INTERNATIONAL PARTNERSHIP FOR THE HYDROGEN ECONOMY (IPHE)

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Presentation on

Hydrogen Energy Programme in India

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Renewable Energy in India

- Renewables contribute 10,255 MW power generation capacity, representing about 8% of the installed capacity.

- Contribution of different renewable power technologies:

Wind Power	: 7092 MW
Small Hydro Power	: 1976 MW
Bio - Energy	: 1187 MW

- In addition, 155 MW equivalent of Off-grid Distributed Renewable Power Capacity has also been set up

- The goal is to achieve about 20,000 MW from renewable power by 2010, which would be 10% of the total installed power generating capacity in the country

- India is fourth in term of wind power installed capacity, seventh in term of solar cells production and second in term of installation of biogas plants in the world.

Hydrogen Energy in India

- R D & D Programmes in Hydrogen Energy and Fuel Cells for over two decades
- Group on Hydrogen Energy set up by National Planning Commission in 2003 to assess the Hydrogen Energy situation in India and propose new approach for the accelerated development of hydrogen energy
- National Hydrogen Energy Board set up by the Ministry in October, 2003. Board has high level representation from government, industry, industry associations, academia, experts and eminent public figures. Three meetings of the Board held in February, 2004, September, 2004 and January, 2006.
- National Hydrogen Energy Road Map was prepared under the guidance of the Board and approved by the Board in January, 2006

National Hydrogen Energy Road Map : Goals & Targets

A. Green Initiative for Future Transport (GIFT)

Demonstrate One Million Hydrogen Vehicles

- 700,000 two wheelers
- 50,000 three wheelers
- 50,000 cars and taxis
- 100,000 buses and vans

B. Green initiative for Power Generation (GIP) :

Set up 1,000 MW Hydrogen Based Power Generation Capacity

- 50 MW small IC engine stand alone generators
- 50 MW stand alone fuel cell power packs
- 400 MW Gas Turbine Based Power Plants
- 500 MW Central Fuel Cell Power Plants

C. Investment for Infrastructure and R&D : 5.5 Billion US $

Hydrogen Energy R&D in India

R & D Focus on:

- Hydrogen Production
- Hydrogen Storage
- Applications in automobiles and power generation using IC engines and fuel cells
- Hydrogen System Integration

Strategies

- R&D through Public Private Partnership
- Demonstration through Public Private Partnership
- Safety, Standards and Codes
- Awareness and Capacity Building
- Commercialization of New Hydrogen and Fuel Cell Technologies

Hydrogen Production

- ***Focus on R & D for hydrogen production through renewable energy sources :***

  Biological processes through fermentation of organic wastes, biomass etc

  Water- splitting using solar energy through photo- catalytic and photo - electrochemical methods

  Electrolysis of water and methanol using polymer electrolyte membrane electrolyzers

- ***Options for large scale production of hydrogen in future* :**

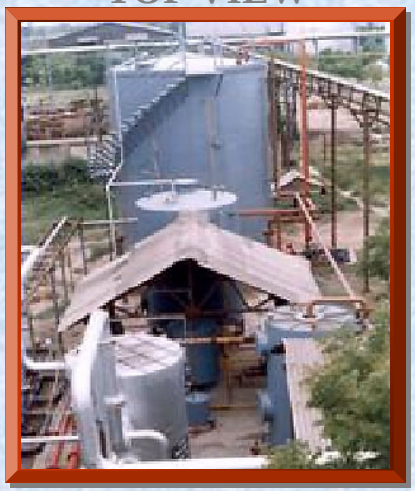
  Gasification of coal

  Thermo-chemical splitting of water using nuclear energy

  Solar assisted hydrogen production

Bio Hydrogen Plant

TOP VIEW



SIDE VIEW

FRONT VIEW

REACTORS

Hydrogen Storage – Thrust Areas for R&D

- Indigenous development of high pressure gaseous storage cylinders
- Improvement in storage capacity (upto 9 wt%) and cycle life (~1500) for inter-metallic hydrides, in phases
- Hydrogen storage in carbon nano-materials and complex hydrides (sodium alanates)
- Other forms of hydrogen storage in zeolites, chemical hydrides etc.

Fuel Cells – Thrust Areas for R&D

Polymer Electrolyte Membrane Fuel Cells

- **Development of indigenous low cost membrane**
- **Development of low cost graphite based bipolar plates**
- **Development of higher CO tolerant anode catalyst**
- **Development of cheaper cathode catalyst**
- **Development of electrode support substrate (graphite paper)**

Solid Oxide Fuel Cells

- **Development of technology for intermediate temperature planar and tubular type SOFC**
- **Development of indigenous sources for raw materials required for SOFC**

FUEL CELL APPLICATIONS IN INDIA

Technology Missions proposed in National Hydrogen Energy Road Map

- Clean Coal Gasification Technologies for Hydrogen Production
- Hydrogen Production through Biological Routes
- Hydrogen Production through Solar Energy (electrolysis, photolytic, photo-electrochemical and thermal splitting)
- Hydrogen Storage in Hydrides
- Hydrogen Storage in Carbon Nanostructures
- Development of IC Engine for Hydrogen fuel
- Development of PEM and SOFC Fuel Cell Technologies

Recent Initiatives

- Implementation of development cum demonstration projects through industry / public - private partnership.
- Support to several new R&D projects.
- Technology Development for SOFC in a Mission Mode
- Strengthening the Hydrogen Energy Centre at Varanasi (North India)
- Setting up National Fuel Cell Centre in New Delhi

HYDROGEN FUELLED VEHICLES IN INDIA

Project on Hydrogen Fuelling Station

- Work initiated for setting up a Hydrogen Fuelling Station in New Delhi
- A water electrolyser with 5 NM^3/hour capacity for hydrogen production to be installed at the fuelling station
- Neat Hydrogen and Hydrogen-CNG blends to be dispensed in vehicles.
- Station likely to become operational by March, 2008


TOYOTA
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Project on Hydrogen-CNG blending

- Project planned for introduction of hydrogen-CNG blends in vehicles through industry participation
- Modification in engines and fuel delivery system
- Optimization of hydrogen-CNG blends for

  - Minimization of emissions

  - Optimal performance
- Seven existing CNG vehicles (3 buses, 2 cars and 2 three wheelers) to be modified to run on hydrogen - CNG blends.

Dedicated Hydrogen Engine

- Experience from H-CNG project would help in development of dedicated Hydrogen Engine
- National Hydrogen Energy Road Map gives high priority on IC Engine route
- Indian Auto Industry also wants to focus on IC Engine route in the initial stages
- Switch over to fuel cell route when fuel cells become cheaper

Hydrogen Power Generating System (10 KW)

National Centre for Hydrogen Energy and Fuel Cells

- National Centre for Hydrogen Energy and Fuel Cells to undertake work on:
  - Research, development and demonstration of technologies
  - Testing of devices and systems
  - Development of Codes, standards and safety practices
  - Capacity building and awareness

CONCLUSION

- **Commercialization of Hydrogen Energy Technologies is far off and needs to be accelerated.**
- **Demonstration of technologies and creation of public awareness to be stepped up.**
- **Strengthening of International Cooperation through IPHE framework in research, development and demonstration.**
- **Hydrogen Energy Conclave is being held on 4th June, 2007 in New Delhi for identifying opportunities for public private partnership in the implementation of the National Hydrogen Energy Road Map.**

Possible Areas of Co-operation

- **Hydrogen production from renewables, especially from fermentation and solar assisted routes**
- **Hydrogen production from coal gasification**
- **High efficiency hydrogen storage materials for on board storage**
- **Low Temperature Fuel Cells (AFC, PMFC) and High Temperature Fuel Cells (SOFC), including fuel cell materials, components and system development**

Possible Areas of Co-operation

- Demonstration of fuel cell systems for public transport and stationary power generation applications, using by-product hydrogen from chlor-alkaly industry
- Development and demonstration of direct use of hydrogen in IC engine
- Development of Codes, Standards and Safety practices
- Co-operation with scientific and academic institutions and exchange visits of scientists & technologists
- Co-operation between industry for R & D, technology demonstration, joint-ventures, local manufacturing and commercialization


THANK YOU