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A futuristic fuel - Hydrogen

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Abstract: The growing concern about depleting oil reserves, detrimental effects of greenhouse gas emissions and the need to reduce emissions from vehicles and power plants are some of the prime factors that increase the necessity for development of alternative energy option. Among the various alternatives, hydrogen is a promising candidate, which would provide efficient and clean production of electricity, heat, and transportation requirements. This paper analyses the futuristic fuel Hydrogen; its economy, current international scenario and national scenario etc., it is clear from the facts that Hydrogen is one of the best fuels of future.

Keywords-futuristic fuel; hydrogen; international scenario; national scenario

I. INTRODUCTION

Hydrogen economy is indubitably an effectual strategy to reduce the increasing amount of carbon in the atmosphere due to usage of fossil fuels. The growth of manufacturing sector in developing countries has increased the demand of fossil fuels. Nowadays, the major global challenge is to supply the clean fuels to meet the future energy requirements through eco-friendly route. The efforts are in progress to reduce dependency on fossil fuels and encourage widespread use of cleaner fuels such as hydrogen. This is driving the research and development towards sustainable technologies for hydrogen production, storage, distribution, and utilization. Hydrogen economy is a planned structure of utilising hydrogen produced from renewable energy sources with the advantages of a reduced dependency on oil and gas and reduced greenhouse gas emissions. According to the International Energy Agency, Global demand for energy is getting increased day by day and is expected to increase 40% by the year 2035.

II. HYDROGEN ENERGY – INTERNATIONAL SCENARIO

A number of countries like Canada, Germany, Japan, UK, USA, etc., are supporting ample research, technology progress, and demonstration programme for developing and implementing hydrogen energy systems for stationary, portable, and transport applications. The main research focus in these countries is on producing fuel cells for automobiles and also for electricity generation by 2020 [1].

2.1. Canada

Canada has become a one of the renowned world leaders in developing hydrogen energy technologies. The Canadian Hydrogen Energy Industry is involved in almost all fields, including fuel cells, fuel cell systems, electrolysers, fuelling stations, storage technologies, and safety assessments. According to Canadian Hydrogen and Fuel Cell Association [2], from 2003-2008, the Government of Canada invested $170 million in the hydrogen and fuel cell sector through the hydrogen economy program. As a result, over the same five years Canadian industry raised and invested more than $1 billion.

Today, most of the hydrogen production worldwide requires natural gas and releases CO_2. Air Liquid Group of Canada is working to develop solutions that will enable to decarbonizes the production of hydrogen. They are exploring various avenues to achieve it. Some of them are: use of renewable electricity for the electrolysis of water, biogas, and the capture and storage of CO_2. In October 2011, the group started a hydrogen initiative program called Blue Hydrogen program. The objective of the program is that by the year 2020 at least 50% of the hydrogen used for energy applications should be produced without releasing any CO_2. They are also innovating in the development of the infrastructure for the distribution and the storage of hydrogen by designing cylinders made of composite materials capable of resisting high pressure and efficient hydrogen distribution stations.

2.2. United States

In the US, the post war era witnessed more development in hydrogen technology. NASA in its spacecrafts used hydrogen based fuel cells for onboard production of electric power, water, and heat even in the 1960s. The first key international hydrogen conference was held in 1974 in Florida [3]. The conclusion of the conference was that hydrogen was the only solution to environmental problems and depletion of fossil fuels. In 1990s, the demonstration of commercial operated power generators based on fuel cells was carried out successfully.

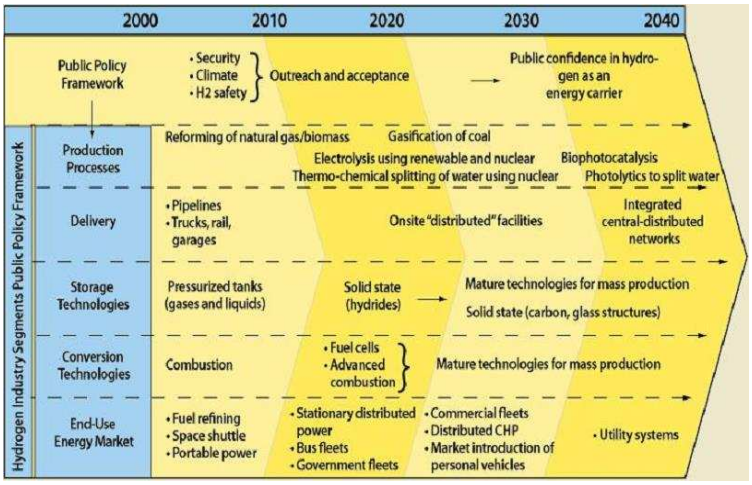

Figure 1 DOE's vision about hydrogen economy [5]

In 2002, U.S. Secretary of Energy, Spencer Abraham and major U.S. car manufacturers proclaimed a research plan called Freedom CAR which developed hydrogen technology for the production of light trucks and cars to assess the U.S. transportation system before transition to a hydrogen economy in full fledge. In 2003, the then President George Bush announced the hydrogen fuel initiative of $1.2 billion for hydrogen technology development. The Bush government had requested nearly $309 million for 2008 [3]. Now in 2014, the request is for a huge $600 million [4]. **Figure 1** prepared by DOE shows the milestones to be made in hydrogen energy implementation. It clearly gives the vision of DOE that the hydrogen power implementation would not begin to displace the petroleum fuels in a significant way before 2030 [5].

2.3. Japan

The Japanese government is showing sky scraping level of dedication to green energy technology development since the Kyoto Protocol was signed in 1997 [6]. To minimize effects of greenhouse gases on climate change caused by the emission, the Japanese government implemented a long-term plan called Cool Earth 50. The main goal of this plan is to reduce greenhouse gases such as CO_2 emissions to 50% by 2050. Fuel cell technologies play a vital role in this plan [6]. To achieve the plan's goal successfully, the Japanese government is concentrating more on fuel cell vehicles (FCVs), stationary fuel cells, hydrogen production, and hydrogen storage technologies.

In July 2010, Japanese government revealed a plan to sell two million fuel cell electric vehicles by 2025, and install 1000 hydrogen fueling stations to support them. The Japanese government has set a goal of fuel cells powering 2 million homes by 2020. In 2012, the Japanese government invested approximately $240 million in fuel cell and hydrogen energy projects. This was nearly twice the amount spent by the US during the same period. The investment details are shown in Table 1

Table 1 Investment details of Japanese government [7]

Hydrogen and Fuel Cell Research in Japan, FY 2012		
	¥ Billion	**$ Million**
H2 infrastructure & vehicle demo.	3.01	37.71
ENE-FARM	9.0	112.77
H_2 production, transport and storage	1.5	18.79
PEM systems	3.5	43.85
SOFC research	0.62	7.77
Industrial SOFC	0.9	11.28
Basic hydrogen research	0.8	10.02
Total	**¥ 19.33**	**$ 242.20**
Yen converted at 2011 average annual rate of 79.81 yen to the dollar per IMF		

2.4. European Union Countries

European countries have made momentous efforts, collectively and severally, in hydrogen-related research activities. Credibly the best-known project is Clean Urban Transport for Europe (CUTE) [3]. The project was carried out successfully between 2001 and 2006. European Commission (EC) and its member nations financed this project. Its plan was a demonstration project that used 27 fuel cell operated buses as public fleets in seven countries covering nine cities [3]. Friendly projects took place in China, Australia, and in Iceland. The CUTE project used natural gas as a prime source to generate hydrogen and also in some instances the electrolysis of water [8].

III. HYDROGEN ENERGY – INDIAN SCENARIO

Figure 2 Block diagram of total hydrogen energy system [1]

National Hydrogen Energy Road Map (NHERMP) prepared by Ministry of New and Renewable Energy (MNRE) has addressed various aspects of hydrogen economy. The key objective of the programme is to identify the routes, which will lead to a gradual induction of hydrogen energy in the country, speeding up the commercialization and facilitate establishment of hydrogen energy infrastructure in the country [1]. The block diagram of total hydrogen energy system proposed by MNRE is shown in **Figure 2**. The Road Map has clearly pointed out that the production of hydrogen is a main area to be concentrated for hydrogen economy. It also insisted that the production of hydrogen should be made from other renewable sources such as nuclear energy, coal gasification, biomass, biological in addition to present methods of production of hydrogen.

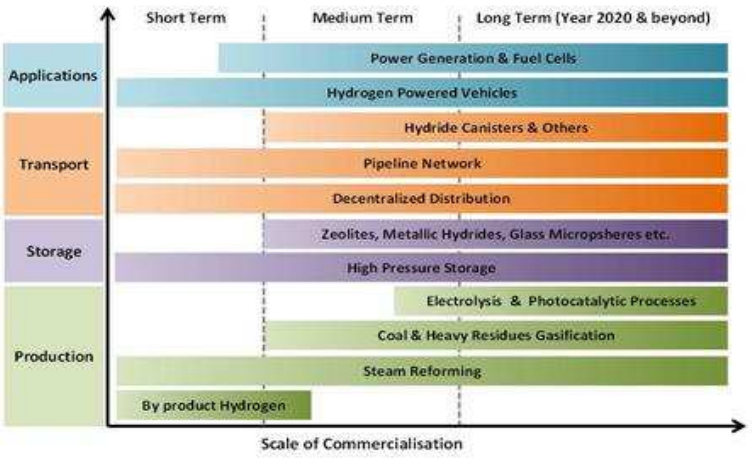

Figure 3 Schematic diagram representing transition to hydrogen economy [9]

Road Map has planned to support the developmental activities to implement hydrogen usage in IC engines in addition to in fuel cells without further delay. It is predicted that about one million hydrogen fuelled vehicles would run on Indian roads and 1000 MW of power would be generated based on hydrogen technology by 2020 [9]. A schematic representation of transition to hydrogen economy is illustrated in **Figure 3**.

IV. CONCLUSION

The purpose of this paper is to analyze the effectiveness of Hydrogen as a fuel of the future. When considering all the data in detail, it is concluded that the Hydrogen economy is growing in a gradual manner. A lot of effects have been taken by international governments as well as by Indian government for its economy and development. More attention and subsidies are given for hydrogen technology research. This undoubtedly shows, the Hydrogen is the fuel of the future.

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