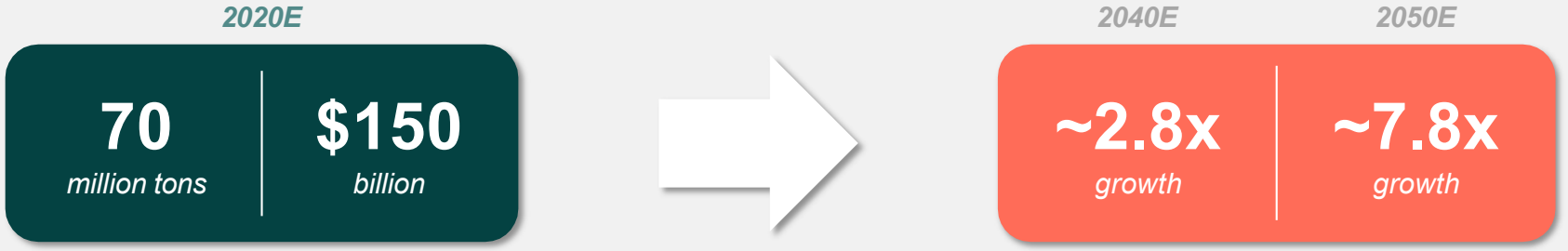
Note(*): Unsubsidized levelized cost of energy

- Source: New Energy Outlook (2019) / Hydrogen Pro

Hydrogen market set to take off…

Hydrogen is already a large established market…

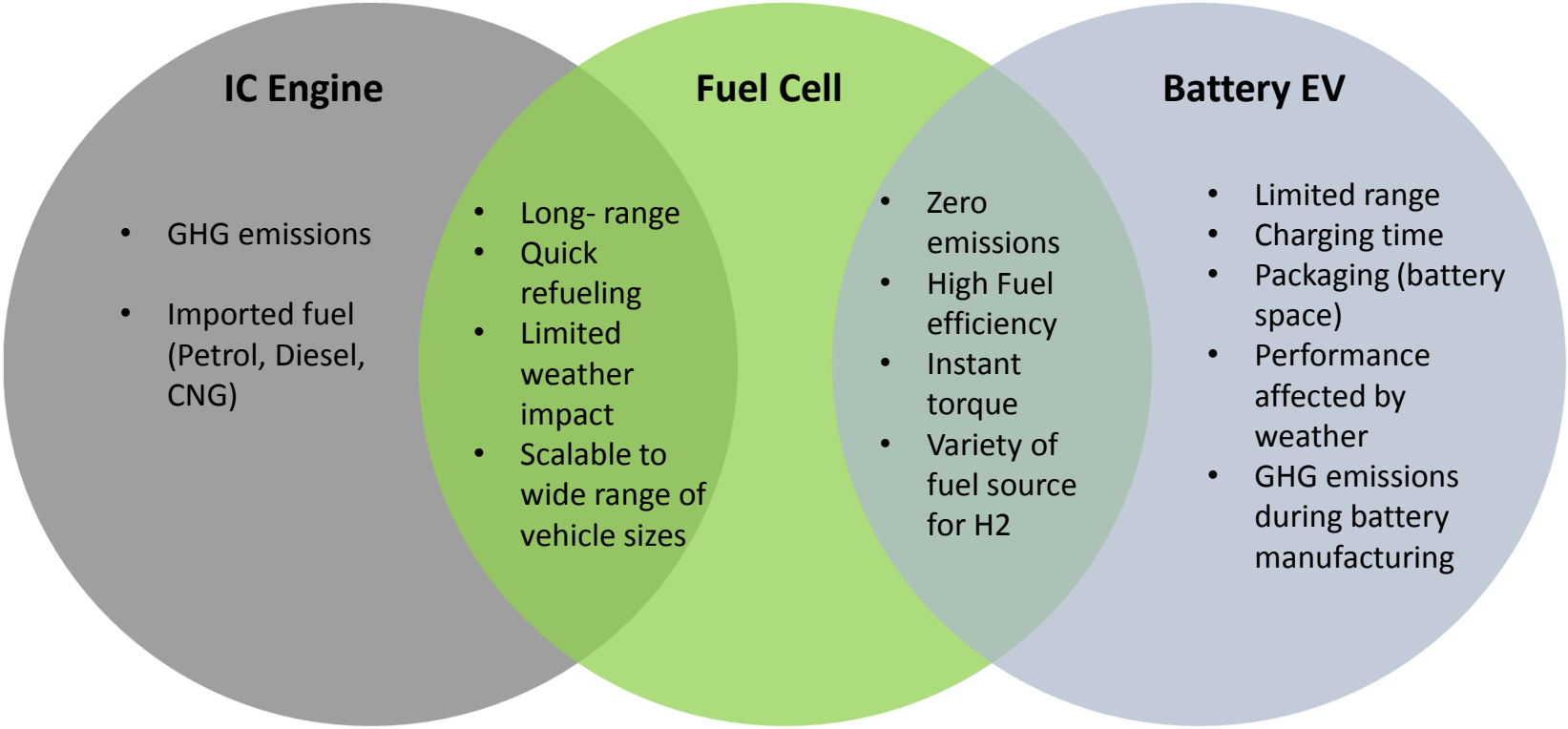
…with huge growth potential going forward



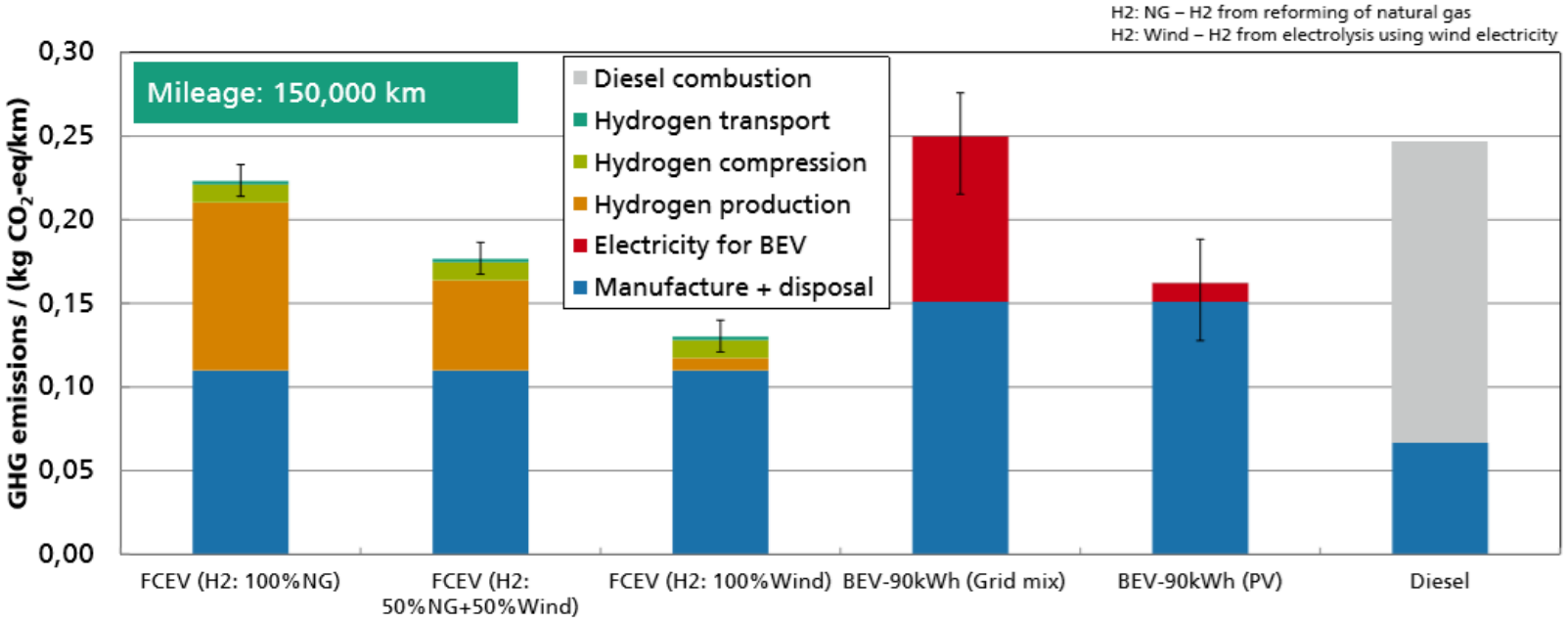
Several market drivers, including renewable energy and addressing key EU development goals

- Source: Hydrogen Council / Hydrogen pro

IC Engine Vs. Fuel Cell Vs. Battery EV



Comparison GHG Emission with Diesel Battery & Fuel Cell Vehicles



Diesel combustion also includes GHG emissions for diesel supply

Glider and drive taken additionally into account, compared to slide 3.

See appendix for data basis

Fraunhofer ISE

Global Scenario: Hydrogen Fuel Cell Vehicles

- Around 12,000 hydrogen fuel cell vehicles have been sold globally since 2013.
  - –50% of these are in California, which is followed by Japan
  - –Toyota accounts for 77% of the FCEV sales

- By 2021, at least 11 automakers including Toyota, Lexus, Hyundai, Kia, Honda, Mercedes-Benz and BMW will have rolled out hydrogen fuel cell vehicles. Other entrants in this space include Tata Motors, Pininfarina S.p.A. (owned by Mahindra & Mahindra), Riversimple and the RONN Motor Group.

Summary

- The key developments contributed in the growth of hydrogen in the recent years are:
  i. Climate Commitment for reduced Green House Gas Emission and cleaner air in the cities.
  ii. The rapid growth and falling costs of renewable energy as well as electrolysers are leading to competitive hydrogen prices.
  iii. Options of fossil fuel-based hydrogen production (grey hydrogen); fossil fuel-based hydrogen production combined with carbon capture, utilisation and storage (CCUS) i.e. Blue Hydrogen need to supplement Green Hydrogen.
  iv. The cost of fuel cell is also coming down at a rapid pace.
  v. Hydrogen fuel cell vehicles offer better options as compared to battery electric vehicles in terms of life cycle emissions, longer range, quick refuelling time etc.

Let us make strides toward a decarbonized economy

THANK YOU