International Partnership for Hydrogen and Fuel Cells in the Economy

2014 Korea Update

21st IPHE SC Meeting Oslo, Norway

Hydrogen and Fuel Cells in Korea

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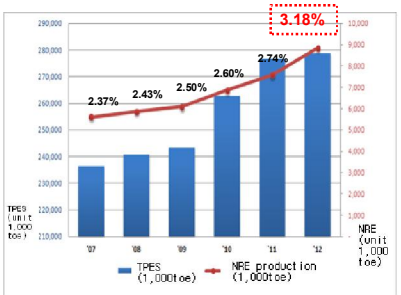
The Status of New and Renewable Energy(NRE)

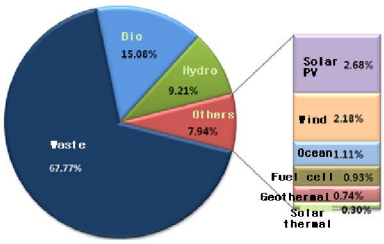
▶ NRE (New and Renewable Energy) Share in TPES (Total Primary Energy Supply): 3.18% (2012)
- TPES(278,698,000TOE) vs. NRE Supply(8,851,000 TOE)

▶ **NRE** supply has been increased by annual average of 9.6% (2007-2012)
(while annual average of TPES growth is 3.3%)

NRE Share in TPES



NRE Supply by Sources



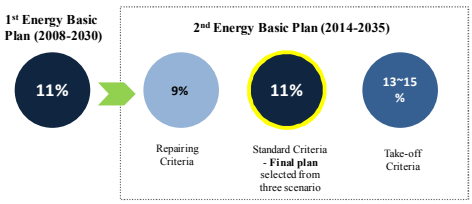
- **RE : 8 Sources**
PV, Solar Thermal, Wind, Waste, Bio(LFG, Bio-Fuels), Hydro, Geothermal, Marine
- **New Energy : 3 Sources**
Fuel-cell, Hydrogen, Coal Liquefaction or Gasification

The Status of New and Renewable Energy : Policy

2nd Energy Basic Plan (2014)

- Goal of Supply 11% from New & Renewable Energy Sources by 2035
- 4th New & Renewable Energy Basic Plan will be announced in 2014

Compare share of renewable energy in the primary and secondary energy master plan



[Supply Status]

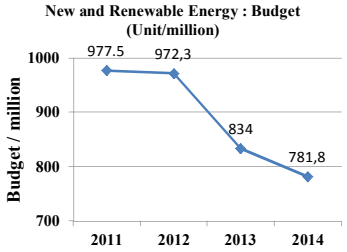
By 2012, the distribution share based on primary energy is 3.18%, while waste, bio and water power accounted for 92% of the total production of the renewable energy.

* Average Annual Increasing Rate ('08-'12,%) : Solar (41), Wind (20), Fuel cell (109), Geothermal(43), Bio (33)

Compared to the total energy generation, the renewable energy generation possess 3.7 % and 80% of the total renewable electricity generation are from waste and water.

2014 New and Renewable Energy R&D : Budget

	2013 Budget	2014 Budget
New and Renewable Energy : Budget	834.02 (million dollar)	781.80 (million dollar)



2013 R&D Budget 264.85 million dollar

7.9%

2013 Hydrogen & Fuel-cell Budget 33.4 million dollar

2014 R&D Budget 242.84 million dollar

7.8%

2014 Hydrogen & Fuel-cell Budget 30.9 million dollar

-10.8%

[Technology Development]

- In the last five years ('08 - '12), more than 70% of the total R & D budget have been supported by the selection and concentration strategy to the three main energy sources of photovoltaic (32.2%), fuel cells (21.9%) and wind (16.4%).

Go-deok vehicle production base of 45,000 household power

Installed the world's first 10 million people metropolitan scale 20MW.
Expected use of environmentally friendly fuel cell power plant case.

◆ **Construction area : 4,133㎡**
◆ **capacity of generating plant : 20MW**
(2.8MW×7, Power supply facilities for emergency)
◆ **Generating System Type : Fuel Cells (Fuel: LNG)**
◆ **Working expense:**
SK E&S(c) invested 105 billion KRW
POSCO Energy: maintenance and repair facilitie

▲ Go-deok fuel cell power plants and green energy business overview

Expected Effect

- The annual production of 168Gwh electricity power supplies for 45,000 households.
- The produced 91,000 Gcal of heat was supplied to 9,000 households in Gangdong-gu area.
- Production of 34,000 TOE by new generation energy can enhance the 0.3% of electricity independence.
- The installed decentralized energy supplying system utilizing underused space in subway car base contributed the power supply to metropolis.
- Contribution to stable operation of subway by supplying the fuel cell as the spare power source in subway car base.

서울특별시

Seoul begins to develop 'Fuel Cell' for eco-friendly power supply

Seoul, Management state of Fuel-Cell Facilities (The end of 2013)

Total	**Power Plant** (Attract private capital)	**For home use** (Green-Home Supply Business)	Seoul Project	**Notes**
290 Places, Capacity 6,085kW	2 Places Capacity 4,800kW	285 Places Capacity 285kW	3 Places Capacity 220kW	LOTTE SUPER TOWER 800kW *(400kW*2, Installation of Fuel-Cells is Complete.)

Case of Installation : Fuel-Cell Power Plant (Seoul)

2.4MW
Fuel-Cell Power Plant

Seoul begins to develop 'Fuel Cell' for eco-friendly power supply

Fuel-Cells supply status :A total of 22 places, capacity 123.8MW

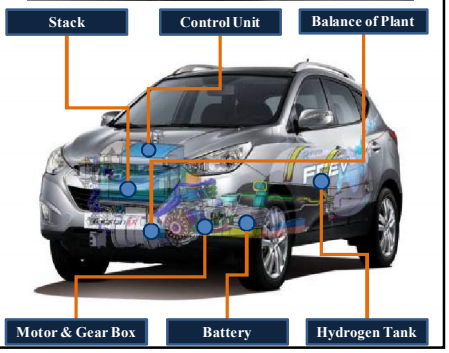
No.	Date of Operation (yy.mm)	Installed Place	Capacity
1	'06.11, '13.04	KOSEP(Korea South East Power CO.) / Gyeonggi	3.38MW
2	'08.03	POSCO ICT /Pohang	300KW
3	'08.09	HS ENP / Jeonju	2.4MW
4	'08.09	Natura Power / Gunsan	2.4MW
5	'08.09	KOMIPO(Korea Midland Power CO.) / Boryeong	300KW
6	'08.10	POSCO ENERGY /Pohang	2.4MW
7	'09.05	SH Corporation / Seoul	2.4MW
8	'09.10	MPC Youl Chon Power / Yeosu	4.8MW
9	'09.10	GS EPS / Dangjin	2.4MW
10	'09.10, '13.02	KOSEP(Korea South East Power CO.) / Il-san	5.2MW(2.4MW+2.8MW)
11	'10.01	POSCO POWER / Inchoen	2.4MW
12	'10.05	Byuck San Engineering & Construction / Pusan	1.2MW
13	'10.08	GS Power /An-yang	4.8MW
14	'10.09, '11.06	TCS1 / Deagu	11.2MW(5.6MW*2)
15	'10.10	POSCO ENERGY / Sangam	2.4MW
16	'11.04	KOSEP(Korea South East Power CO.) / Il-san	2.8MW
17	'11.10	The Cobalt sky / Pusan	5.6MW
18	'12.01	MPC Youl Chon Power /Yeosu	5.6MW
19	'12.02	Seoul (For building, Hospital)	100kW
20	'12.02	Seoul (For building, Seoul Children's Grand Park)	100kW
21	'13.08	KOSEP(Korea South East Power CO.) / Ulsan	2.8MW
22	'13.12	Gyeonggi Green Energy / Gyeonggi	58.8MW

FCEV Development – Tucson ix

FCEV – Tucson ix

- 'Tucson ix' which is equipped with independently developed 100KW Fuel Cell System with 2 H_2 containing tank(700 atm)
- Driving 594km by charging once, Fuel Efficiency 27.8km/L
- Start-up Ability with under -20 ℃
- Total 1000 H2 Fuel Cell will be produced until 2015
- The automaker started to develop an FCEV in 1998 and the first FCEV to be tested was a Santa Fe SUV in 2002, followed by a Tucson SUV in 2007 and then a Tucson ix35 model in 2012. It recently introduced the new Tucson hydrogen fuel-cell crossover at the L.A. Auto Show

Tucson ix Fuel Cell Vehicle Spec	
Fuel-Cell Stack	100KW
Motor(Fuel Cell Power)	100KW
H_2 Tank	700atm(H_2 storage:5.6kg)
Energy Storage	24KW Li-Ion Polymer Batt.
Max. Speed	160 km/h
Acceleration(0→100km)	12.5 S
Driving Range(maximum mileage/Cruising range by 1 charge)	594km
Gasoline equivalent fuel-efficiency (NEDC*)	27.8km/L(0.95kg • H2/100km)



FCEV Development – Tucson ix

By 2025, Cumulative 10,000 vehicles

▲Hyundai Motor's fuel-cell Tucson. (Hyundai Motor)

- Main components of the hydrogen fuel cell vehicle were achieved more than 95% localization through the collaboration with more than 200 domestic partners.
- In order to maintenance and A/S for the hydrogen fuel cell vehicles,

→ Exclusive service center will be expanded 23 centers, 100 maintenance shops until 2025.

- At the present (2014. 04) in Korea, 11 Hydrogen stations are operated. In 2014, two hydrogen stations charging pressure of 700bar will be constructed.
- Department of Environment in Korea plans to build additional 10 hydrogen stations by 2020 and 200 hydrogen stations by 2025.

Combined Support Program : Ulsan H_2 Town

H-Town Pilot Project for Housing

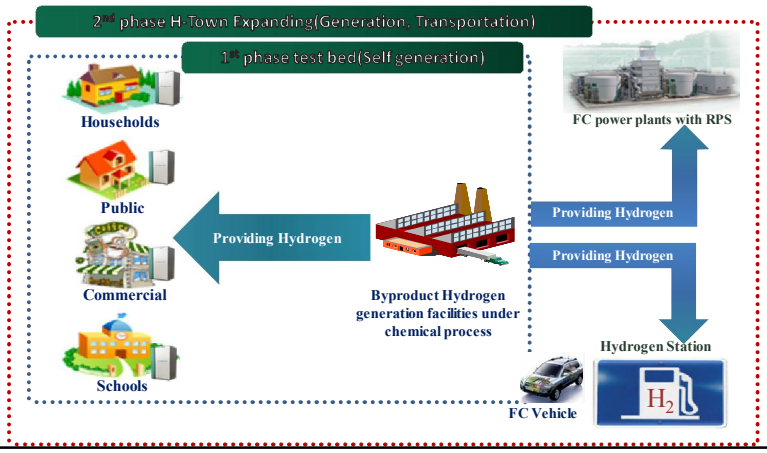
Using byproduct hydrogen under chemical process to produce fuel cell (no need for reformers)

-Diversification of energy and reinforcement of fuel cell's price competitiveness
→ Development of hydrogen fuel cell and expansion in the market

-Promoting Ulsan consortium (local government, a hydrogen supply company, 4 manufacturing companies, etc)

* Facilitate 140 household, 3 public & private buildings, infrastructures, and FC advertisement center

** For the households, installed capacity of 185kW in facilities and invested 8.8mil USD



New and Renewable Energy Test-bed

Background

- Not enough developed basis for NRE companies
- To commercialize new NRE product, test- beds are necessary for SMEs to do performance test, durability inspection, equipment test, etc.

➡ Building test-beds for technology & product of SMEs (40mil USD)

Regional Promoters

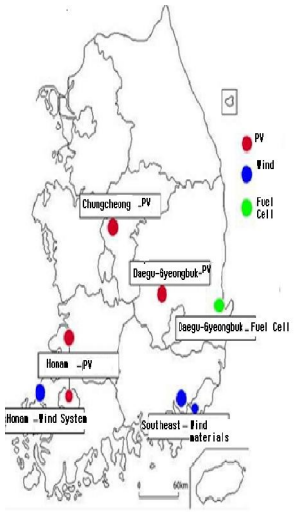
- 6 test-beds(institutes) selected for Test Bed Development

- PV(3) : ① middle-west area(chung-buk TP),
  ② South-east area(Kumi institute of electric information technology)
  ③ South-west area(Jeon-buk Univ & Guwang-ju institute of industrial technology)
- Wind(2) : ① South-west(Chun-nam TP-System)
  ② South-east(Kyung-nam TP & Busan TP-Component
- **Fuel cell : South-east(Postech)**

New and Renewable Energy Test-bed : Current Status of Certified Test-bed promoters

➢ Development of the cluster linking industries and academies with 6 test-beds as center of diffusion. (2014~)

Energy Source	Region	Promoters	Investment(3yrs) (public+private) (100 mil KRW)	Equipments
PV	(1)Chung Cheong	Chungbuk Techno Park	267	64 Equipments (Cell Simulator, Module Solar Simulator etc)
	(2)Daegu-Gyeongbuk	Gumi Electronics Research Institute	211	38 Equipments (Anti-reflective Coating & Doping System, Sun Accelerated etc)
	(3)Honam	University-Industry Collaboration Center at Chonbuk University [main, Honam Regional HQ of KITECH [co-promoter]	138	20 Equipments (Wafer Inspection System, Wire Sawing, Materials Light Exposure Test system etc)
Wind	(4)South East	Gyeongnam Techno Park [main] Southeastern HQ of KITECH [co-promoter]	166	26 Equipments (Pitch/Yaw System Performance Test Equipment, Dynamometer Controller Inverter etc)
	(5)Honam	Jeonnam Techno Park	105	9 Equipments (Power Substation System, Wind Power Monitoring system etc)
Fuel Cell	(6)Daegu-Gyeongbuk	University-Industry Collaboration Center at POSTECH	138	59 Equipments (Fuel Cell System Performance Evaluation Station, Reformer Tester etc)
		Total	1,024	



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Thank you for your attention.