Hydrogen & Fuel Cell Activities in Korea

January 21, 2005

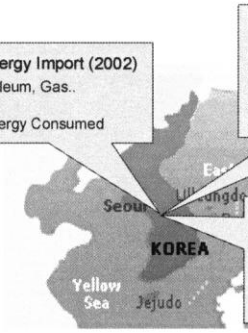
Seong-Ahn Hong*
National RD&D Organization for Hydrogen and Fuel Cell

* Affiliated with Korea Institute of Science and Technology

Energy Situation in Korea

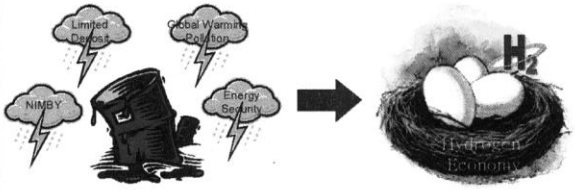
Primary Energy Import (2002)
- Coal, Petroleum, Gas..
- $ 32 B
- 97 % of Energy Consumed

Energy Consumption (2002)
- Coal: 33 B M/T
- Petroleum: 722 M bbl
- City gas: 14 B m^3
- Electricity: 280 TWh
- No. 10 in World



Electricity Production (2002)
- Hydro: 1.7 %
- Atomic: 38.9 %
- Coal: 38.5 %
- Petroleum: 8.2 %
- Gas: 12.7 %

Hydrogen Economy



Hydrogen Energy : Most Feasible Solution to Energy Problems

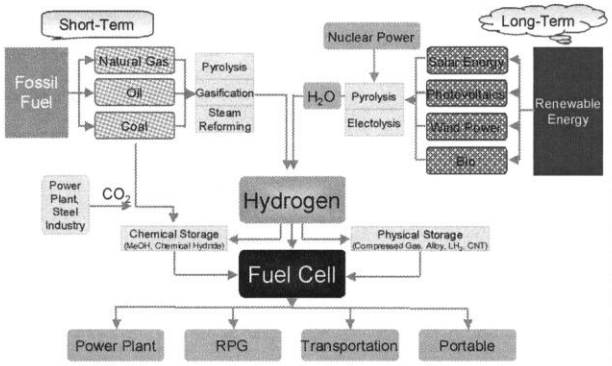
↓

Fuel Cell : Core Technology for Hydrogen Energy Utilization

↓

Selected as One of 10 Economy Growth Engine for Next Generation

Hydrogen and Fuel Cell



Advantages & Disadvantages (Fuel Cells)

- Advantages
  - High efficiency: no Carnot limit (>40%)
  - No pollution: no emission of NO_x and SO_x
  - No noise: no moving part
  - Module: easy to construct and add up
  - Multi-fuel: gasoline, natural gas, methanol, coal gas, ...
  - Cogeneration system: possible to use high quality waste heat
- Disadvantages
  - Cost down needed
  - Reliability of technology
  - New infrastructure needed

Brief History

Period		'88 ~ '94	'95 ~ '99	'00 ~ '02
Objectives		Fundamental Technology	Scale-up	System Engineering
Budget	Hydrogen	Government: $ 5 M Private Sector: $ 1.5 M		
	Fuel Cell	Government: $ 40 M Private Sector: $ 34 M		

Current Status

Type	Status
Hydrogen	Basic technology focused on alternative energy
MCFC	100kW demonstration plant under construction (2001~2005)
PEMFC for RPG	Proto-type 3kW system development (2001~2004)
PEMFC for Transportation	FCV(80 kW fuel cell) development (2004~2009)
DMFC	50 W portable power pack development(2004~2007)
SOFC	1.5 kW RPG system (2003~2006) 3kW APU system (2004~2007)

Government Policy

- Increase portion of alternative energy in national energy consumption
  - From 1.4 % in 2002 to 5 % by 2011
- Select Hydrogen and Fuel Cell as one of 10 economy growth engine for next decade
- Strong support for R&D
  - National RD&D Organization for Hydrogen and Fuel Cell (MOCIE)
  - Hydrogen Energy R&D Center (MOST)

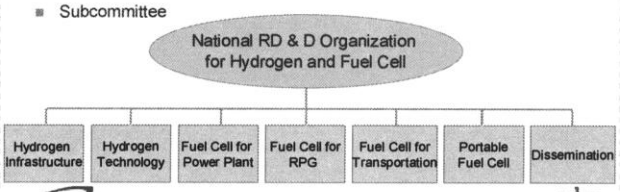
	Government Budget for next 8 years		
	MOST	MOCIE	Total
R & D for Hydrogen	$ 80 M	$ 110 M	$ 190 M
R & D for Fuel cells	$ 40 M	$ 280 M	$ 280 M
Demo. & Dissemination		$ 250 M	$ 250 M

Dissemination Plan for Hydrogen · Fuel Cells (Ministry of Commerce, Industry & Energy)

Classification	Phase I ('03-'05) R&D for Reliability	Phase II ('06-'08) Dissemination	Phase III ('09-'12) Penetration & Enlargement of Market
Hydrogen Station	1	10	50
Distributed Power Generation	Cumulative 300 units (250-1,000 kW)		
Building	Cumulative 2,000 units (5-50 kW)		
RPG	Cumulative 10,000 units (less than 3 kW)		
Transportation	Passenger Car: 10 Bus: -	Passenger Car: 300 Bus: 30	Passenger Car:3,200 Bus 320

National RD&D Organization for Hydrogen and Fuel Cell

- Role
  - Established in 2003 to expedite the commercialization of hydrogen and fuel cell technology
  - Suggest vision to hydrogen economy
  - Develop a national plan and road map to create a new energy industry
  - Set up a detailed action plan to meet nation's dissemination target
  - Co-ordinate and allocate RD&D programs supported by government
- Subcommittee



Vision of Hydrogen/Fuel Cell

Realization of Hydrogen Economy (2050+)

<National Plan for Hydrogen Economy (2040+)>

◇ Replacement of 20% out of national energy demand by hydrogen energy produced from renewable energy and fossil fuel
◇ Replacement of 30% of automobile fuel by hydrogen energy
◇ Replacement of 30% of power plant by fuel cell generation

< Target >

◇ Creation of New Hydrogen·Fuel Cell Industry
- Hydrogen station (2010+)
- Construction of hydrogen infrastructure (2015+)
- Fuel cell vehicle (2012+)
- Fuel cell power plant (2010+)
- Residential/commercial fuel cell (2010+)
- Power generator for IT and potable device (2008+)

Vision of Hydrogen/Fuel Cell [continue]

< Short-term Target for Dissemination >

Classification	Phase 1('03~'05) R&D for Reliability	Phase 2('06~'08) Dissemination	Phase 3('09~'12) Penetration and Enlargement of Market
Hydrogen Station	1	10	50
Distributed Power	Cumulative 300 units (250~1,000kW)		
Building	Cumulative 2,000 units (5~50kW)		
Residential Power	Cumulative 10,000 units (<3kW)		
Transportation	Passenger car 10 Bus ~	Passenger car 300 Bus 30	Passenger car 3,200 Bus 320
Potable Power	Development of key tech. for commercialization	Commercialization of each item	

Vision of Hydrogen/Fuel Cell [continue]

< Action Plan >

◇ Hydrogen Infra and Hydrogen Technology
- Construction and demonstration of hydrogen station (2004~2008) √
- Development of 30 Nm³/hr class hydrogen station (2004~2006)
- Hydrogen Production(Biological, Photochemical, photoelectrolysis, thermochemical, electrolysis)(2003~2010)
- Hydrogen Storage(High pressure storage system, Metal hybride, Nano Materials, Chemical hybride) (2003~2010)
- Hydrogen Sensors / safety (2003~2010)
- Hydrogen Policy (2003~2010)

◇ Fuel Cell for Power Plant
- Development of 100 kW class MCFC system (2001 ~ 2005)
- Development of 250 kW class CHP MCFC Prototype (2005 ~ 2008)
- Development of MW class MCFC system (2008 ~ 2012)
- Demonstration of 250 kW class MCFC system (2004 ~ 2007) √
- Development of original MCFC model (in processing)

◇ Fuel Cell for Transportation
- Development of 80kW class power for vehicle (2004 ~ 2006) √
- Establishment of fuel cell module and system performance (2007 ~ 2009)
- Establishment of reliability on fuel cell module and system (2010~2013)
- Development of fuel cell bus (in processing)

Vision of Hydrogen/Fuel Cell [continue]

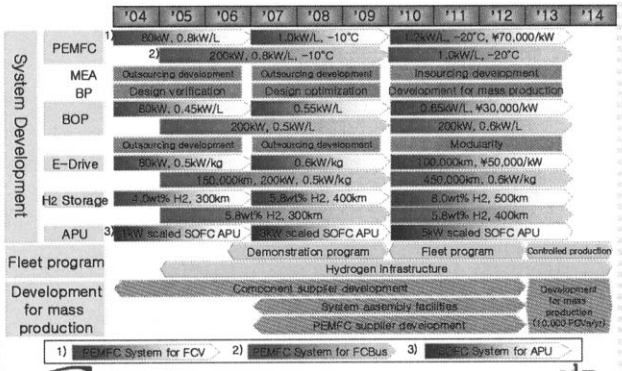
< Action Plan >

◇ Fuel Cell for Residential Power and Building
- Development of 3kW PEMFC system for residential power (2002 ~ 2004)
- Demonstration of residential PEMFC system (2004 ~ 2005) √
- Development of 1kW SOFC system for residential power (2003 ~ 2006)
- Development of 1~3kW SOFC system for APU (2004 ~ 2006) √
- Development of 5~50kW PEMFC system for building (in processing)
- Development of 5~15kW CHP SOFC system for building (in processing)

◇ Fuel Cell for Potable Power
- Development of 50W class PEMFC system (2004 ~ 2006)
- Development of 50W class DMFC system (2004 ~ 2006) √
- Development of 2W class DMFC system for IT (in processing)
- Development of 50kW PEMFC system for mobile power (2004~2007)

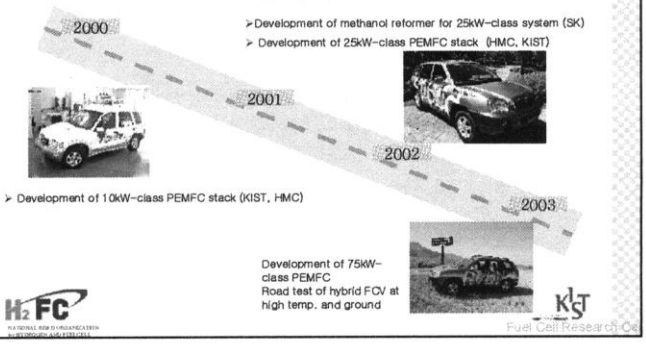
◇ Commercialization
- Demonstration and evaluation of domestic and imported system
- Participation in validation of Code & Standards
  - Hydrogen · Fuel Cell Standardization (2004 ~ 2006) √
- Demonstration plan of hydrogen production, delivery, storage (Power Park)
- Education and public information for enlargement of social infrastructure
- Drafting of a government policy for affordable market introduction
- Organization of evaluation center
- Acceleration of international co-work

Action Plan - PEMFC for Transportation

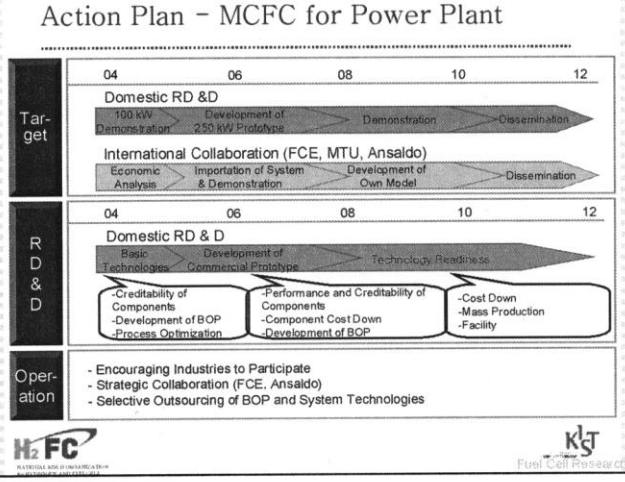


PEMFC for Transportation

- Participants
  - Main Contractor: Hyundai Motor Company
  - Sub Contractors: KIST, SK, Universities...

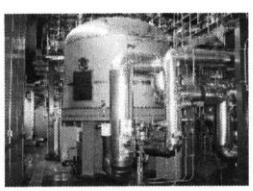


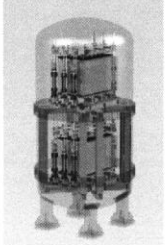
Action Plan - MCFC for Power Plant



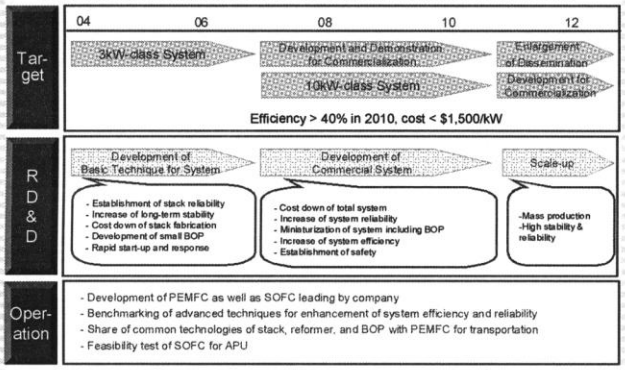
MCFC for Power Plant

- Participants
  - Main Contractor: KEPRI/POSCO
  - Sub Contractors: KIST, RIST, Twin Energy, Hyosung HI, Samsung Engineering, Universities...



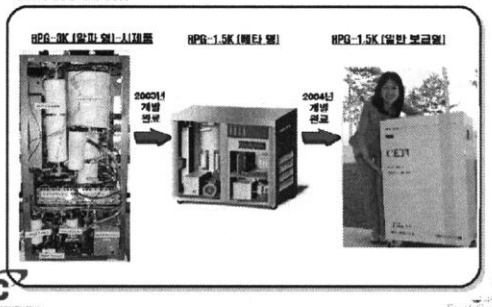


Action Plan – PEMFC/SOFC for RPG



PEMFC for RPG

- Participants
  - Main Contractor: CETI
  - Sub Contractors: KIER, KEPRI, KOGAS, Hankook Tire, Universities...

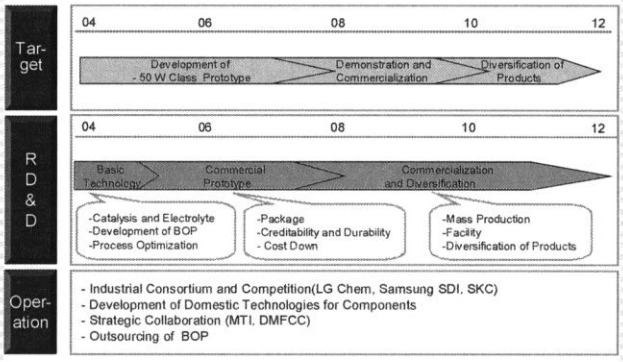


Dissemination Plan of RPG Fuel Cell

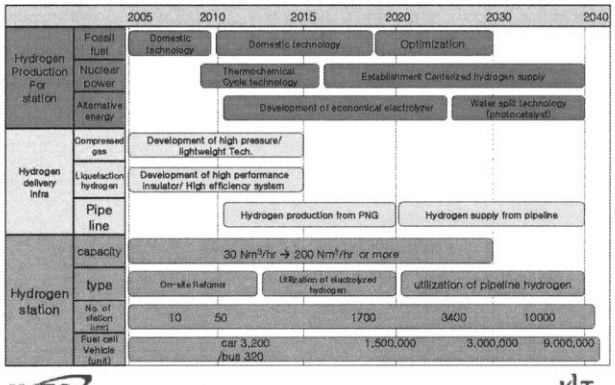
Year	Number of Units	Target Price ($/kW)
2006	100	50,000
2007	300	20,000
2008	600	15,000
2009	1,000	7,000
2010	1,500	5,000
2011	2,500	4,000
2012	4,000	3,000

1$=1,000 Won

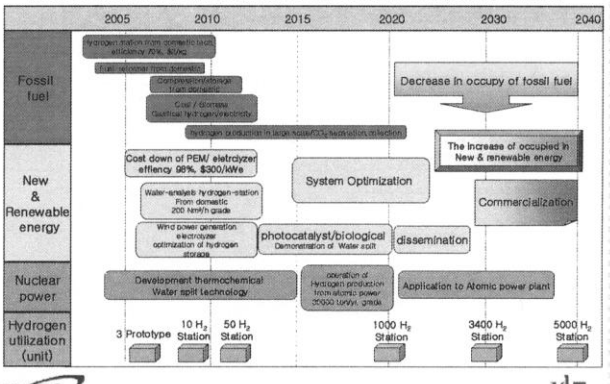
Action Plan - DMFC for Portable Power



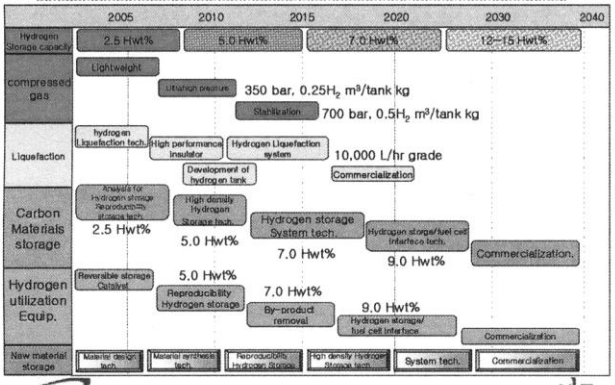
Roadmap of hydrogen infra



Roadmap of hydrogen production



Roadmap of hydrogen storage



Supports from Government

- Subsidy
  - To promote dissemination of fuel cell systems by subsidizing the difference between production cost and market price of electricity
- A low-interest loan for fuel cell manufacturers and users
  - Interest rates : 5.0 % → 2.0 ~ 3.0 %
  - Up to $ 8 M per each manufacturer
- Tax-reform
  - Tariff : 8.0 % → 2.8 % for all alternative energy equipments
  - Local tax on land where alternative energy facility locates will be cut by half
- Others
  - Mandatory installation in public building

Conclusion