Initial Stage of Commercialization of Residential Fuel Cells in Korea

Current State of FC in Korea

Current State

	State
PEFC Residential Power Generation	- At the stage of field test and Demonstration, plan to dissemination for Green Home distribution Plan. - 210 Units installed by 2009 under demonstration program Manufacturer: GS FuelCell, FuelCell Power, HyoSung
MCFC Distributed Power	- 300kW(from 2007) and MW Plants(from 2008) are Developing by Doo-San Heavy Ind. - POSCO Power is manufacturing MCFC systems by technical alliance with FCE.
SOFC	- At the stage of R&D - 5kW, 25kW, 100kW, 180kW Stacks and systems are developing by KEPRI, SamSumg, and POSCO Power.

Roadmap for Small Stationary Fuel Cells

Short -term			Long-term	
2008	2010	2012	2020	2030
Electric efficiency : 38% **Heat recovery : 48%** **Durability : 40,000 hrs** **Cost : 20000 USD**			**Electric efficiency : 40%** **Heat recovery: 50%** **Durability : 90,000** **Cost : 3,000 ~5,000 USD**	
R&D of BOPs, Components				
Dissemination of 1kW RPGs			Dissemination of 100,000 RPGs	
	Field Monitoring of Commercial Cogeneration Fuelcells		Dissemination of Commercial Cogeneration Fuelcells	

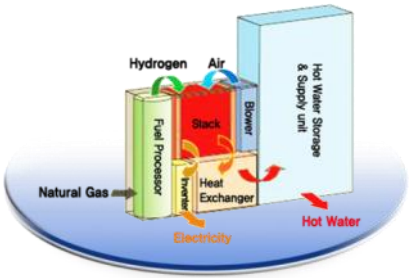
History of RPG Development

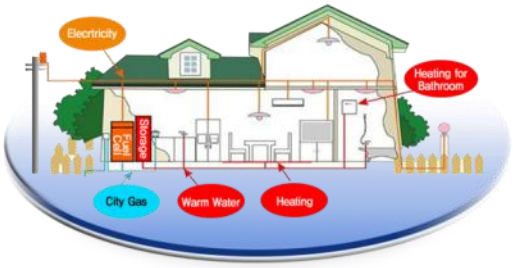
1996 ~ 2001
Development of 5kW RPG
(Korea Institute of Energy Research)

2004~ 2006
Development of 3kW RPG
(CETI)

2004~ 2006
Initial Field Test of 1kW RPG
(Fuel Cell Power, GS Fuel Cell, Daegu City Gas)

2006~ 2009
Field Monitoring of 1kW RPG
(KOGAS, Gas Companies, Regional Government, Fuel Cell Power, GS Fuel Cell)





Small stationary fuel cell systems in Korea

1kW fuel cell system for homes

United type (A model to minimize a floorage)

Separated type (A model to minimize a height)

5kW fuel cell system

Index	Specifications
Electric capacity	1kW / Grid connected, 220V
Thermal capacity	1.3kW (A built-in 27,000kcal of auxiliary boiler)
Heat storage	60℃ (140℉) / thermal storage capacity of 150 ℓ
Fuel	LNG / LPG
Efficiency	Electric efficiency 36% over / Thermal efficiency 46% over
Operation feature	Automatic, web-based, and load following operation (50 ~ 100%)
Size (Separated type)	800 X 490 X 910 mm / 820 X 490 X 1,200 mm
Size (United type)	806 X 616 X 1,800 mm
Applications	Home, small stores, and etc.
Features	Water cooling, Air cooling, and water recycling system

Index	Specifications
Electric capacity	5kW / Grid connected, 220V
Thermal capacity	6.5kW
Heat storage	60℃ (140℉) / thermal storage capacity of 200 ℓ
Fuel	LNG / LPG
Efficiency	Electric efficiency 33% over / Thermal efficiency 50% over
Operation feature	Automatic, web-based, and load following operation (50 ~ 100%)
Size	1,200 X 650 X 1,400 mm / 650 X 650 X 1,400 mm
Applications	Computer rooms, small stores, buildings, and etc.

High Temperature PEM System

- Demonstrated comparable performance to low-temp fuel cell systems
  - Advantage in efficiency in fuel processor and BOP and parasitic power
  - Disadvantage in stack efficiency
- Should have competitive advantages in system robustness and use of higher quality heat

Main Specification		**SAIT (HT-PEM FC)**		Typical (LT-PEM FC)
		(2008)		(2009)
Electrical Efficiency (HHV)	Stack [%]	**46.4**		50
	FP [%]	**85.7**		82
	PCS [%]	**92**		92
	BOP [%] (Parasitic Power [W])	**93 (81.1)**		90 (121)
	Total [%]	**34**		34
System Volume [L]		**286**		286.3

Demonstration at KOGAS

1st stage (2006)

2nd stage (2007-8)

3rd stage (2008-9)

Monitoring Project for Residential Fuel Cell

Residential Fuel Cell Monitoring National Project

	'06. 8 - '09.7	'07.12 - '10.11	'08.12 - '11.11	Total
Subsidy(Billion Won)	5.5	7.0	8.0	20.5
Units (E.A.)	40	70	100	210
Price (Million Won)	130	100	80	-
Operator	City Gas	Local Government	• Energy related Company • Private person	-
Tactic	Training and installation start to the natural gas supplier	Driving forward connected to the governmental population project of New and Recycled energy to the locality	Securing the optimal operation method for needs of user	-

※ Main Contractor : Korea Gas Company

Small stationary fuel cell systems Evaluated in Korea

Monitoring Project

5kW (IHI)

5kW (Plug Power)

5kW High Temp PEM (Plug Power)

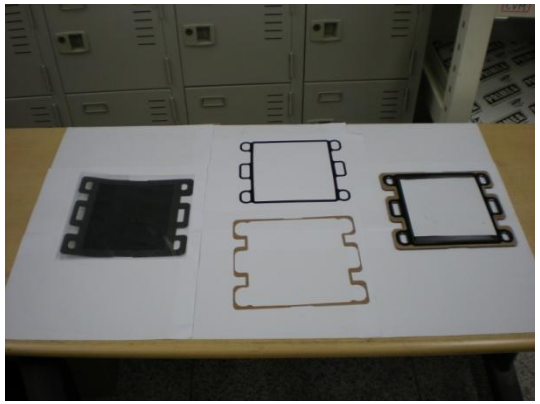
640X740X1730mm
(50liter Water tank)

1kW (LS Industry)

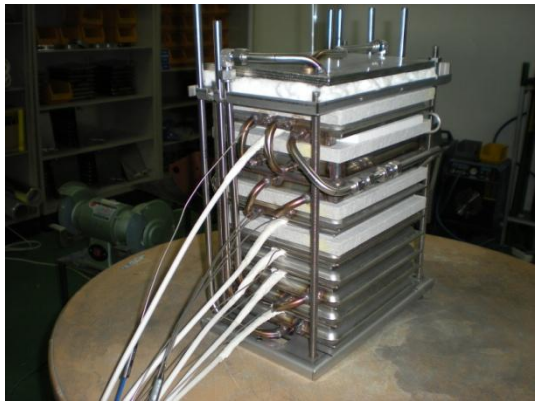
1kW PEM
(Hyundai Hysco)

L540 x W690 x H1650
(160 liter Water tank)

Component Checking in monitoring project



Stack



Fuel Processor

Stack

BOP & Control board

System manufacturing

Evaluation of fuel cell and installation

Evaluation instruments

Remote controller

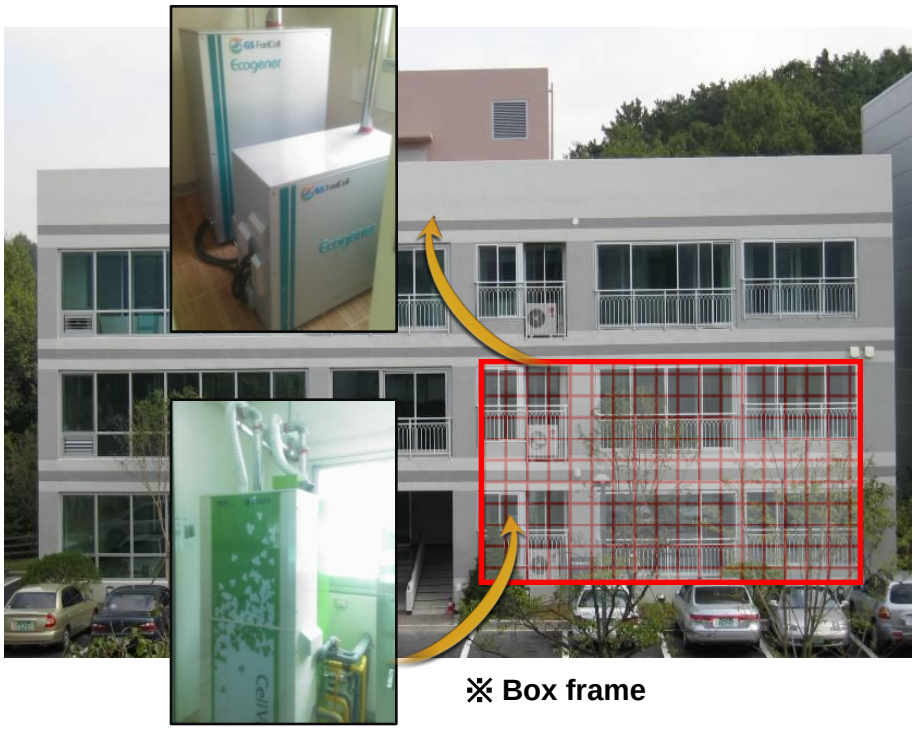
Stationary Fuel Cell Certification

Wind test

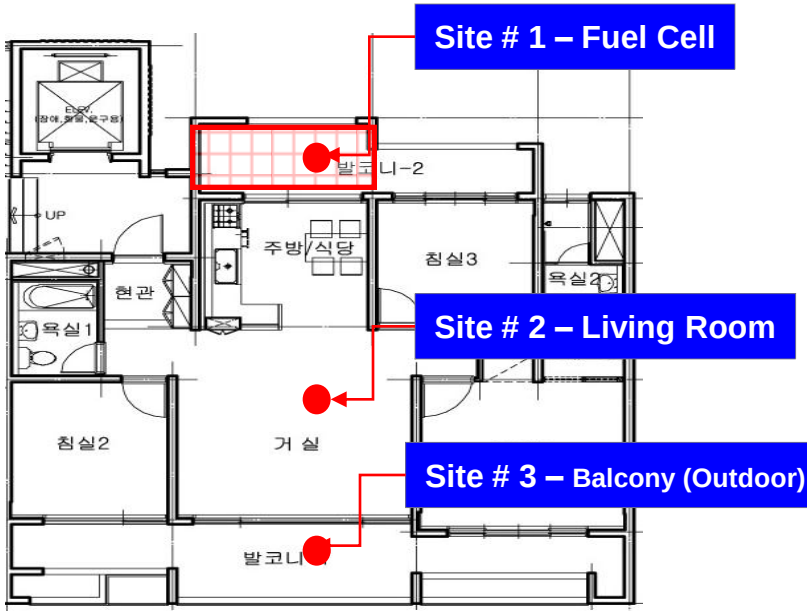
Wet-proofing test

Temp. test

Evaluation at Construction Company



※ Box frame



Items	Analysis
SO_2, NOx,, O_3, CH_4, THC, CO, CO_2, PM_{10} :	Analysis system (HORIBA, APSA-370 series, VA-3000)

Demonstration at Public sites

Gyunggi provincial
governor residence (’08.11)

Seoul city hall<Nam-san>
(’08.7)

Mayor official residence
of Gwachon city (’08.11)

Official Residence
of KIST Director (’08.12)

Seoul city hall<Seoso-mun>
(’08.4)

Rainwater pump place
(’08.8)

Demonstration at Public sites

Monitoring Project

Presidential residence ('09.10)

Daegu urban development Corporation (of building roof)

Gyungbook National Univ.

KOGAS

Han Gin city gas

Korea world trade center complex (COEX)

Demonstration at Public sites

Presidential residence ('09.10)

Green Growth Committee

Agricultural R&D Institute

Kyunggi Province office

Demonstration at Private sites

Green Home

Private house (2009)

Private house
- All in one type(2009)

Indoor- Installation (2009)

Distribution Model(2010)

Hyundai Bulkwang 3th Apt.
(2010)

Dawoo Dongtan
Haim Apt.(2010)

Taeyoung construction
House (2010)

1 million Green home project (2011)

Green Home

Source	Capacity	Budget (Million Yen)	Subsidy	
Photovoltaic	< 3kW/house	3,385	below 50% of base price	Grid connected basis
		462	Public tender	(Public-House Rent)
Solar heat	< 30m^2/house	1,154	below 50% of base price	-
Geothermal	< 7.5kW/house	923	below 50% of base price	
Small wind power	< 3kW/house	38	Not fixed	Grid connected basis
Fuel Cell*	< 1kW/house	885	Not fixed (below 80% of base price in 2010)	• Grid connected basis • Demonstration project type
Total		6,847		

<13Yen/1Won>

* Base Price is 4.6 million Yen/1kW residential fuel cell in 2010

Million Green Home 2020

	2004-7	2008-12	2012-20	Total
Goal (unit)	17,400	94,150	913,000	1,024,550
Budget (10^9₩)	2,280	13,300	137,530	153,080

Candidate for Million Project

- **1kW Residential Fuel Cell**
- **5kW RPG – GS Fuel Cell, LS Industry (Clear Edge)**
- **10kW PEMFC for Commercial Use (FCP)**
- **50, 100kW MCFC for Apartment house and public building (POSCO power)**
- **10-100kW SOFC (POSCO Power)**

The first year of commercialization

Green Home

Establishment of standard

Ventilation, Gas Sensor

- Korea Gas Safety Corporation
- Korea Electric Safety Corporation

Inspection for the apartment buildings

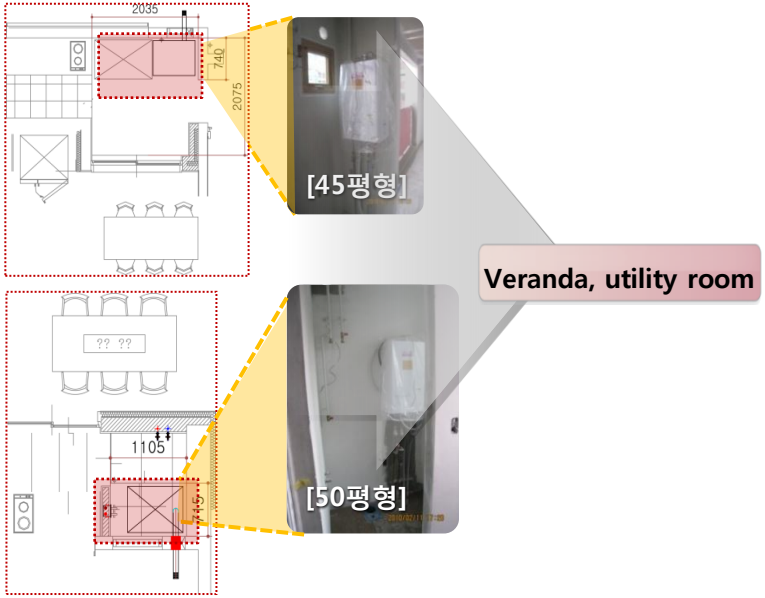
Korea Energy Management Corporation
(for subsidy)

Installation at apartment building

Green Home

Hill State constructed by Hyundai construction

- Vent pipe (FC)
- Vent pipe (boiler)
- Gas pipe
- Gas meter
- Room con (FC)
- Roon con (Boiler)

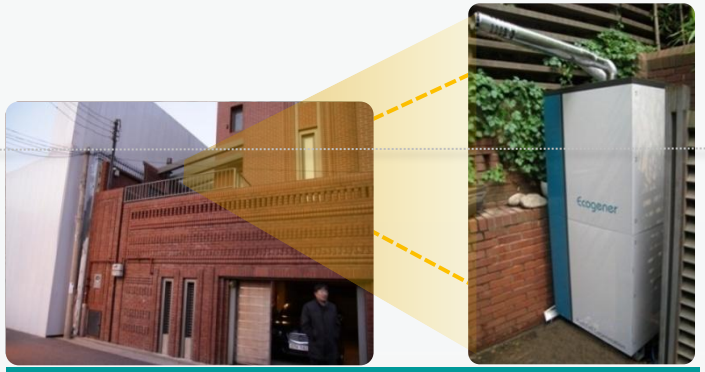


Installation at private building

Green Home

Million Green Home 2020
(2010)

Inchon



Taeyoung Contruction

Summary and Outlook

- Korea has one of the world's most promising early markets for small stationary fuel cells in a range of 1-10kW , and has the potential to be a major manufacturer of units for a range of applications.

- The Korean government has had a consistent policy of investing in fuel cell dissemination (one million green home project) and working closely with industry over several decades. The Korean fuel cell industry is beginning to see the fruit of this collaboration, by ramping up production and adoption of fuel cells for CHP.

- The Korean fuel cell supply chain is well developed. However, Korea has a plethora of strategically more significant fuel cell stack and systems manufacturers and is addressing the lack of component capability at present.

- Korea is capable of supplying on the order of millions of fuel cell units over the next decade, ramping up manufacturing of PEM for small stationary applications.

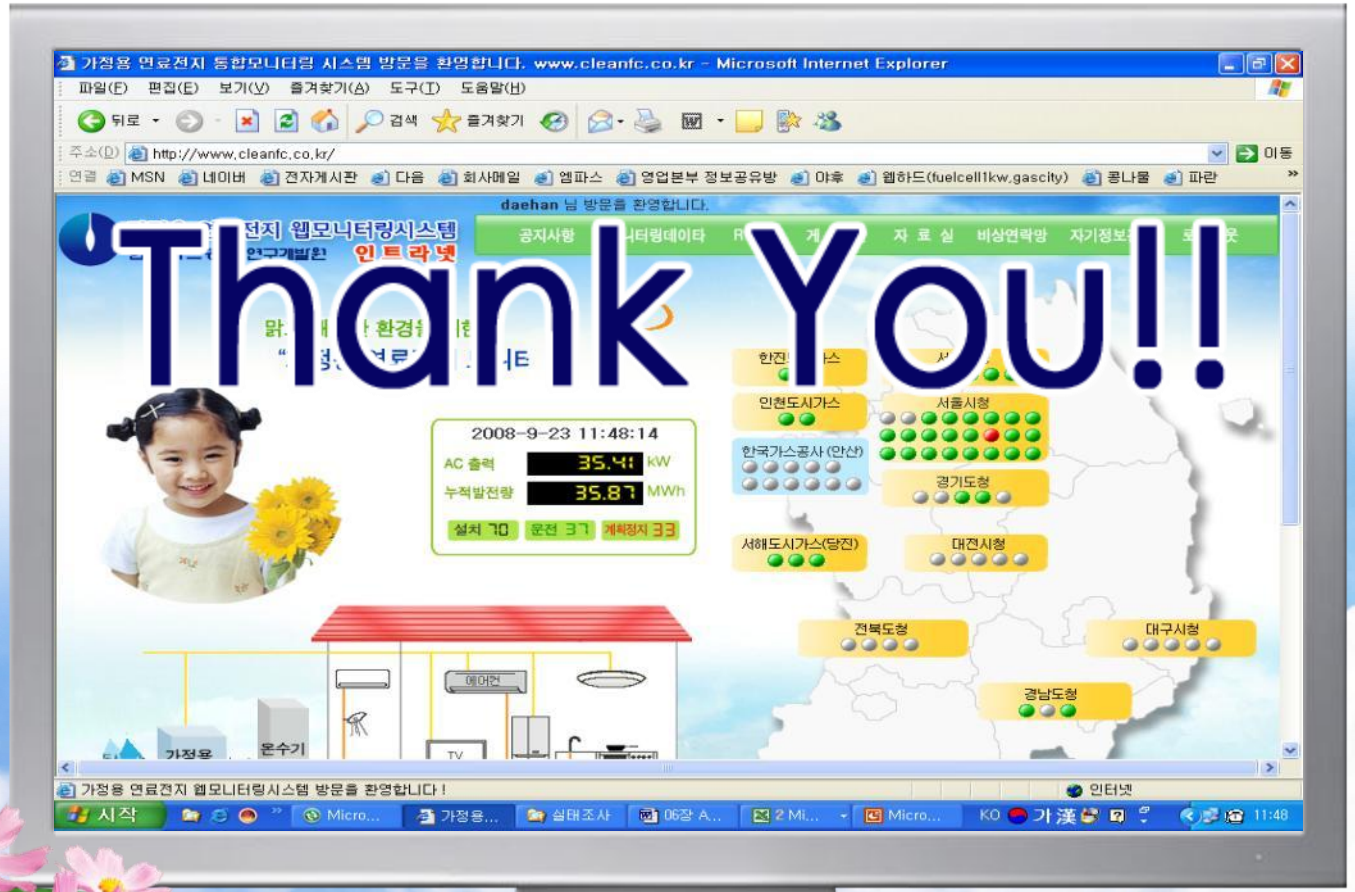
- Korea reinforces fuel cell design for building & new towns and promote role enhancement of local authorities and develop integrated technology and reduce regulatory barriers.

http://www.knrec.or.kr/knrec/index.asp

http://www.ketep.re.kr/

http://www.kemco.or.kr/

WWW.CLEANFC.CO.KR



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