
# Green Hydrogen For Mobility

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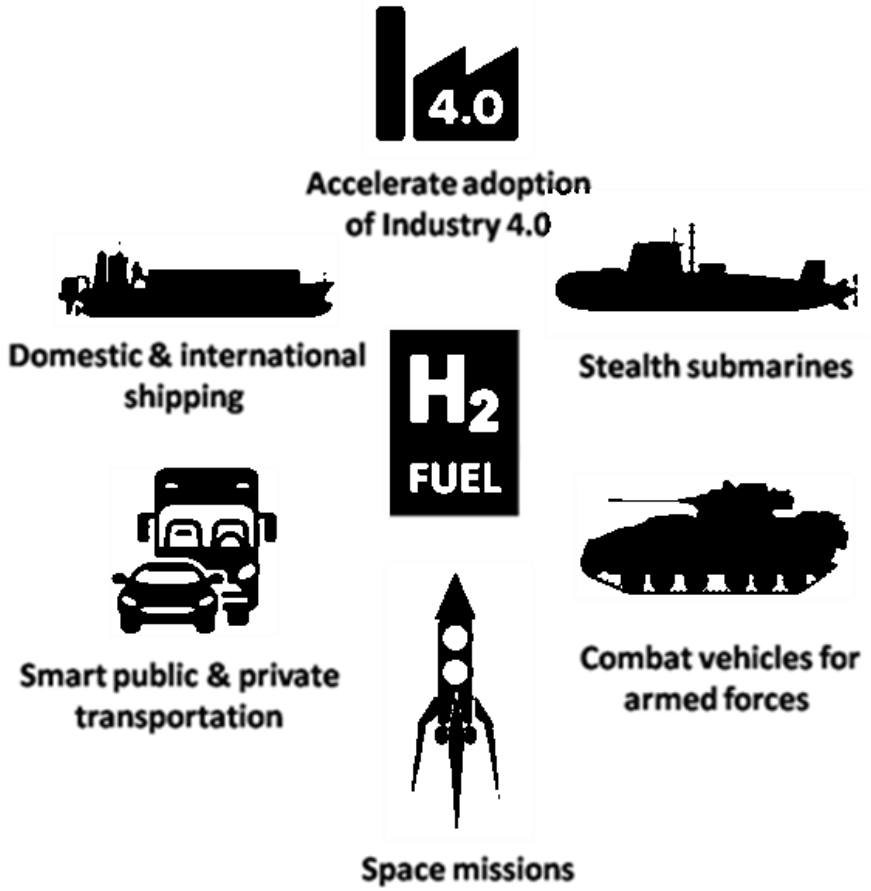
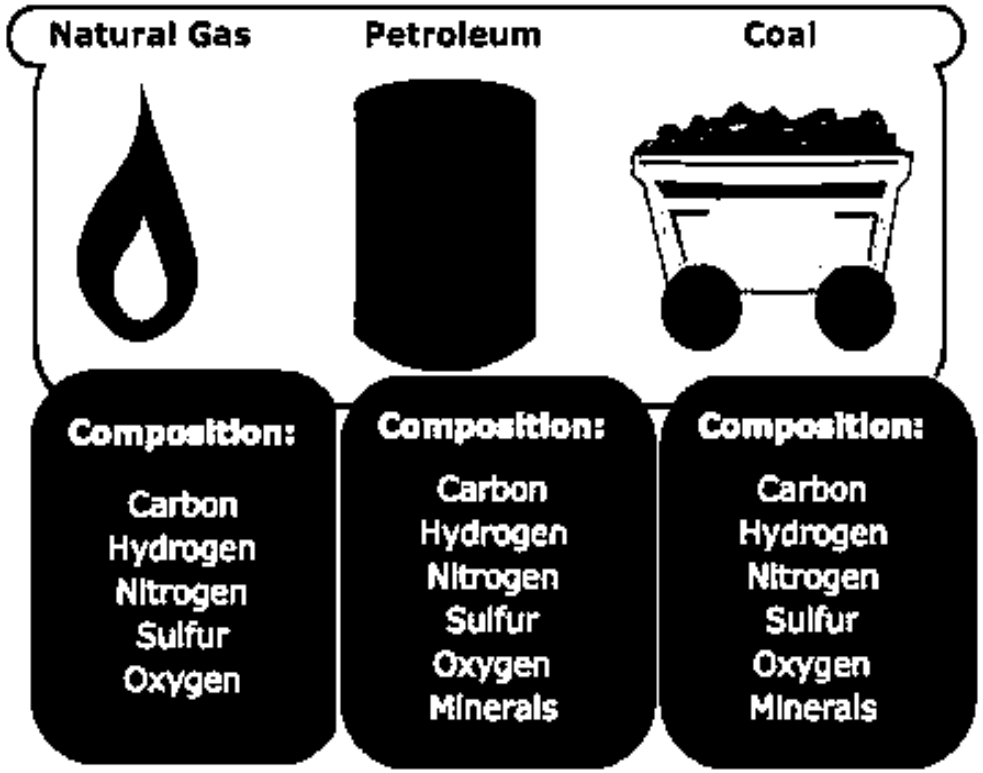
# Relevance of Hydrogen economy

- **For a rapidly developing industrial economy, electricity becomes a growing and important energy carrier. However, electrification of all energy services remains elusive**
- **Some industrial processes and heavy transport need very high energy-density fuels, which cannot be delivered by electricity technologies in the near term**
- **Hydrogen emerges as the solution in the energy transition scenario**



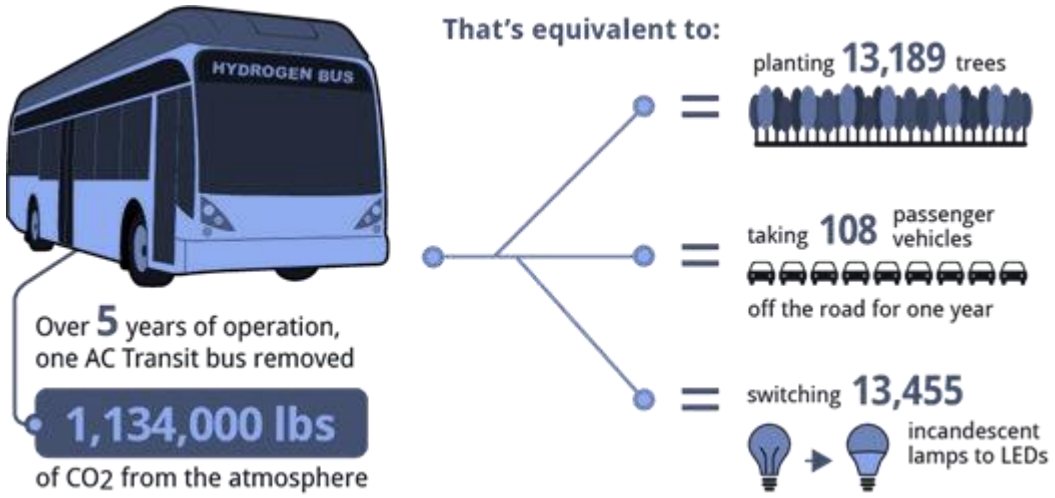
# Hydrogen vs. Conventional Fuels

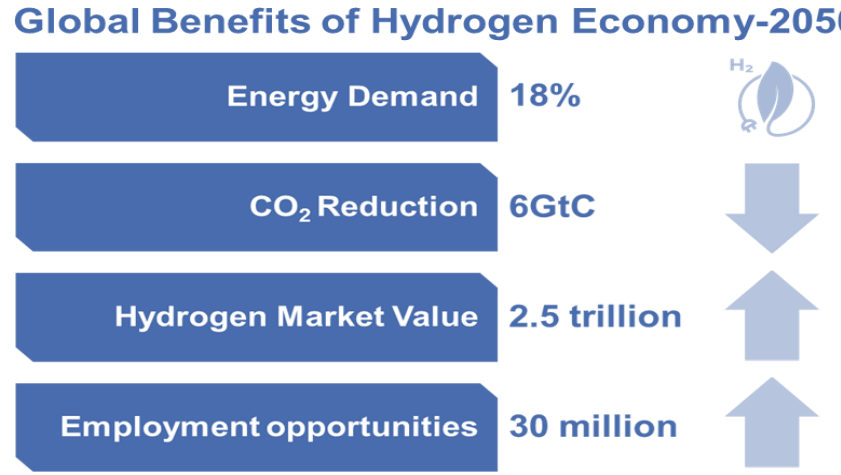
- **Hydrogen produces harmless water as byproduct when burned/oxidized**
- **It can be burned directly in furnaces**
- **An alternative to battery- electric systems for heavy transport when used in a fuel cell EVs**



# Hydrogen Economy

- **Hydrogen Economy refers to the vision of replacing hydrogen as a low-carbon energy source**




## Benefits of Hydrogen Economy

- **Reduced imports**
- **Energy Security**
- **Integration of renewables**
- **Decarbonization of different sectors**
- **Address Climate change issues**

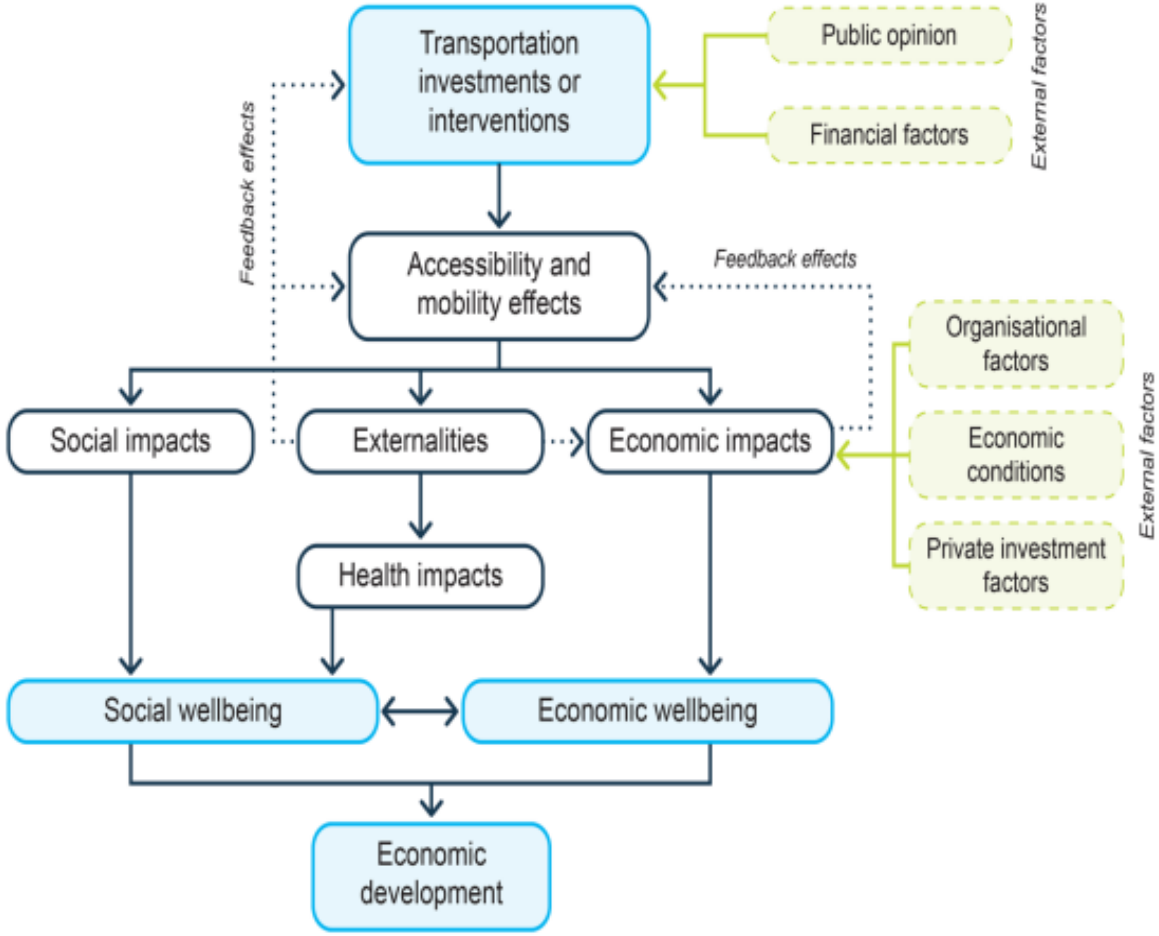
# Green Initiative for Future Transport (GIFT)

- **Hydrogen cost at delivery point at Rs. 60-70 per kg hydrogen bulk storage methods and transport via pipeline to be in place**
- **Hydrogen storage capacity to be 9 wt%, Support infrastructure- large number of dispensing stations**
- **Development of safety regulations, legislations, codes and 1000 MW hydrogen-based power generating capacity setup**
- **1,000,000 hydrogen-fuelled vehicles on road- 50 MW small IC engine standalone generators**
- **Two/three wheelers - 50MW standalone fuel cell power packs**
- **Cars/taxis - 900 MW aggregate capacity centralized plants**

# Transportation

**For the business sector, this involves connections between businesses and their suppliers, between businesses and other businesses, and between businesses and their markets.**

**For the household sector, transport provides people with access to workplaces, schools and shops.**




**Source:** adapted from Leung (2006)

# Pollution in Transportation Sector

**In 2019, according to International Energy Agency (IEA) in World transportation sector contributed 8222 Mt of $CO_2$ which is 24.6 % of total emitted $CO_2$ in World.**

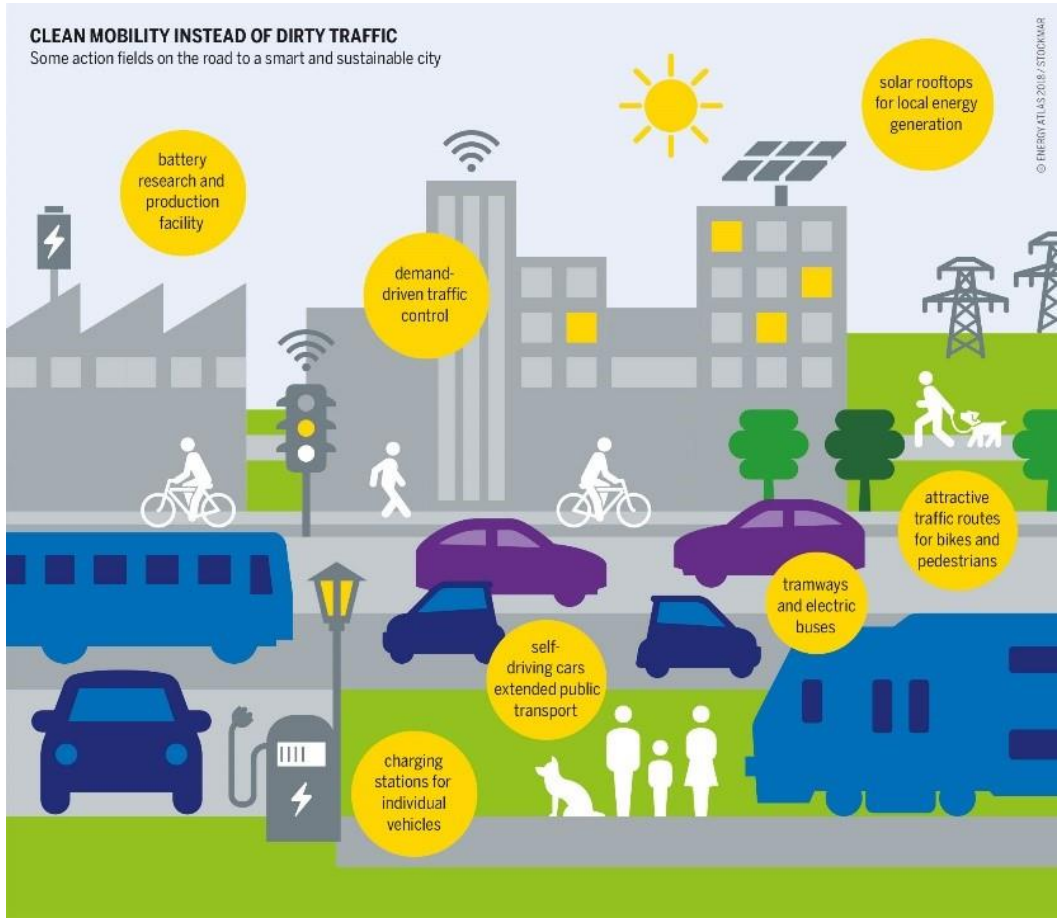
**In 2019, according to International Energy Agency in India transportation sector contributed 308 Mt of $CO_2$ which is 13.3% of total emitted $CO_2$ in India.**

**India is the third largest emitter of $CO_2$ followed by China and USA.**

**Transportation sector is the 2$^{nd}$ Largest in the World and 3$^{rd}$ largest emitter of $CO_2$ in India.**

**The transportation sector can be able to reduce 1/10 of the pollution if the sector can be NetZero.**

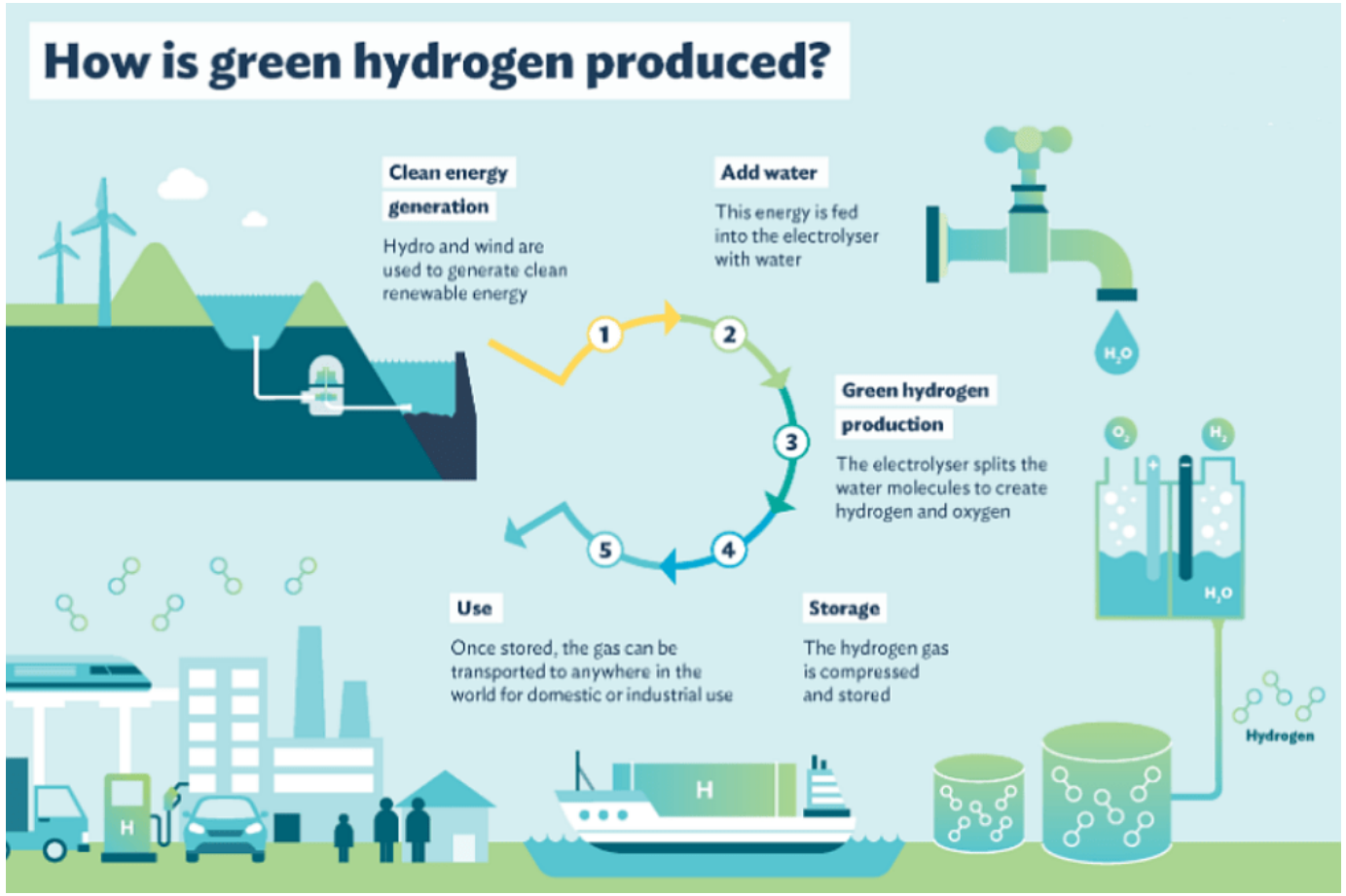
# Transportation Sector in India



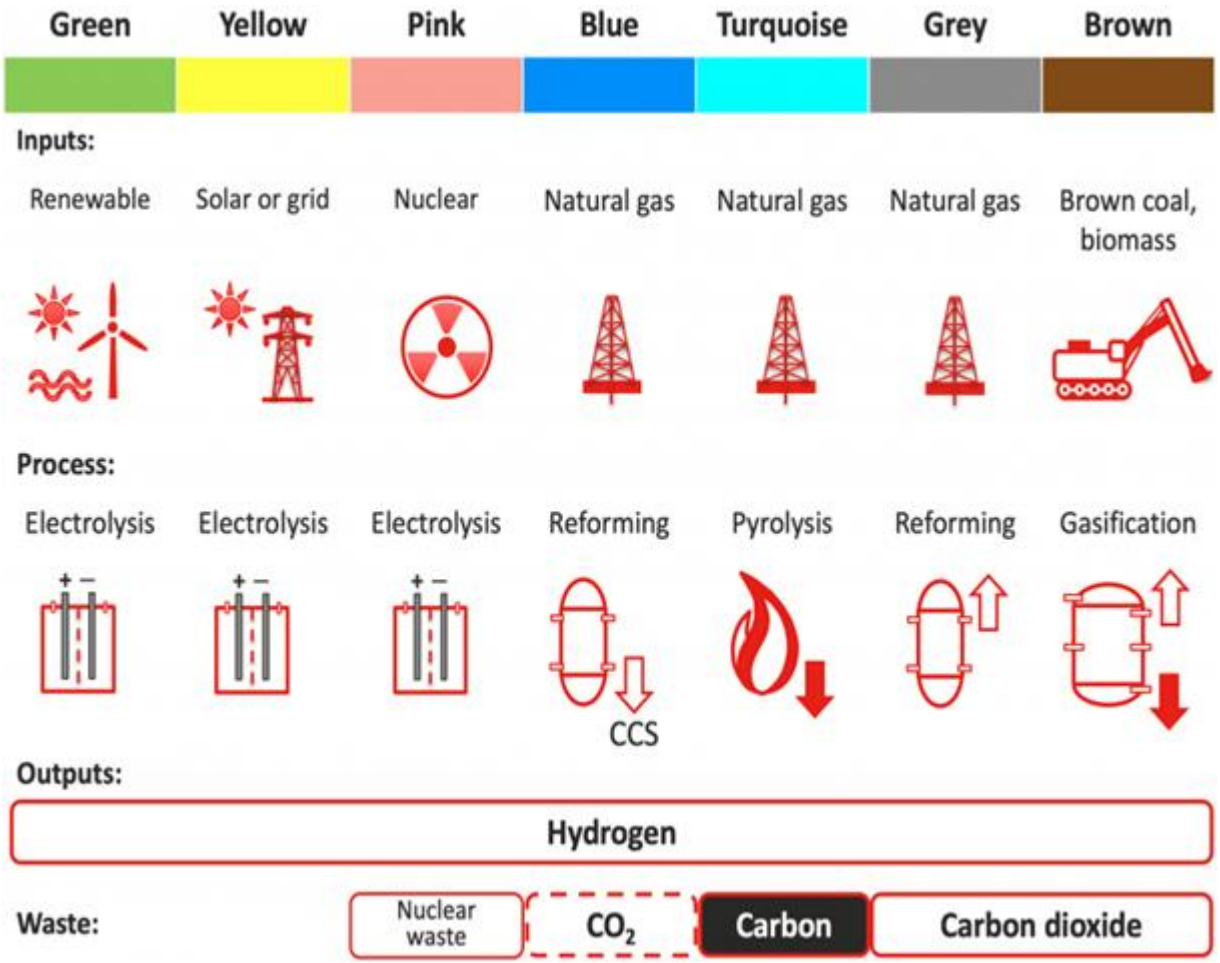

- **Transportation sector plays an important role in shaping the economics of the country.**
- **Major Mode Transportation of goods in India Includes the**
  - **I. Railways: Indian Railways major share of revenue comes from transportation of goods all over the country,**
  - **II. Road: Can reach every corner of the country using trucks,**
  - **III. Air and Water transportation is used for the exporting of the goods to different countries depends on the speed and distance.**

# Hydrogen Generation

- **Hydrogen can be generated using various methods but producing it without any carbon dioxide emissions is capital intensive.**
- **Currently green hydrogen is in the demand as the government of India has released its plan for the NetZero emission plan through hydrogen.**
- **Currently Steam Methane Reforming is the cheapest and commercially proven technology to produce hydrogen in a bulk and cheapest way.**



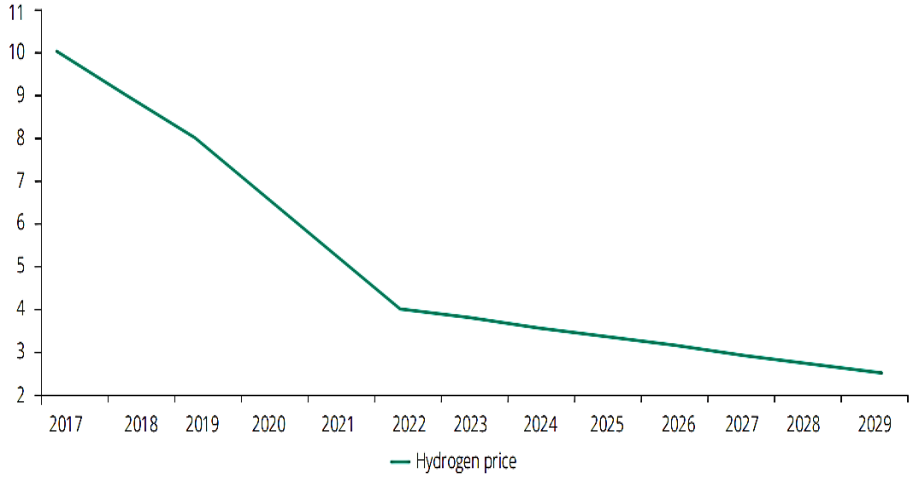
# Hydrogen Color Spectrum

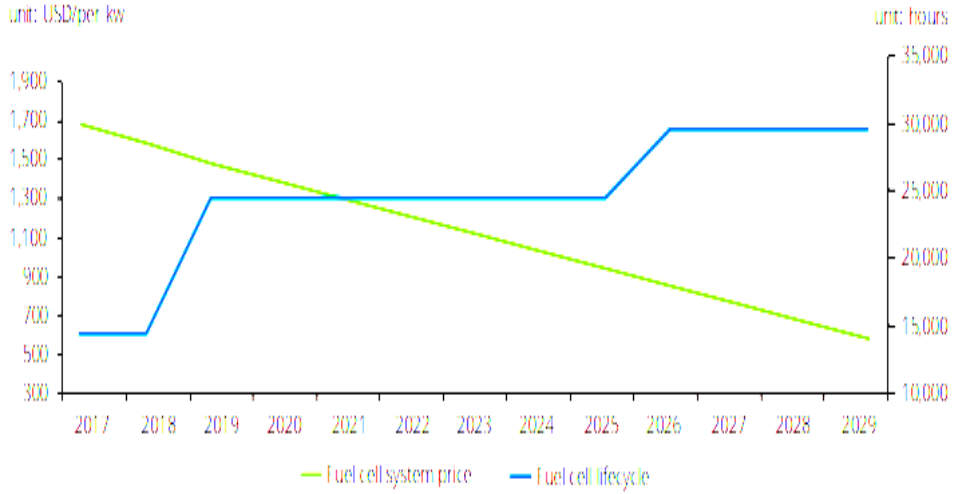



- **Green Using Renewable Energy.**
- **Yellow using solar**
- **Pink using nuclear**
- **Blue using Natural Gas reforming with CCUS.**
- **Turquoise using methane pyrolysis.**
- **Grey using methane reforming without CCUS.**
- **Brown using coal gasification.**

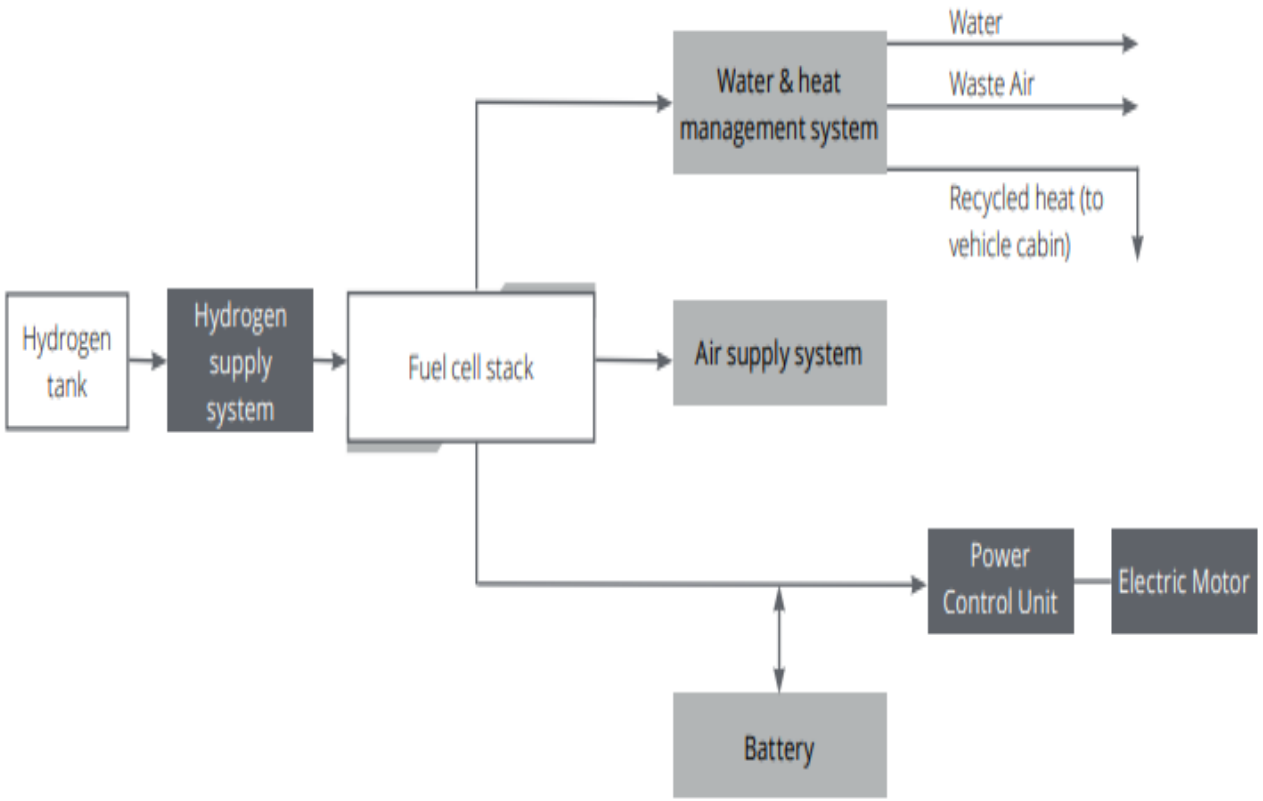
# Current Techno-economics of Green Hydrogen in India Transportation Sector

- **India has committed to reducing the emission intensity of economic activity by 33–35 per cent by 2030.**
- **Currently, 1 kg of Hydrogen in India costs around ₹ 320 - ₹ 340 for the Steam methane reforming method..**
- **The New hydrogen policy from the Indian Government set to reduce the prices by 50%.**
- **The cost of having a fuel cell vehicle for the transportation sector is still high and less availability of cars.**



# Fuel Cell




- **Fuel cells are the devices that convert chemical energy to electrical energy.**
- **In the process of generation, the fuel cell emits water and heat as the byproduct of the fuel cell.**
- **The Fuel cell can be utilized as the alternative source for the power generation to the existing fossil fuel technology.**
- **The excess amount of energy that is not utilized from the power generation of the renewable energy can be utilized to produce the hydrogen.**
- **This hydrogen can be stored, transported to required areas for the electricity generation.**

# Fuel Cell Vehicles

- **Fuel cell vehicles use the Polymer electrolyte membrane fuel cells. These cells are costly and can be suitable for the automotive applications.**
- **Reduction of GHG emissions in the transportation sector to meet a 2050 goal of 80% below 2005 levels.**
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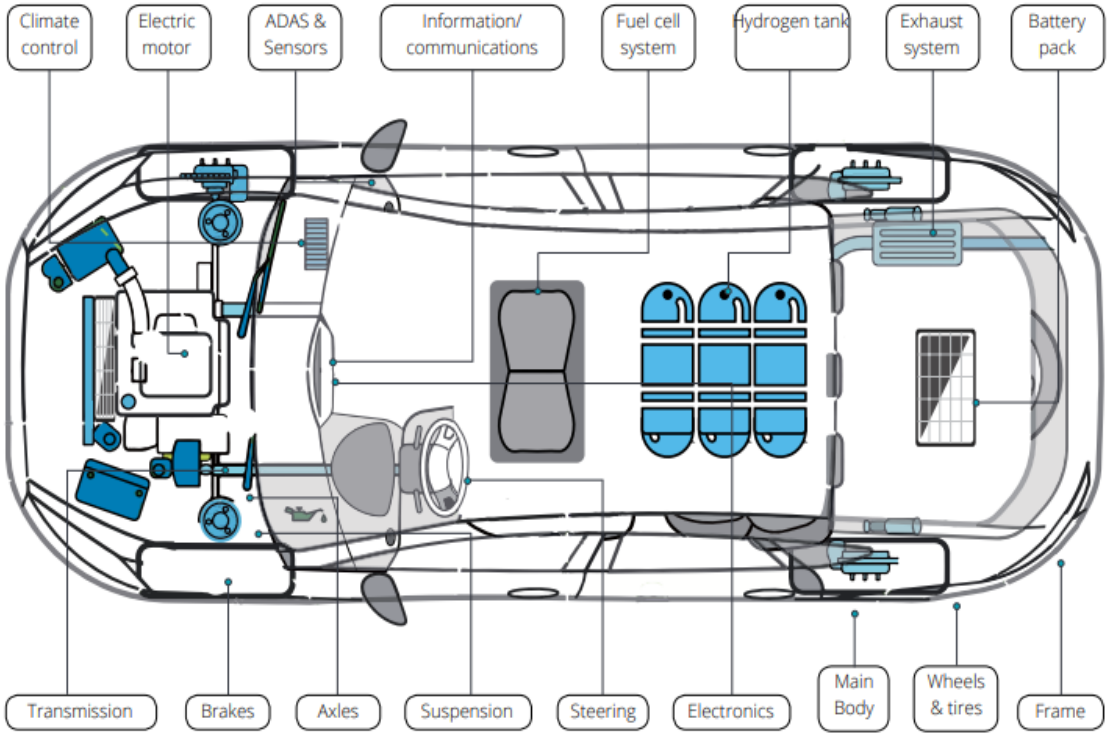

# Hydrogen Mission

**National Hydrogen Mission** was launched by Prime Minister **Narendra Modi** on **August 15, 2022**

- To help the government in making India a **green hydrogen hub**.
- To achieve the environment and climate related targets.
- To help in meeting the target of production of **5 million tonnes of Green hydrogen** by **2030**
- To aid in the development of related renewable energy capacity.

# Government Policies

- **India has committed to reducing the emission intensity of economic activity by 33–35 per cent by 2030.**
- **To achieve this goal, the Government of India has drafted policies to reduce emissions from the power, industry, and transport sectors.**
- **The targeted measures include an ambitious 450 GW of electric power generation through renewable energy sources by 2030**
- **The World Energy Outlook 2018 estimated that India's industrial and transport emissions, will rise from 37 per cent in 2017 to 50 per cent in 2040 (International Energy Agency [IEA] 2018).**

# Investors fueling $H_2$ Economy

- **Adani** committed to invest **$70 bn**
- **ONGC** along with **ICT, Mumbai** acquired an US Patent on '**Hydrogen Production Method by Multi-step Copper-Chlorine Thermochemical Cycle**'
- **ONGC** signed MoU with **Greenko** to pursue opportunities in hydrogen/ammonia sector
- **RIL** to invest **$9.375 bn** over the next three years in renewable energy.
- **GAIL** plans to build India's largest green hydrogen plant of **10 MW**

# Investors fueling $H_2$ Economy

- **NTPC** has the country's first green hydrogen microgrid project at its Simhadri plant in Andhra Pradesh and also launched Hydrogen Fuel bus and car project for Leh and New Delhi
- **IOCL** has already announced its plan of operating 15 fuel cell buses in the Delhi-NCR region along with **Tata Motors** and also plans to develop India's first green hydrogen plant at its Mathura Plant.
- **OIL** commissions India's first **99.99%** pure green hydrogen plant in Jorhat, Assam
- **L&T** commissions Green Hydrogen Plant at its manufacturing complex in Hazira with 380kW capacity on 20-Aug-2022


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