

**Presentation
to
IPHE Steering Committee
on
Hydrogen Energy and Fuel Cells
Development in India**

**Ministry of New and Renewable Energy
20th and 21st May, 2014**

**Hydrogen Energy in India
Ministries / Departments Involved**

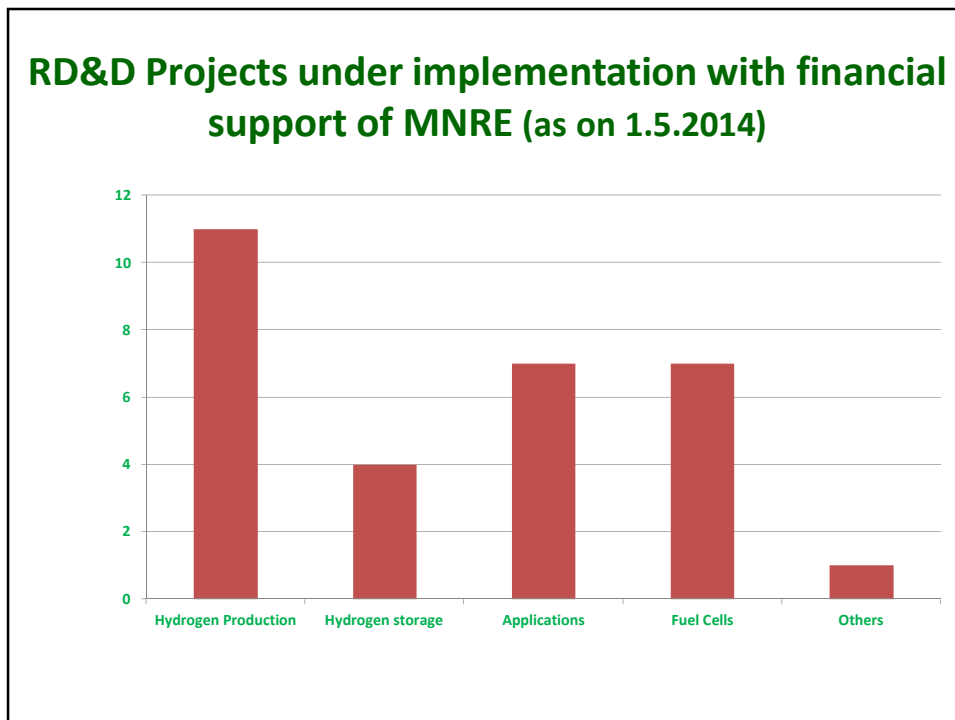
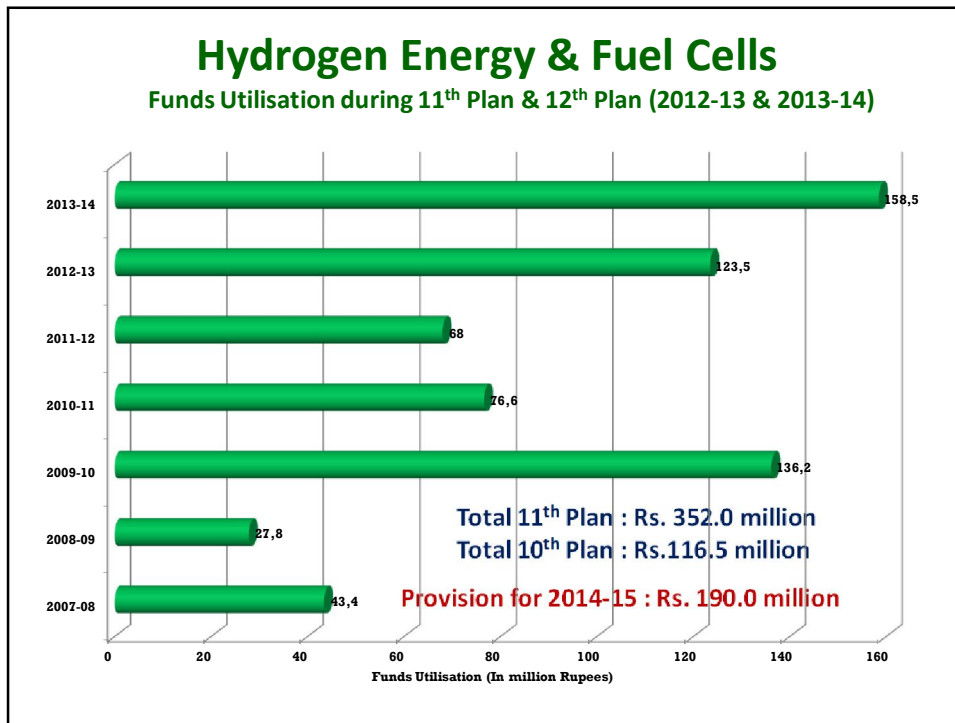
- **Activities relating to Hydrogen Energy for civilian applications (excluding applications in defence and space) are implemented by :**
 - **Ministry of New and Renewable Energy (MNRE)**
 - **Ministry of Petroleum and Natural Gas**
 - **Department of Science and Technology**
 - **Department of Biotechnology**
 - **Department of Scientific and Industrial Research**
- **MNRE is nodal Ministry for Hydrogen Energy & Fuel Cells**

National Hydrogen Energy Road Map

- Roadmap was adopted in 2006
- Identified RD&D efforts for bridging technological gaps
- Production of hydrogen identified with emphasis on development of technology from nuclear energy, coal gasification, biomass, biological and renewable energy methods to produce low cost hydrogen as key area of research
- Excess by-product hydrogen from chlor-alkali units also to be tapped
- For hydrogen storage, goals concerning storage capacity, useful cycle life, compactness and cost, etc. were identified
- Mission Mode Projects to be taken up were identified
- Two initiatives suggested for promoting use of hydrogen in automobiles and for power generation:
 - Green Initiative for Future Transport (GIFT)
 - Green Initiative for Power Generation (GIP)

RD&D Efforts during 11th & 12th Plan Periods (2007-08 to 2011-12 & 2012-13 to 2016-17)

- RD&D efforts were accelerated by MNRE after adoption of National Hydrogen Energy Road Map in Jan, 2006 and a new policy for supporting RD&D projects in December, 2006
- Grants-in-aid support up to 50% to industry and up to 100% to educational institutions / research organizations is provided by MNRE under its on-going RD&D Policy
- Other Ministries and Departments are also supporting RD&D projects
- Though some projects with industry participation have been sanctioned, yet industry in India considers hydrogen technologies as futuristic and therefore its interest is lukewarm



Hydrogen Energy & Fuel Cell Technologies

Institutions Involved in implementing R&D projects

Hydrogen Production

- Central Institute of Mining & Fuel Research, Dhanbad; Indian Institute of Science, Bangaluru; Indian Institute of Technology Kharagpur; Indian Institute of Chemical Technology, Hyderabad; University of Petroleum & Energy Studies, Dehradun; Centre for Materials for Electronics Technologies, Pune; National Institute of Technology, Calicut; Institute of Minerals & Materials Technology, Bhubaneswar; Indian Institute for Cultivation of Science, Kolkata; and R&D Centre of Indian Oil Corporation, Faridabad.

Hydrogen Storage

- Banaras Hindu University, Varanasi; Indian Institute of Technology Madras, Chennai; Indian Institute of Technology Guwahati; & National Environmental Engineering Institute, Nagpur.

Applications of Hydrogen in Engines

- Banaras Hindu University, Varanasi; Mahindra & Mahindra, Chennai; Indian Institute of Technology Delhi; University of Petroleum & Energy Studies, Dehradun; and Indian Institute of Technology Kanpur

Fuel Cells

- University of Calcutta, Kolkata; Institute of Advanced Studies in Science & Technology, Guwahati; Bengal Engineering & Science University, Howrah; Central Salt & Marine Chemicals Research Institute, Bhavnagar; Indian Institute of Technology Madras, Chennai; Indian Institute of Technology Guwahati; and Institute of Minerals & Materials Technology, Bhubaneswar

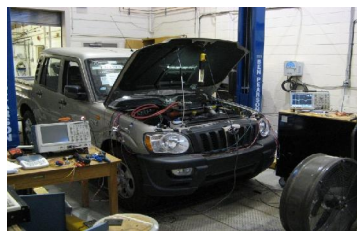
RECENT DEVELOPMENTS

Solar- Hydrogen Demonstration Project at SEC

- A Demonstration project is under implementation at National Institute of Solar Energy (formerly Solar Energy Centre) on solar hydrogen production - Likely to be commissioned by June, 2014
- Components of the Project are:
 - ~120 kW SPV array to produce electricity
 - Alkaline electrolyser of capacity 5Nm³/hr for electrolysis of water
 - Compressor for storage of hydrogen
 - Electronic controls,
 - Utilization of hydrogen in end-use devices (2&3 wheeler vehicles, Fuel cells and IC engines)
- Participants of the Project are:
 - National Institute of Solar Energy
 - University of Petroleum and Energy Studies,
 - IOC (R&D Centre)
- Total project Cost : Rs. 140.16 million

Hydrogen-Diesel SUV Mahindra & Mahindra (M&M)

- M&M has developed five hydrogen-diesel dual fuel SUV under an RD&D project supported by MNRE in 2009-10 with support of about Rs. 44.7 million
- Saskatchewan Research Council (SRC), Canada is a collaborating institution
- Under the project diesel engine modified to run on hydrogen-diesel dual fuel mode.
- Performance and emission tests undertaken to compare it with diesel engine
- Five vehicles (2 passenger & 3 goods) to undergo demonstration in New Delhi and nearby during 2014-15



Hydrogen fuelled 3 wheelers

- 15 nos. of hydrogen fuelled 3 wheelers were developed jointly by IIT Delhi and Mahindra & Mahindra with partial financial support from the International Centre for Hydrogen Energy Technologies (ICHET) of UNIDO
- Air Products has set hydrogen dispensing facility and is arranging supply of hydrogen to vehicles
- A consortium of IIT Delhi, Mahindra & Mahindra, UNIDO, Air Products and India Trade Promotion Organisation (ITPO) are engaged in demonstration and exhaustive trials of the three wheelers in Pragati Maidan, New Delhi
- 2nd Phase of project for field trials of three wheelers up to 30,000 km each was supported by MNRE during 2013-14 for a period of 2 years with financial support of about Rs. 30 million
- BHU, Varanasi is also developing hydrogen fuelled 3 wheeler, wherein hydrogen is stored in metal hydride instead of composite cylinder



Hydrogen 3 Wheeler

Hydrogen 3 wheeler



Figure 21. Hydrogen Fuelled Passenger 3 Wheeler

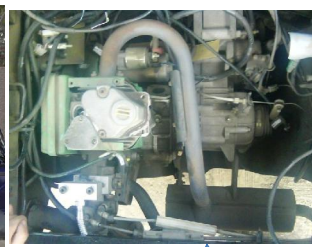
Composite cylinder for hydrogen storage



Hydrogen Filling Point



Hydrogen filling



Engine



Sitting arrangement

Hydrogen Dispensing Station at Pragati Maidan



↑ Dispensing Unit



↑ Bank of Hydrogen cylinders



→ Nozzle for Hydrogen Dispensing

Development & Demonstration of Hydrogen fuelled IC Engine & Buses by IIT Delhi and M&M

- Hydrogen fuelled (4 cylinder, 2.50 litres, turbocharged) engine with power output of 90 bhp developed by modifying an existing CNG engine
- 2 Nos. of Hydrogen Fuelled Engines and buses being developed for demonstration during 2014-15
- Project was sanctioned in March, 2010 for a duration of 5 years with a total project cost of Rs. 127.4 million to IIT Delhi
- Mahindra & Mahindra is industrial partner in project
- IC engine technology is expected to play important role before transition to fuel cell vehicle is made



Development & Demonstration of Fuel Cell Buses by Tata Motors

- Tata Motors is developing 10 fuel cell buses
- Demonstration of 2 buses to start in Delhi during 2014-15
- Hydrogen refueling facility being set up by IOCL at Faridabad with financial support of Rs. 54.45 million from MNRE
- 30 Nm³/h capacity PEM electrolyser with associated facilities for hydrogen dispensing to be set up at an estimated cost of Rs. 108.9 millions
- Demonstration of other 8 Fuel Cell buses proposed at other suitable locations



Fuel Cell installation in a Telecom Tower



- 30 fuel cell based back power systems have been installed in Nagda in the state of Madhya Pradesh using hydrogen systems from chlor-alkali unit
- Fuel Cell based power back up units may be installed at other sites in future
- Methanol reforming based fuel cell system may be suitable for Indian conditions

Power to Gas

- India would be keen to share experiences of other member countries in 'Power to Gas' field as this concept has not been implemented in India so far
- However, related studies for use of hydrogen blended CNG in automobiles and hydrogen production by water electrolysis using electricity generated by small wind turbines have been undertaken
- An RD&D project for using 18% hydrogen blended with CNG as automotive fuel was implemented with participation of 5 automobile companies
- Another R&D project for hydrogen production by integrating alkaline electrolyser with small wind turbines was also implemented

National Steering Committee on Hydrogen Energy & Fuel Cells

- A National Steering Committee has been constituted in May 2012 to advise the Ministry of New and Renewable Energy and steer the overall activities of Hydrogen Energy & Fuel Cells in the country
- Five Sub-Committees have been constituted by National Steering Committee to look into different aspects of hydrogen energy and fuel cell development in India
- The recommendations of the Committee are expected to provide measures for strengthening research and development capabilities in the country in existing organizations on different aspects of hydrogen energy e.g. production, storage, transportation and applications, including policy initiatives and financial /fiscal / regulatory measures for promotion of hydrogen as clean fuel

Thank you