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Challenges in Hydrogen Fuel Cell Vehicles

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Abstract: *Nowadays, the combustion of fossil fuels for transportation has a major negative impact on the environment. All nations are concerned with environmental safety and the regulation of pollution, motivating researchers across the world to find an alternate transportation fuel. The transition of the transportation sector towards sustainability for environmental safety can be achieved by the manifestation and commercialization of clean hydrogen fuel. Hydrogen fuel for sustainable mobility has its own effectiveness in terms of its generation and refueling processes. As the fuel requirement of vehicles cannot be anticipated because it depends on its utilization, choosing hydrogen refueling and onboard generation can be a point of major concern In terms of performance, affordability, and lifetime, onboard hydrogen-generating subsystems must compete with what automobile manufacturers and consumers have seen in modern vehicles to date. Fuel cell vehicles have a high potential to reduce both energy consumption and carbon dioxide emissions.*

Keywords: hydrogen fuel; sustainability; green fuel; sustainable transportation; future mobility.

I. INTRODUCTION

The advancement of technology and increasing demand for electrical power have motivated all nations to find alternate energy sources for power generation .It is estimated that the drastic increase in power demand will deplete fossil fuel for power production . Moreover, the environmental impacts of fossil fuel utilization in various sectors include to the emission of greenhouse gases (GHGs) and the generation of pollutants in the environment . The aforementioned causes justify the increase in demand for renewable and sustainable energy-based power stations and the dependency of various sectors on them.

hydrogen fuel-cell vehicle (HFCV) uses the same kind of electric motor to turn the wheels that a battery-electric car does. But it's powered not by a large, heavy battery but by a fuel-cell stack in which pure hydrogen (H2) passes through a membrane to combine with oxygen (O2) from the air, producing the electricity that turns the wheels plus water vapor are released What this means is that a fuel-cell vehicle is technically a series hybrid, which is why they are sometimes classified as fuel-cell hybrid electric vehicles (FCHEV). Fuel cell electric vehicles (FCEVs) made up a relatively small fraction of the worldwide stock of total cars in 2020, and hydrogen consumption in the industry has been confined to less than 0.01 percent of the energy used, as have electric automobiles (0.3%). However, as a result of events in Asia and the United States, the FCEV market is starting to take off.

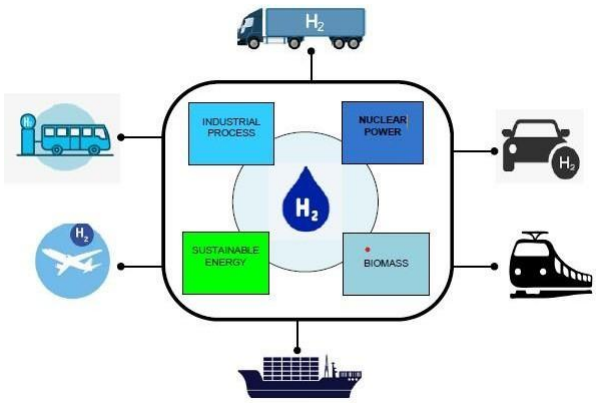

Figure 1. Structure of hydrogen generation sources at various transportation sectors.

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Nowadays, considering that climate-friendly means of transport and fossil fuels are incompatible, many countries are favoring the transition from conventionally fueled vehicles to low-emission vehicles to tackle environmental pollution issues..

II. HYDROGEN FUEL CELL VEHICLES TECHNOLOGY

Fuel cell cars are powered by compressed hydrogen gas that feeds into an onboard fuel cell "stack" that doesn't burn the gas, but instead transforms the fuel's chemical energy into electrical energy. This electricity then powers the car's electric motors.

By combining hydrogen and air in the presence of a catalyst, a fuel cell generates electricity to drive an electric motor, with water vapor as the only by-product. So, compared to a battery, a fuel cell is an energy converter rather than a storage device.

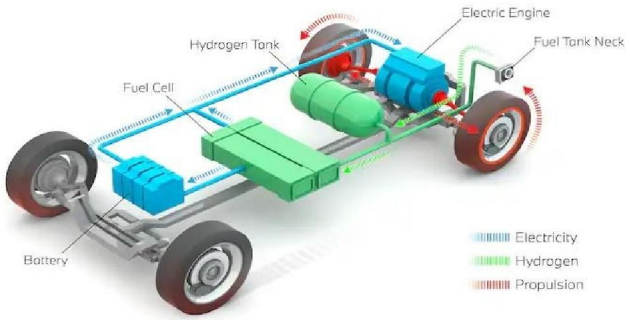

Figure 2 hydrogen fuel cell technologies

Green hydrogen is produced by splitting water by electrolysis. This produces only hydrogen and oxygen. To achieve the electrolysis we need electricity, we need power Producing green hydrogen by electrolysis from renewable sources involves breaking down water molecules (H_2O) into oxygen (O_2) and hydrogen (H_2). to conduct the electricity

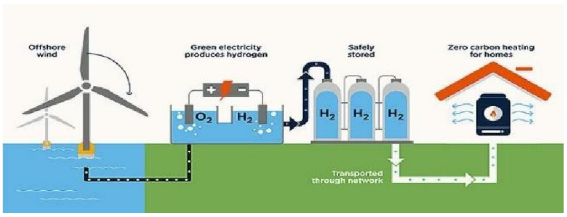

Figure 3- production of hydrogen

III. EXTRACTION OF HYDROGEN

Technology used in extraction of hydrogen:

Steam methane reforming and gasification – used for both grey and blue hydrogen extraction and carbon by product are released to environment in grey hydrogen extraction but blue hydrogen involves recapture and reuse of carbon by products.

Pyrolysis – used for extraction of Turquoise hydrogen. Electrolysis – used for the extraction of green hydrogen

IV. CHALLENGES OF HYDROGEN FUEL CELL VEHICLES:

Hydrogen fuel produced by steam process uses natural gas methane(ch4) , and releases hydrogen and carbon dioxide . C02 leads to environmental pollution .To produce 1kilo of hydrogen it releases 10 kilo of carbon dioxide, so the world now switching towards the green hydrogen .The internal combustion engines by consuming 4liter of diesel releases 10kilo of c02.In electrolysis to produce 1kilo of H2 we require 50kw of power and for liquefying H2 we require 12kw of power .Hydrogen fuel station cost relatively more than normal ev's and other fuel station it was estimated that it requires 20cr for hydrogen fuel station and 1-2cr for normal fuel stations. Hydrogen requires high pressure of 500bar psi for storage.

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Requires high pressure station where the station infrastructure cost will be high. Energy loss in electrolysis is 35% , in liquefying 15% and in storage and transportation 10% energy loss is seen. On an average65% energy loss is seen .But in ev's only 25% of energy loss is seen .Round trip efficiency is very less only 30-40% of efficiency Hydrogen gas production involves only natural gas and dependent on it.

V. ADVANTAGES

- Renewable and Readily Available.
- Hydrogen is a Clean and Flexible Energy Source to support Zero-Carbon Energy Strategies.
- More Powerful and Energy Efficient than Fossil Fuels.
- Highly Efficient when Compared to Other Energy Sources.
- Almost Zero Emissions.
- Reduces Carbon Footprints.
- Fast Charging Times.
- Provides greater range than ev's.
- Has energy to weight ratio 10 x times greater than lithium ion battery.
- Flexible for heavy duty load vehicles.
- No range anxiety.

VI. APPLICATIONS

- Warehouse Logistics and Global Distribution
- buses and trains : hydrogen fuels are used to public transportations
- Personal vehicles : notable models include the Toyota mirai, honda clarity, Hyundai nexo and bmw 1 hydrogen next
- Planes
- Backup Power Generation
- Mobile Power Generation
- Unmanned Arial Vehicles (UAVs)
- Boats and Submarines

VII. CONCLUTION

This paper presents a review of hydrogen fuel for mobility in various transportation sectors. This clean energy has zero environmental impact, which attracts the automobile industries for hydrogen vehicle development.
Costs may be reduced if the plant is close to its natural resources, and therefore, the locations of its sources should be considered while developing a hydrogen plant. People will adopt hydrogen technology if they are aware of the benefits it provides to the environment and human life. Educating residents about hydrogen technology is critical in gaining public support for the technology's growth

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[5] Hydrogen Fuel for Future Mobility: Challenges and Future Aspects Santanu Kumar Dash 1, Suprava Chakraborty 1, Michele Roccotelli 2, and Umesh Kumar Sahu 3.