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

Ministry of New and Renewable Energy

13th & 14th November, 2012

Hydrogen Energy in India

Agencies Involved

- **Activities relating to Hydrogen Energy for civilian applications (excluding applications in defence and space) are presently being implemented by several Ministries/Departments:**
  - **Ministry of New and Renewable Energy**
  - **Ministry of Petroleum and Natural Gas**
  - **Department of Science and Technology**
  - **Department of Biotechnology**
  - **Department of Scientific and Industrial Research**

National Hydrogen Energy Road Map

- **Identified RD&D efforts to be undertaken in the country for bridging the technological gaps in different areas of hydrogen energy & fuel cells**
- **Production of hydrogen identified as a key area of action with emphasis on development of technology from nuclear energy, coal gasification, biomass, biological and renewable energy methods to produce low cost hydrogen**
- **Tapping by-product hydrogen from chlor-alkali units for meeting immediate requirement of hydrogen**
- **For hydrogen storage, various goals concerning efficiency of storage, useful cycle life, compactness and cost, etc. have been identified**
- **Putting in place necessary infrastructure for transport and delivery of hydrogen**
- **Two initiatives for promoting use of hydrogen in automobiles and for power generation**
- **These initiatives were named as Green Initiative for Future Transport (GIFT) and Green Initiative for Power Generation (GIP)**

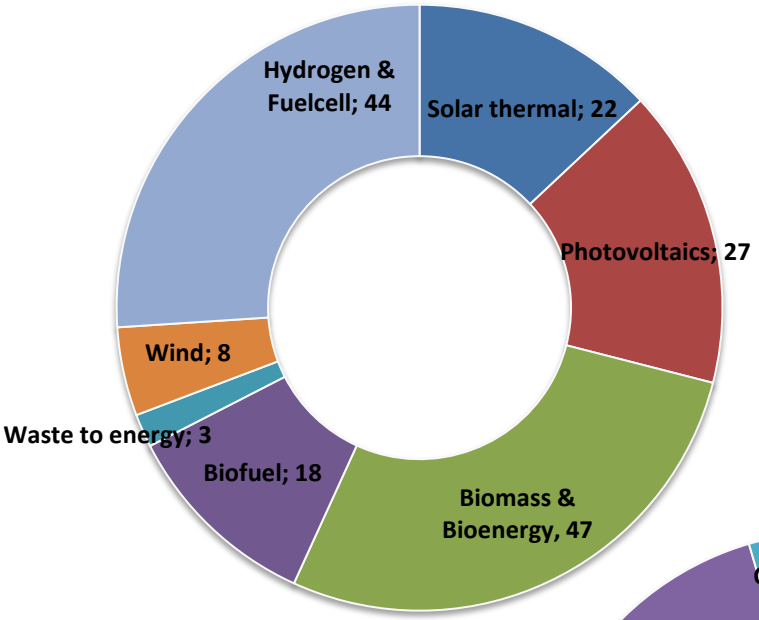
Mission Mode Projects Suggested in National Hydrogen Energy Road Map

- **Clean Coal Gasification Technologies for Hydrogen Production**
- **Hydrogen Production through Biological Routes**
- **Hydrogen Production through Renewable Energy Routes**
- **Hydrogen Production through Nuclear Thermo-Chemical Water Splitting Route**
- **Hydrogen Storage in Hydrides**
- **Hydrogen Storage in Carbon Nano-Structures**
- **Development of IC Engine for Hydrogen Fuel**
- **Development of Polymer Electrolyte Membrane Fuel Cell and Solid Oxide Fuel Cell Technologies**

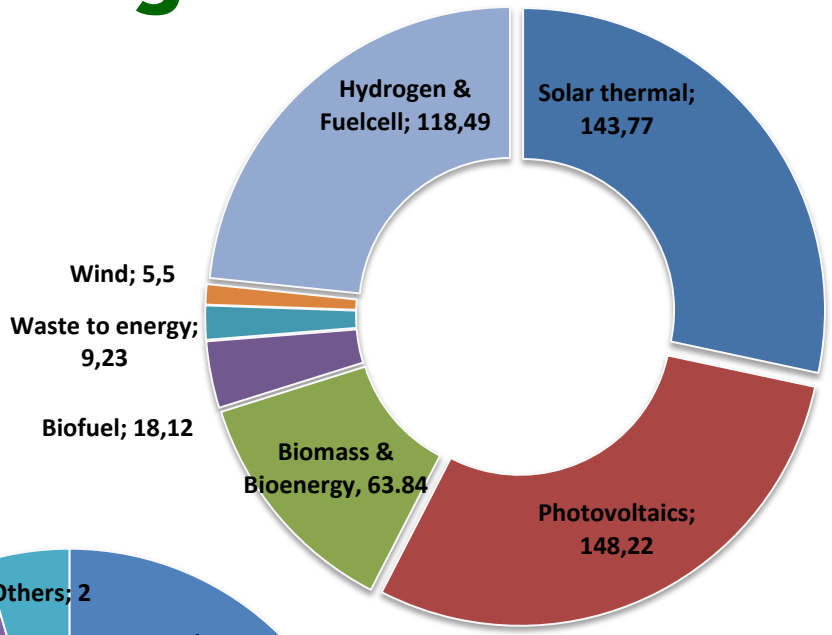
RD&D Efforts during 11th Plan Period

- **RD&D efforts were accelerated by MNRE after acceptance of National Hydrogen Energy Road Map by National Hydrogen Energy Board in Jan, 2006 and adoption of 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 organisations can be provided as per MNRE R&D Policy**
- **Other Ministries and Departments are also supporting RD&D projects**

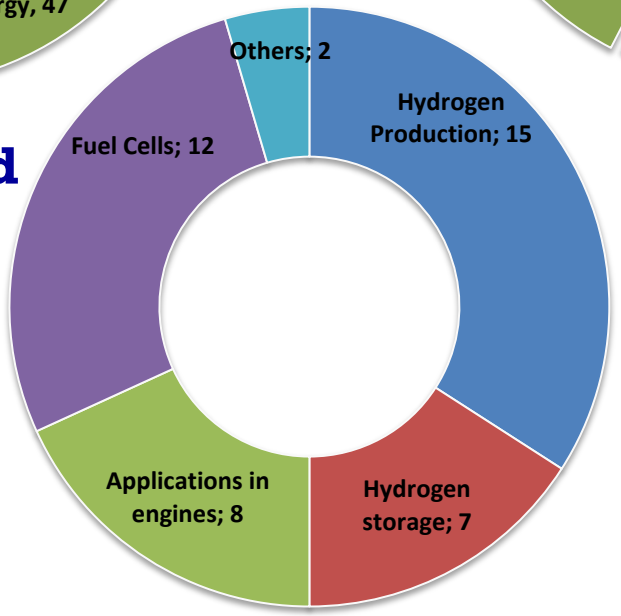
RD&D Efforts during 11th Plan Period



R&D Projects supported by MNRE



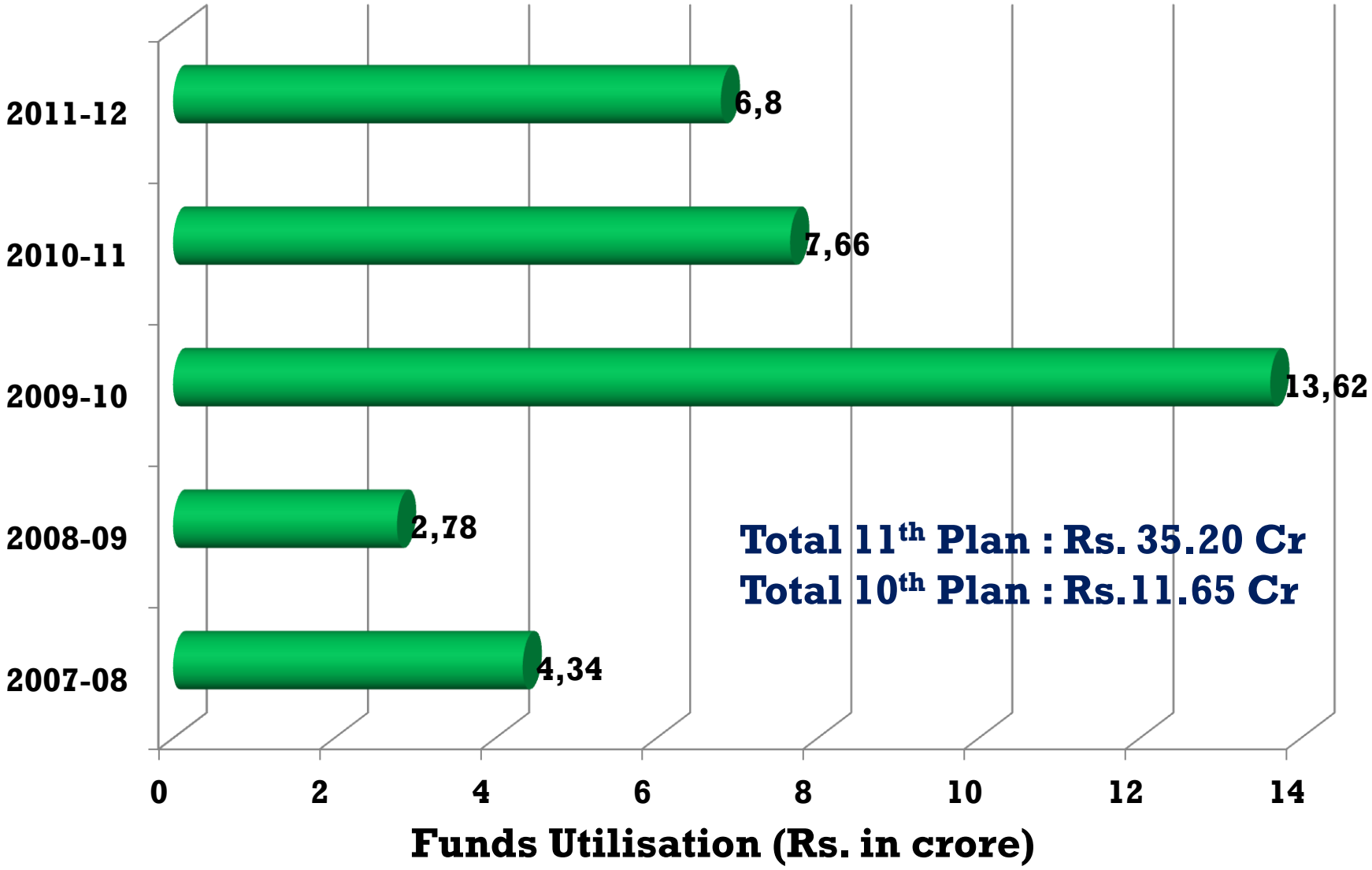
MNRE share of Project cost (Rs. In crore)



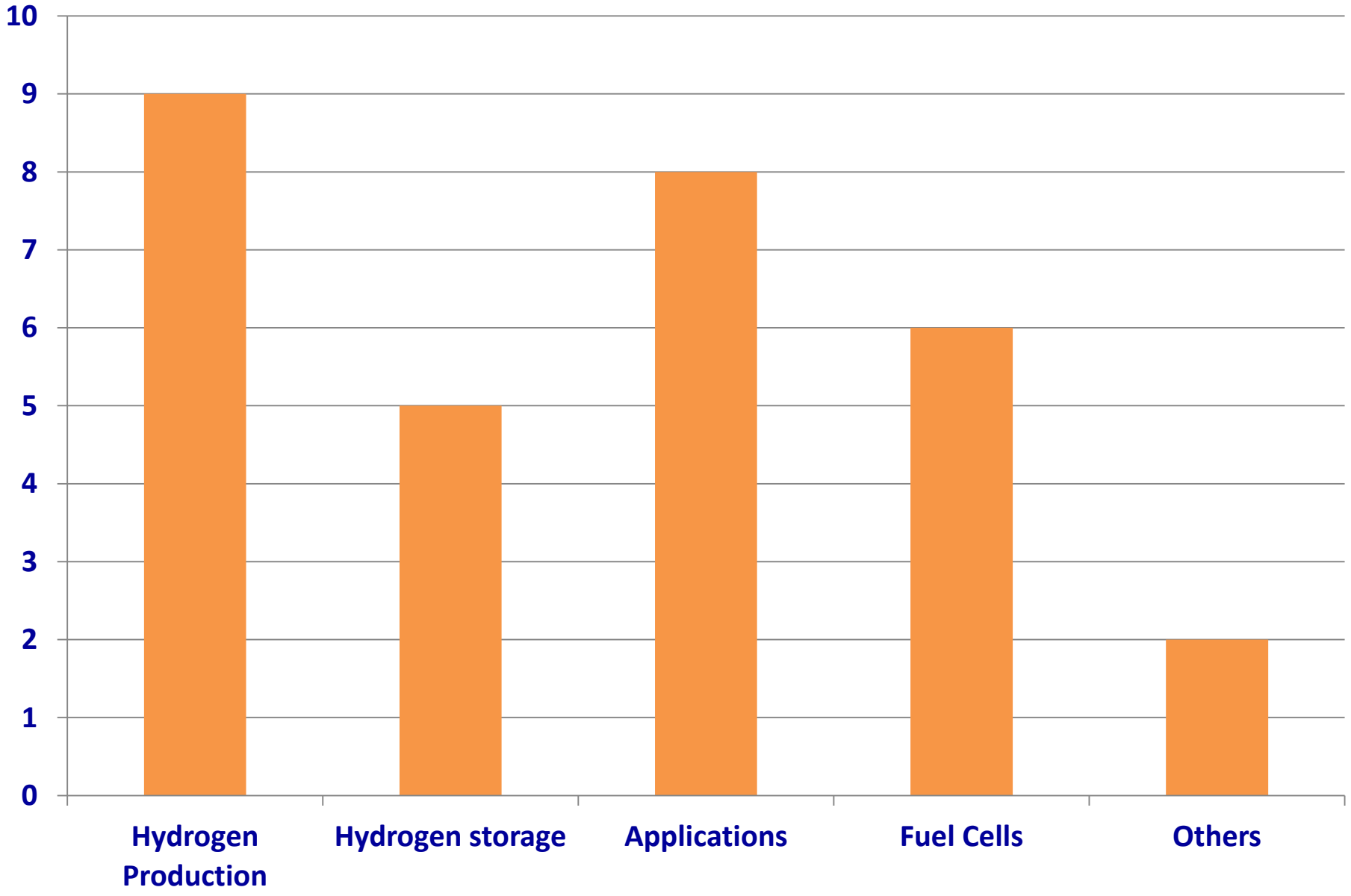
R&D Projects on Hydrogen Energy & Fuel Cells Supported

Hydrogen Energy & Fuel Cells

Funds Utilisation during 11th Plan



RD&D Projects under implementation



Hydrogen Production through Biological Routes

(Mission Mode Project – Lead Institute : IIT Kharagpur)

- 3 pilot plant demonstration of 10 m^3 capacity each to be set up at Kharagpur, near New Delhi and Hyderabad with hydrogen generation capacity of 30-50 m^3 / day using organic waste
- Design of 100 m^3 bioreactor for the commercial application
- In order to address issues of lower hydrogen yield as well as lower rate of hydrogen production, project focuses on (a) Selection of suitable organic wastes, (b) development of suitable consortia, (c) use of thermophiles to avoid the sterilization of the waste materials, and (d) development of an integrated (two stage fermentation) processes
- Project was sanctioned for a duration of 5 years on 16.12.2009 with total project cost of Rs. 597.20 lakh
- This is a co-ordinated project with IIT Kharagpur as lead institute and Allahabad University, BHU, IICT, JNTU and TERI as collaborating institutes

Hydrogen Storage Materials (Hydrides): R&D

(Mission Mode Project – Lead Institute : BHU, Varanasi)

- Synthesis,characterization, optimization of hydrogenation /de-hydrogenation, recyclability and other related characteristics of:
  - Inter metallic hydrides
  - Mg and Mg based compounds and composites
  - Alane (AlH_3)
  - Complex hydrides ($NaAlH_4$)/ Mg $(AlH_4)_2$, $LiAlH_4$ $Li(Mg\ AlH_4)_3$
  - Other hydrides such as borohydrides, amminoborane, zeolites, clatherates, metal organic frameworks and cyclohexane
- Storage capacity of up to 6 wt%, cycle life of 1000 cycles and volumetric storage capacity of about 60 kg/m^3
- Project sanctioned on 16.12.2009 for a duration of five years with total project cost of Rs. 1090.14 lakh to BHU
- MIDHANI and DMRL are industrial partners in project

Studies on Hydrogen Storage in Carbon Materials

(Mission Mode Project – Lead Institute : IIT Madras)

- **Develop high surface area carbon materials capable of storing ~6 wt % of hydrogen either physically or chemically or both**
- **Carbon materials up to 1500 m^2/g material have been already prepared and attempts are underway to prepare carbon materials with surface area of the order of 3000 m^2/g**
- **Project sanctioned in December, 2009 for a duration of 5 years with total project cost of Rs. 581.68 lakh to IIT Madras**
- **CFCT, Chennai and Nano Ram Technologies, Bangalore are associated in project**

Development and Demonstration of hydrogen fuelled internal combustion engines for vehicles

(Mission Mode Project – Lead Institute : IIT Delhi)

- Hydrogen fuelled (4 cylinder, 2.50 litres, turbocharged) engine with power output of 90 bhp to be developed by modifying an existing CNG engine
- 2 Nos. of Hydrogen Fuelled Engines and mini buses to be developed and demonstrated for 1 lakh kms
- Project was sanctioned on 30th March, 2010 for a duration of 5 years with a total project cost of Rs. 1274.0 lakh to IIT Delhi
- Mahindra & Mahindra is industrial partner in project and is contributing Rs. 322.0 lakh in project cost
- IC engine technology is expected to play important role before transition to fuel cell vehicle is made

Hydrogen from Biomass Gasification
IISc, Bangalore

- **A pilot plant for production of 2kg/hr of hydrogen using a biomass gasifier system of 30 kg/hr using oxygen and steam as oxidants**
- **Project sanctioned on 14th Sept., 2009 for a duration of 3 years with total project cost of Rs. 209.55 lakh**
- **Experimental results conducted so far have provided encouraging hydrogen yield of 101 g per kg of biomass with steam to biomass ratio of 2.7 and equivalence ratio value of 0.3 (~20 kg/hr of biomass may be needed for 2 kg/hr of hydrogen production)**
- **An open top downdraft gasification system is used for hydrogen production**
- **Design of a technology package for production of liquid fuel from biomass using FT synthesis is also envisaged under project**

Solar- Hydrogen Demonstration Project at SEC

- **A Demonstration project is under implementation at Solar Energy Centre on solar hydrogen production**

- **Components of the Project are:**
  - **~120 kW SPV array to produce electricity**
  - **Electrolyser of capacity 5Nm^3/hr for electrolysis of water**
  - **Compressor for storage of hydrogen**
  - **Electronic controls,**
  - **Utilization of hydrogen in end-use devices (2&3 wheeler vehicles, Fuel cell and IC engines)**

- **Participants of the Project are:**
  - **Solar Energy Centre/ NHEFCC**
  - **University of Petroleum and Energy Studies,**
  - **IOC (R&D Centre)**

- **Total project Cost : Rs. 1115.24 lakh**

Hydrogen Dispensing Stations

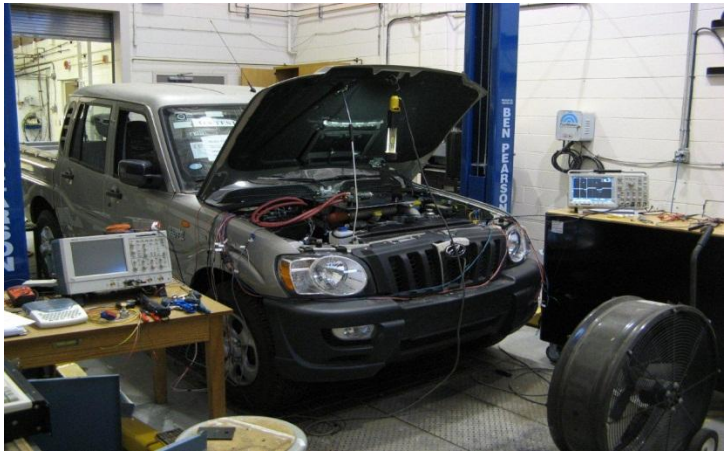
- **An electrolyser based hydrogen production and H-CNG dispensing station was set up by IOCL in its R&D Centre at Faridabad in 2005**
- **IOCL set up one more H-CNG dispensing station (5 Nm^3/h, i.e. 11 kg/day, 24 hrs operation) at Dwarka, New Delhi with partial financial support from MNRE in March, 2009**
- **These dispensing stations are providing H-CNG fuel to vehicles undergoing field trials**

H-CNG Fuelled Vehicles

- Project sanctioned for demonstrating blending of hydrogen (up to 30%) with CNG in different types of vehicles (3 buses, 2 cars and 2 three wheelers) to SIAM in September 2007. Project is likely to be completed by end 2011
- SIAM, IOCL and 5 Auto companies i.e. Tata Motors, Ashok Leyland, Eicher Motors (Volvo-Eicher), Mahindra & Mahindra and Bajaj Auto participating in project
- Based on performance and emissions tests undertaken, it has been decided to blend 18% hydrogen by volume with CNG
- Field trials are under progress
- Project would help in optimization of engine performance and blend ratio of hydrogen with CNG

Hydrogen-Diesel SUV
Mahindra & Mahindra

- M&M implementing an R&D project on development and demonstration of hydrogen-diesel dual fuel SUV
- Saskatchewan Research Council (SRC), Canada is the collaborating institution in the project
- Under the project diesel engine to be modified to run on hydrogen-diesel dual fuel mode, collect the data for the pollution, efficiency and mileage and compare it with the current diesel engine; optimise it and undertake field trials
- On the first vehicle sent to SRC, dual fuel strategy has been developed
- Five dual fuel vehicles will be developed and demonstrated under project
- Supply of hydrogen may be a constraint and therefore M&M wants demonstration in New Delhi



Hydrogen fuelled 3 Wheeler

- **A consortium of IIT Delhi, Mahindra & Mahindra, UNIDO, Air Products and India Trade Promotion Organisation (ITPO) are demonstrating 15 hydrogen fuelled three wheelers in Pragati Maidan, New Delhi**
- **International Centre for Hydrogen Energy Technologies (ICHET) of UNIDO has provided partial financial support for the project**
- **These three wheelers use high pressure gaseous hydrogen stored in composite cylinder**
- **M&M has manufactured three wheelers as per design developed jointly by IIT Delhi and M&M**
- **Air Products has set hydrogen dispensing facility and is arranging supply of hydrogen**
- **UNIDO may demonstrate hydrogen fuelled three wheelers in other developing countries**

Hydrogen 3 Wheeler

Hydrogen 3 wheeler

DELHY 3W, 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

Fuel Cell Bus by Tata Motors (under DSIR support)

Specifications of fuel cell bus

- **Seating capacity : 30**
- **Fuel cell gross peak power : 114 H.P. (85 kW)**
- **Fuel System : 4 Cylinders of 205 litres capacity each**
- **Total useful amount of fuel : 14.5 kg.**
- **Electric propulsion motors : 2 nos. AC induction motors**
- **Energy storage system : Li-Ion Battery**
- **Maximum speed : 70 kmph**
- **Body dimensions (LxWxH) : 12mx2.6mx3.5m**

Fuel Cell installation in a Telecom Tower

Activities for 12th Plan

- **RD&D projects on hydrogen production, storage and applications in IC engines and fuel cells would continue to be supported**
- **Mission Mode Project on PEMFC and SOFC to be developed and supported**
- **Demonstration of hydrogen for stationary power generation and vehicular applications proposed to be supported**
- **Demonstration of H-CNG / Hydrogen fuelled vehicles based on IC engine and fuel cells**
- **National Hydrogen Energy and Fuel Cell Centre in campus of Solar Energy Centre at Gwalpahari, Gurgaon**

Proposed Budget for 12th Five Year Plan and for 2012-13

Sl. No.	Item	Target / CFA	Proposed Budget for 12th Plan	Proposed Budget for 2012-13
	Hydrogen Energy			
1	Support for R&D Projects		55.00	8.00
2	Stationary power generation	Target (kW)	4000	200
		CFA	5.00	0.25
3	Hydrogen / H-CNG Stations	Target (Nos.)	10	2
		CFA	50.00	9.00
4	Demonstration of hydrogen / H-CNG vehicles	Target (Nos.)	500	50
		CFA	50.00	5.00
	Sub-total for Hydrogen Energy		160	22.25
	Fuel Cells			
1	Support for R&D Projects		35.00	5.00
2	Stationary Power Generation	Target (MW)	10.0	0.5
		CFA	60.0	3.0
	Back-up Units for Tele-com Towers	Target (MW/Nos.)	10/2000	1/200
		CFA	85	10
3	Fuel Cell Buses	(Nos.)	100	1
		CFA	55	1
	Sub-total for Fuel Cells		235	19.0
4	National Hydrogen Energy & Fuel Cell Centre		50*	10*
	TOTAL		445	51.25

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-groups have been constituted by the 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 fuel cells, including policy initiatives and financial /fiscal / regulatory measures for promotion of hydrogen as clean fuel**

Thank you