Hydrogen For Mobility

By

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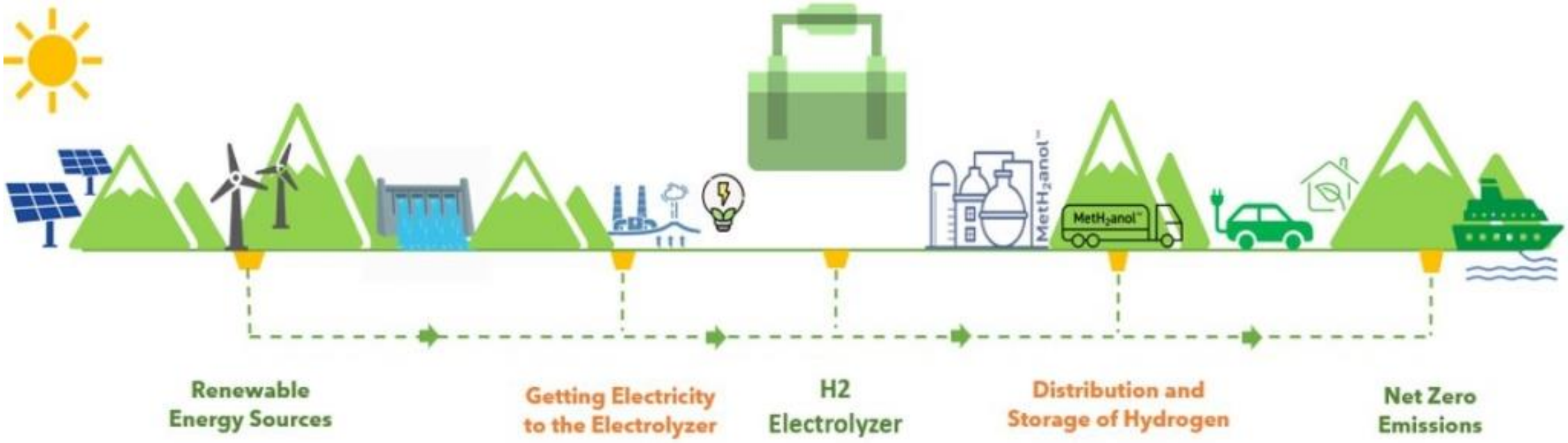
Simple Depiction of Green Hydrogen Generation



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.

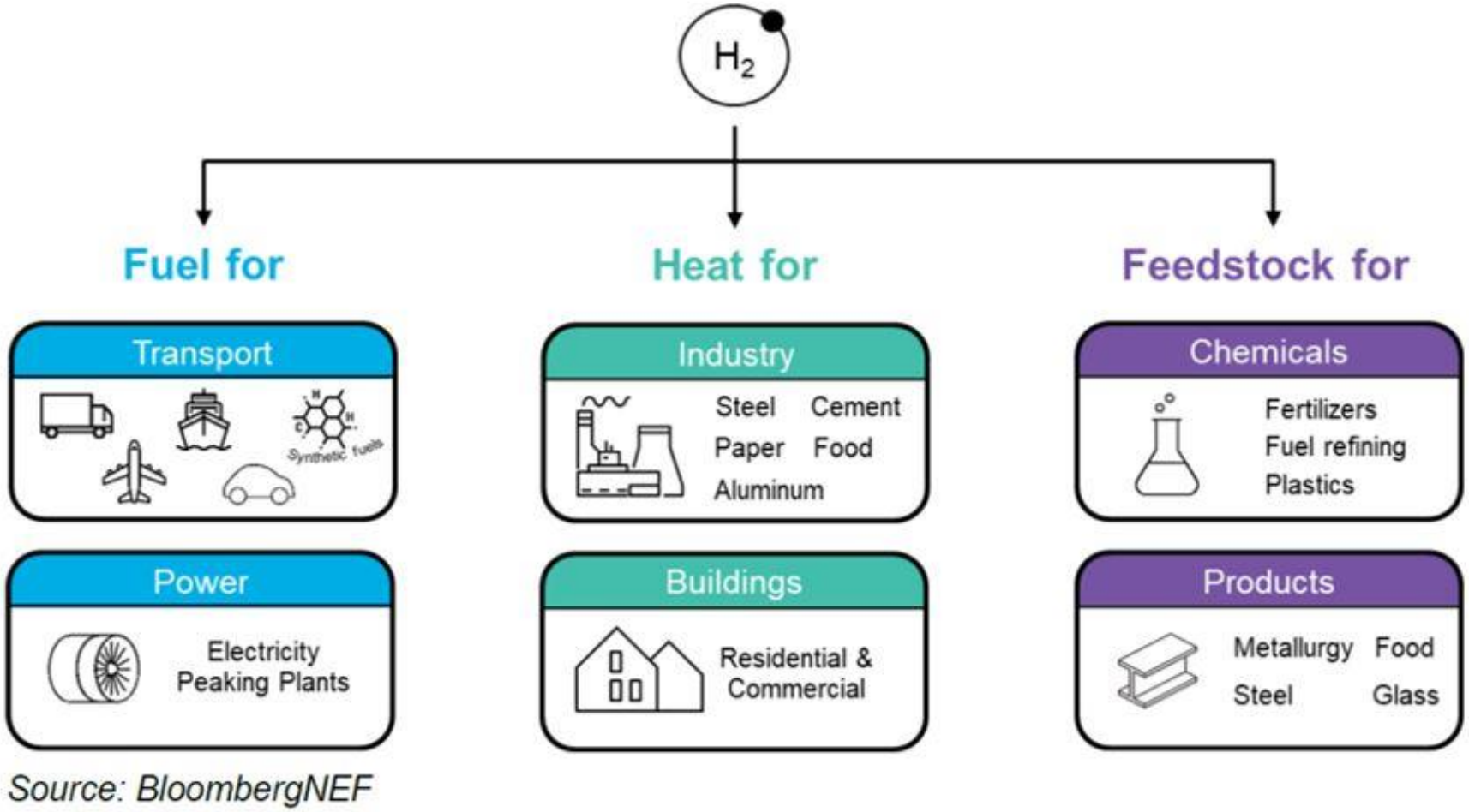
In 2019, according to International Energy Agency in India transportation sector contributed 308 Mt of CO_2 which is 13.3% of total emitted CO_2 in India.

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

Transportation sector is the 2nd Largest in the World and 3rd 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.

Application Hydrogen



Source: BloombergNEF

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.

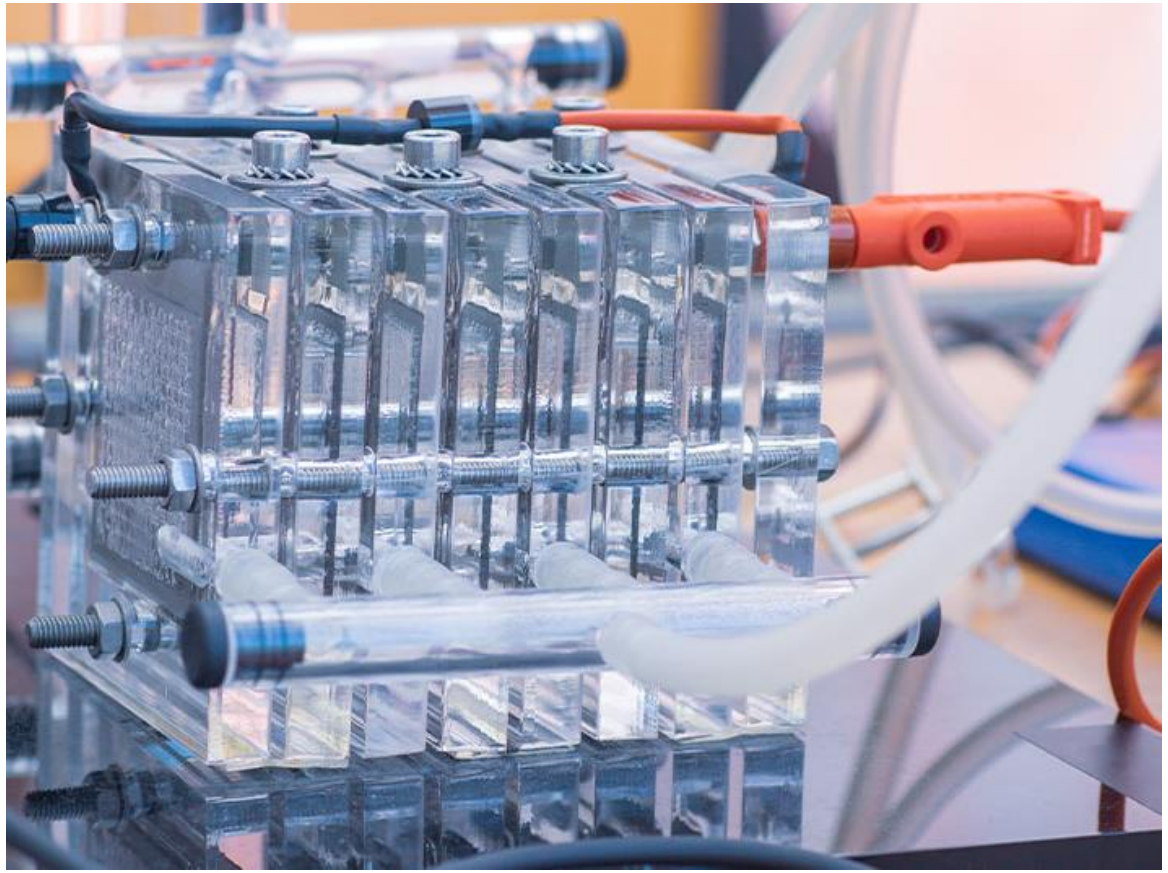
The Fuel cell can be utilized as the alternative source for the power generation to the existing fossil fuel technology.

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.

Types of Fuel Cells

- Alkaline Fuel Cells
- Direct Methanol Fuel Cells
- Molten Carbonate Fuel Cells
- Phosphoric Acid Fuel Cells
- Polymer Electrolyte Membrane Fuel Cell
- Solid Oxide Fuel Cells



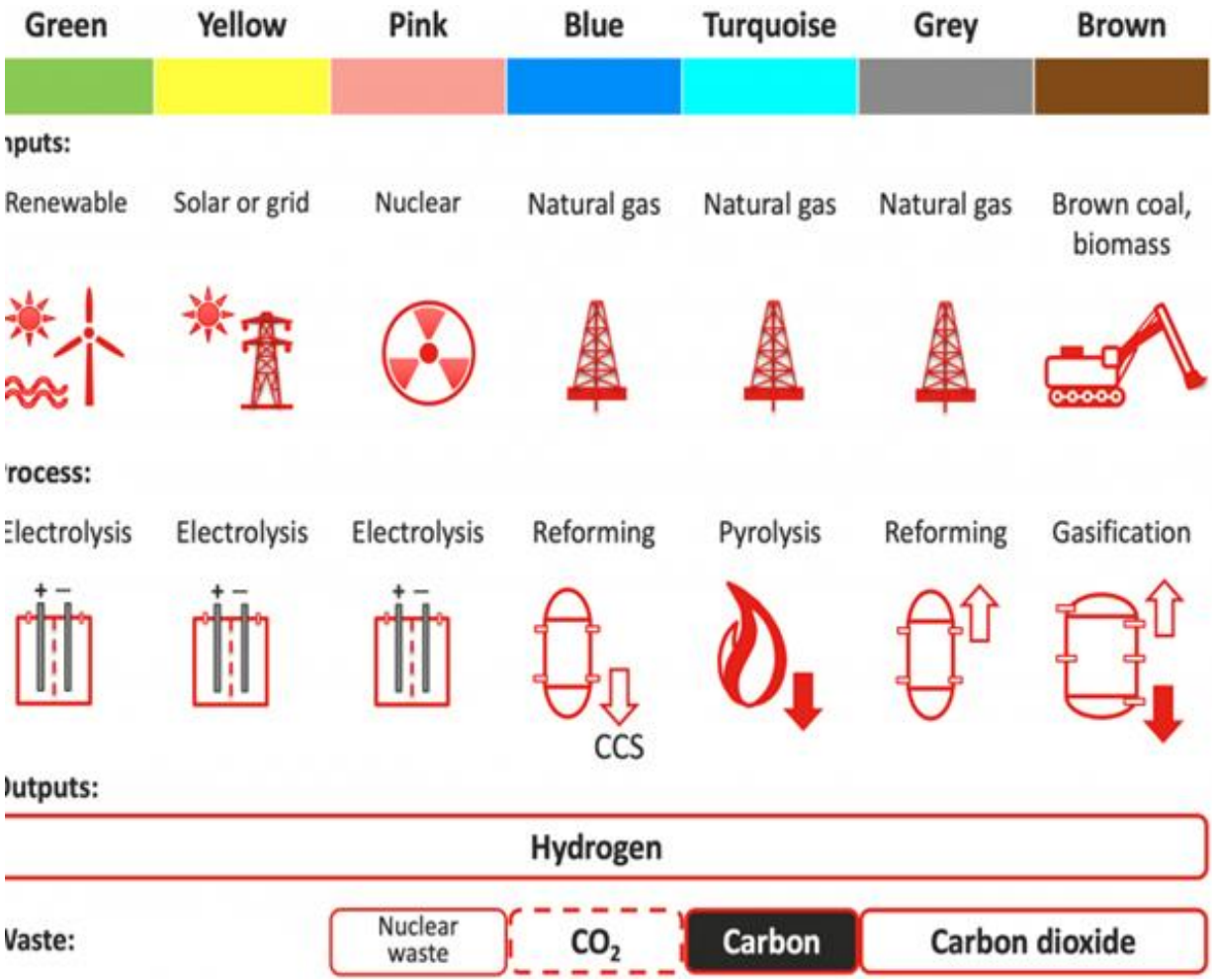
Source: https://www.investors.com/

Different Fuel Cells and their Applications

Types of Fuel Cell	Operating Temperatures of the fuel cell in (°C)	System Output in (kW)	Electrical efficiency of the fuel cell in (%)	Combines heat and power efficiency (CHP)	Applications of the fuel cell	Advantages of the fuel cell
Alkaline fuel cell	90 – 100	10 – 100	60	>80	Military and space	Cathode reaction faster in alkaline electrolyte leads to higher performance with various catalysts.
Phosphoric Acid Fuel Cell	150 – 200	50 – 100	>40	>85	Distributed generation	Higher overall energy efficiency with CHP and higher tolerance to impure hydrogen.
Solid Oxide Fuel Cell	600 -1000	<1 – 3000	35 - 43	<90	Auxiliary power, Electrical Utility, Large Scale distributed generation	Higher efficiency with fuel flexibility and can use various catalysts
Molten Carbonate Fuel Cell	600 -700	<1 – 1000	45 -47	>80	Electrical Utility and Large scale distribution	Higher efficiency and Fuel Flexibility. Suitable for CHP.
Polymer Electrolyte Membrane Fuel Cell	50 -100	<1 – 250	53 – 58	70 -90	Power Backup, Portable Power, Transportation	Lower operating temperature and quick start-ups.
Direct Methanol Fuel cell	60 -200	0.0001 – 100	40	80	Replacement of batteries in portable devices	Reduced cost due to absence of fuel reformer

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.



Fuel Cell Buses in India

- **In August 2022, Dr Jitendra Singh today launched India's first truly indigenously developed Hydrogen Fuel Cell Bus developed by KPIT-CSIR in Pune.**
- **Tata and Indian Oil Corporation Jointly tested the India's first Hydrogen bus named Tata Starbus Fuel Cell bus. With help of partial financial support of DST and Industrial Research, Ministry of Science and Technology.**

Image Source:
energy.economictimes.indiatimes.com

Fuel Cell Train in Japan

- **The two car “Hybari" train costs about $35 million (4 billion yen) and can travel up to 140 kilometers (87 miles) at a top speed of 100 km/h on a single filling of hydrogen.**
- **This hydrogen-fueled train has been developed by East Japan Railway Co in partnership with Toyota Motor Corp. and Hitachi Ltd. The commercial services likely to begin in 2030.**
- **Indian Railways also planning to launch hydrogen powered train.**

Image Source: blog.2nd-train.net

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