

# Fuel cell system for buildings to activate clean and safe hydrogen economy

2019 Global Commercialization Conference and Workshop



지구를 살맛나게 하는 1도의 기술

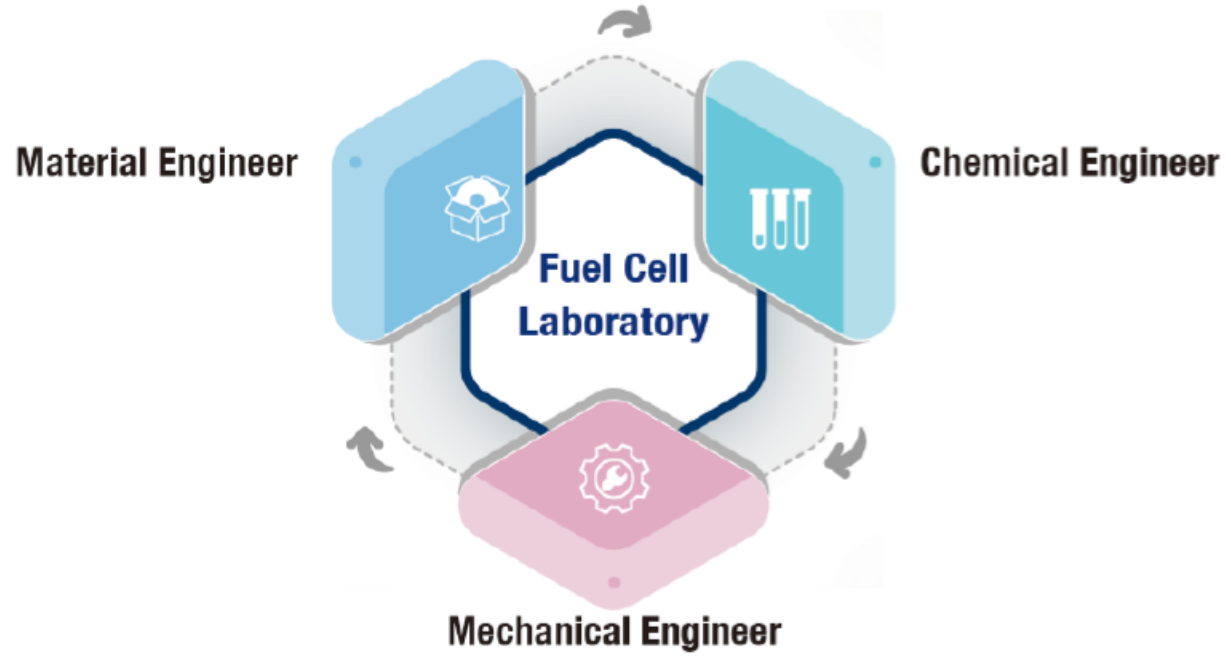
Korea Institute of Energy Research

Principal researcher

Min-jin Kim, Ph.D.

# Fuel cell research center in KIER

Began in 1980  
National Research Center for Fuel Cell Research (1999)



**PEMFC**

**Buan Fuel Cell Center**

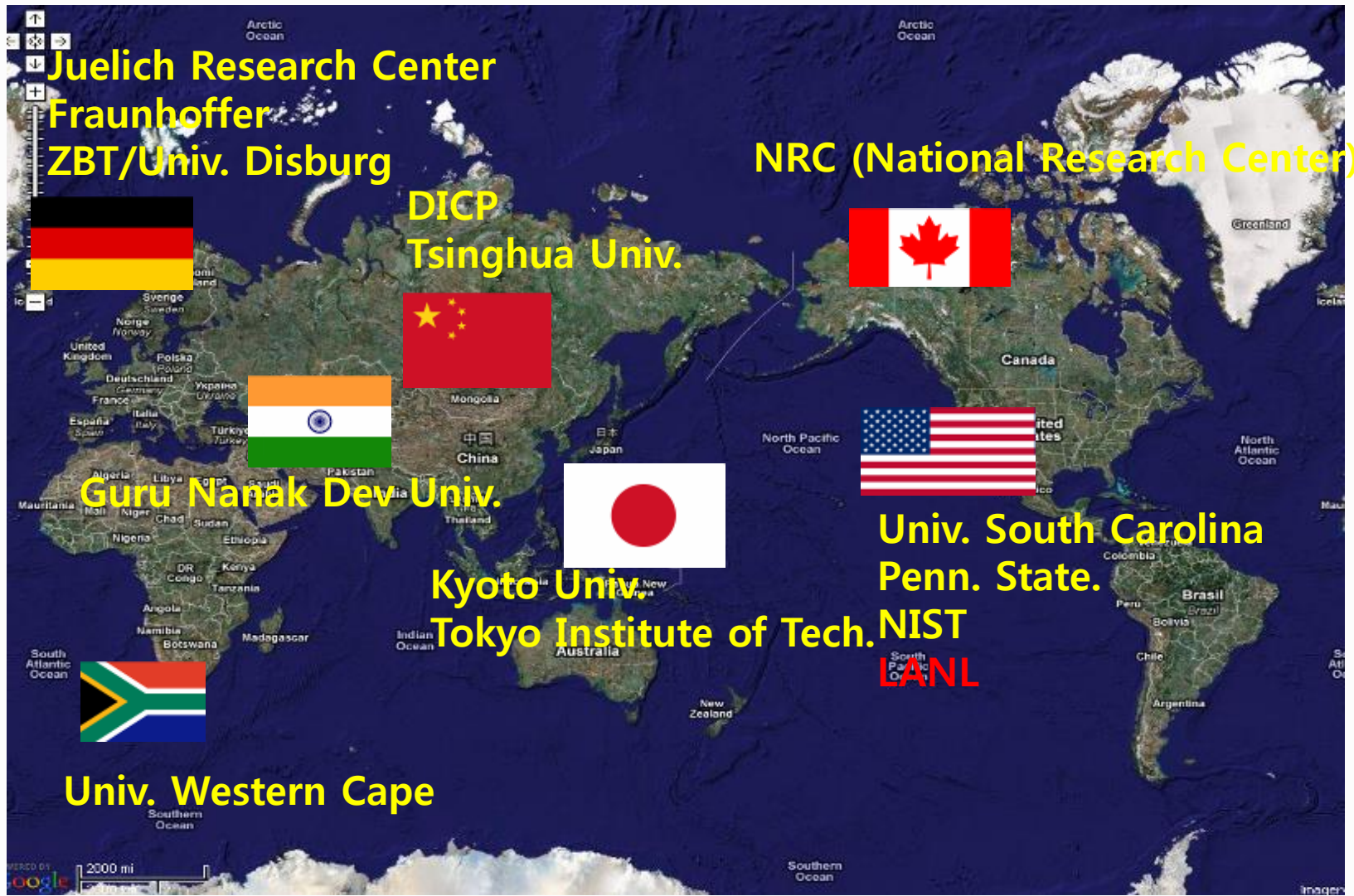
Staff : 33 / Assistant Researchers : 62

**SOFC**

**DMFC**



# International R&D networking





# Industrial R&D partnership

## Main Players



# Activities of PEMFC research group



## Research fields



- Basic Materials for PEFC (Electro-catalyst, Electrolyte, MEA, etc.)
- Fuel cells total system Design & Integration (Portable, automobile, distributed power, military, etc.)
- Micro-channel reactor for Hydrogen production
- Demonstration & Field Test of Fuel Cell Systems
- Test & Evaluation Center for Fuel Cells (International Certification)
- Fuel Cell Education Center



# Brief history of development in PEMFCs



1996-1997  
2kW Stack



1996-1998  
5kW system with  
Methanol  
reformer



1997-2000  
10kW system  
for a hybrid fuel cell  
vehicle



1999-2001  
5kW system  
with NG  
reformer



1999-2004  
1kW system for  
Portable power



2003-2004  
50W system  
for Laptop  
computer



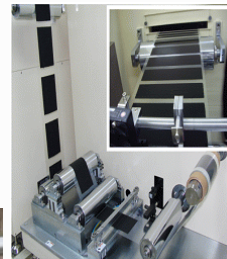
2013 - 2017  
200W  
Regenerative  
Fuel Cell for  
UAV



2013~2014  
10kW  
System



2009~2014  
1kW UAV  
System



2009 - 2010  
MEA  
Fabrication  
Process



2009  
1 kW RPG  
System



2006 - 2008  
Fuel Cell/Battery  
Hybrid Bus with  
a 50 kW stack



2004  
Fuel Cell/Battery  
Hybrid Vehicle  
with Air-cooled  
Stack



# Technology transfer to company



2009

GDL Evaluation Equipment



2010

1 kW RPG System



2010

Single Cell & Evaluation



2012

500 W Air-Cooled Stack



2013

Stack Rapid Activation Protocol



2014

MEA Lamination Process



2015

MEA Fabrication Process



2016

HT-PEM Stack



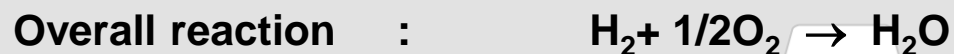
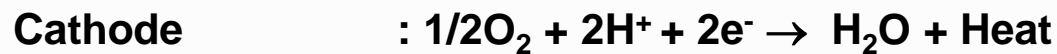
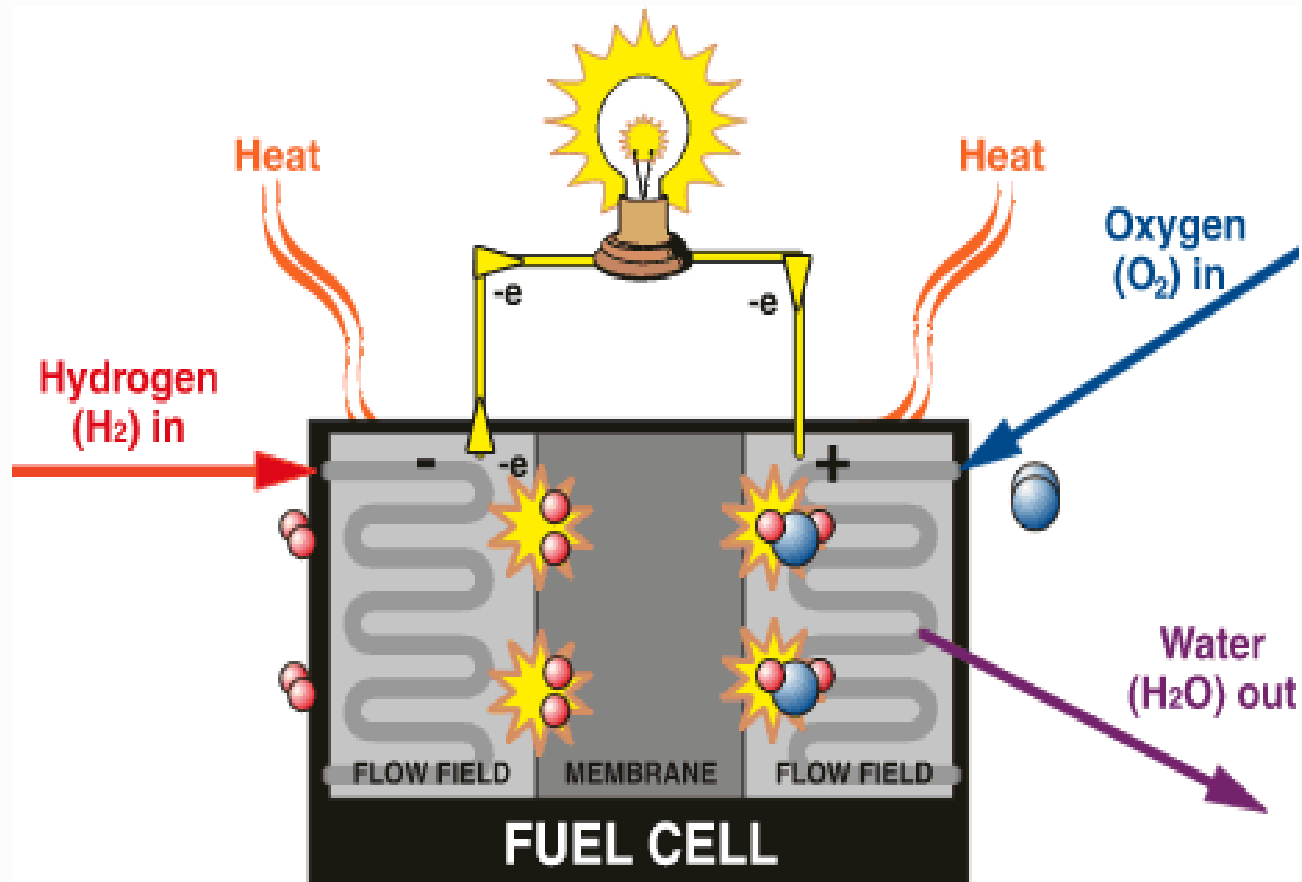
# Story telling of hydrogen society



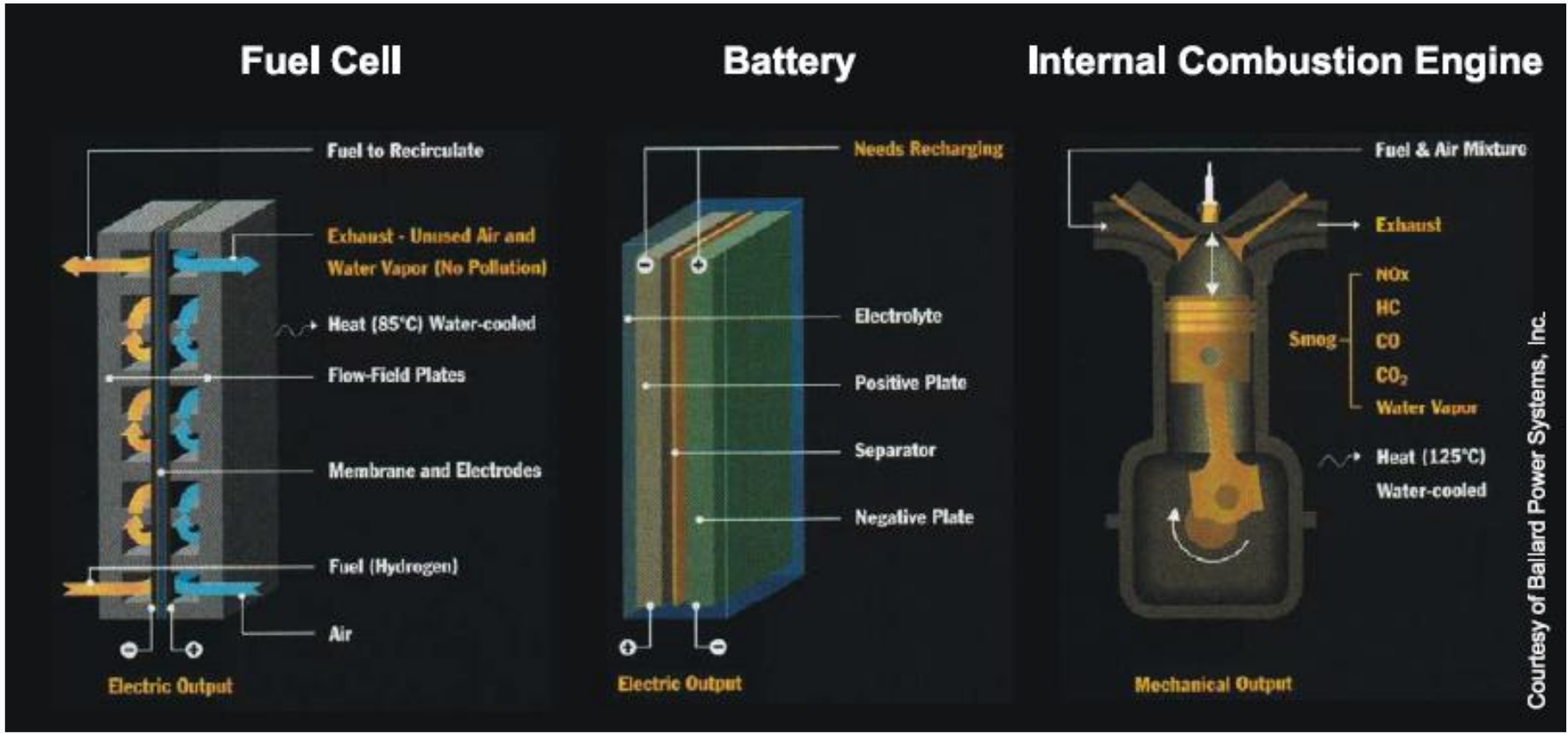
Story Telling Film  
75



# Principle of fuel cell



# Comparison energy systems



Courtesy of Ballard Power Systems, Inc.

Energy Generator  
Chemical E → Electric E

Energy Storage  
Chemical E → Electric E

Energy Generator  
Chemical E → Mechanical E

# Commercialization process of MEA

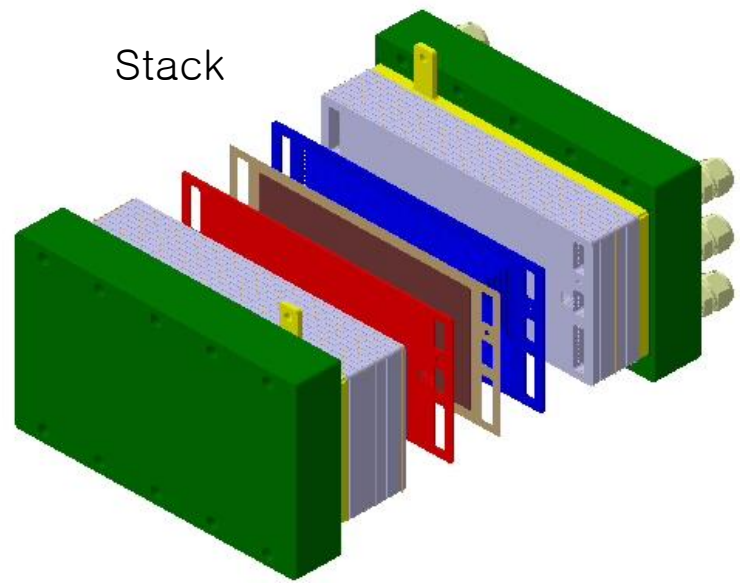


## MEA 양산화공정 기술개발

# Construction of PEM fuel cell stack



Stack



# PEM fuel cell stack

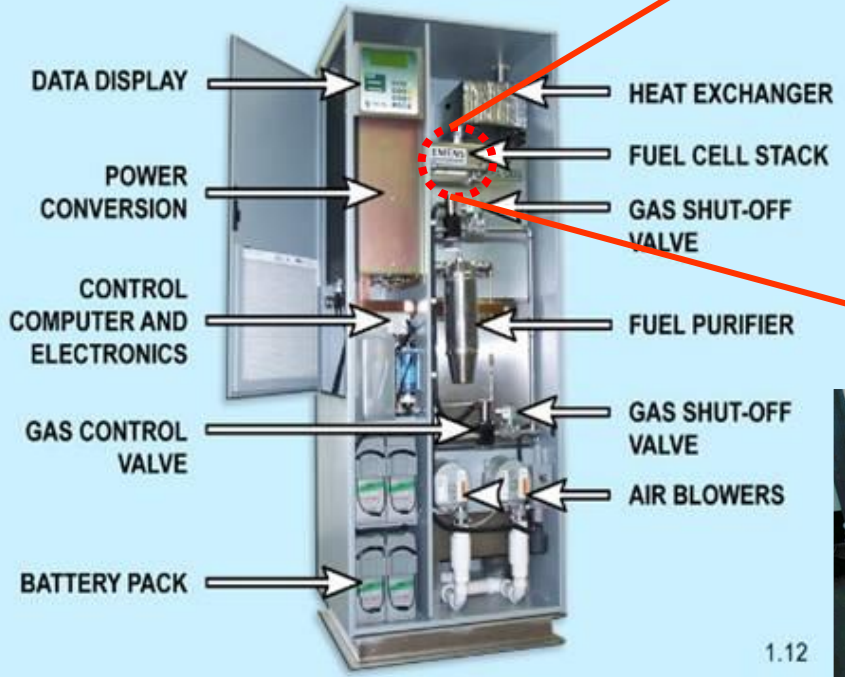




# Construction of PEM fuel cell system



## A FUEL CELL SYSTEM



1.12



# Applications of fuel cell

IT/ UPS



1W – 100kW

Military



1-200kW

Building



0.5- 100kW

Transportation



80-200kW

Power Plant



250 kW <

## PEMFC \*

DMFC \*\*\*

SOFC \*\*\*\*

MCFC \*\*

SOFC \*\*\*\*

PAFC \*\*\*\*\*

- \* Polymer Electrolyte Membrane Fuel Cells
- \*\* Molten Carbonate Fuel Cells
- \*\*\* direct Methanol Fuel Cells
- \*\*\*\* Solid Oxide Fuel Cells
- \*\*\*\*\* Phosphoric Acid Fuel Cells

<출처 : 두산FC>

# KIER's Hy-Cogen



With the living in a green home as the motivator, KIER has developed a residential fuel cell cogeneration system that is planned for a next generation energy supply system.



Type	PEMFC
Power Capacity	1-1.3 kW
Fuel	City Gas (LNG)
Dimensions <ul style="list-style-type: none"> <li>- Electric module</li> <li>- Hot water tank</li> </ul>	750L x 460W x 780H mm 530L x 380W x 1725H mm (200 L)
Efficiency <ul style="list-style-type: none"> <li>- Electric efficiency</li> <li>- Heat recovery efficiency</li> </ul>	34%, Max 39% (LHV) 45%, Max 50% (LHV)



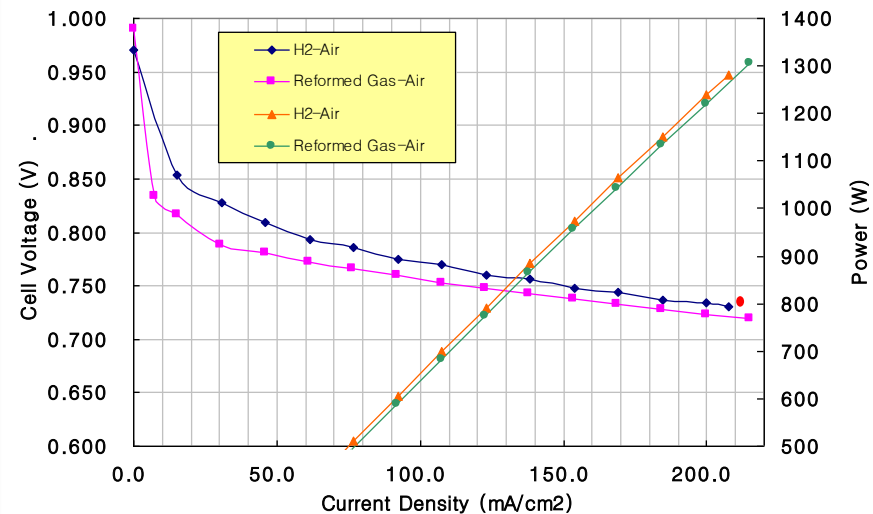
# Fuel cell stack



- Performance : rated power 1300 W  
current@rated power 30 A  
dc voltage 47 V
- Fuel : reformat
- Oxidant : filtered air
- Operating conditions : S/U temperature  $> 5\text{ }^{\circ}\text{C}$   
coolant temperature 57 to 67  $^{\circ}\text{C}$   
relative humidity 50-70 %  
stack temperature 70  $^{\circ}\text{C}$   
fuel / air pressure ambient pressure
- Durability : lifetime 40,000 hrs target  
on-off cycles 4,000 target
- Physical : size 378Lx202Wx101H mm  
volume 7.7 L



## Stack I-V Curve



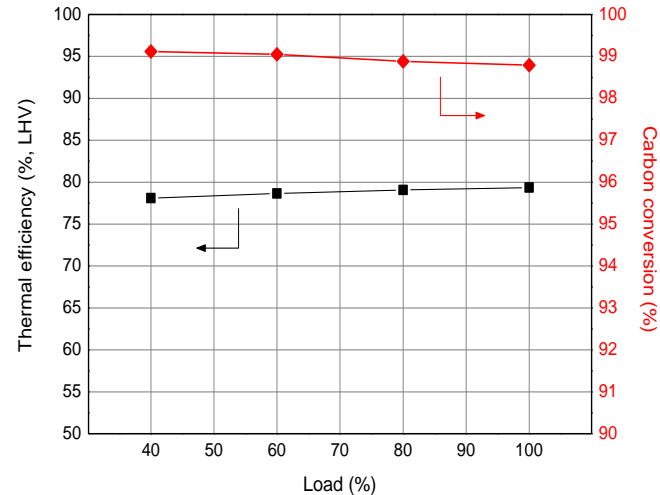
# Fuel process



- Fuel : city gas (LNG)
- Hydrogen production : max. 1.3 Nm<sup>3</sup>/h
- CO concentration < 10 ppm
- Operating condition : start-up time < 1h  
S/C = 3.0
- Thermal efficiency : 79 % (LHV)
- Durability : lifetime 40,000 hrs target  
on-off cycles 4,000 target
- Physical : size 185Øx610H mm  
volume 16.4 L



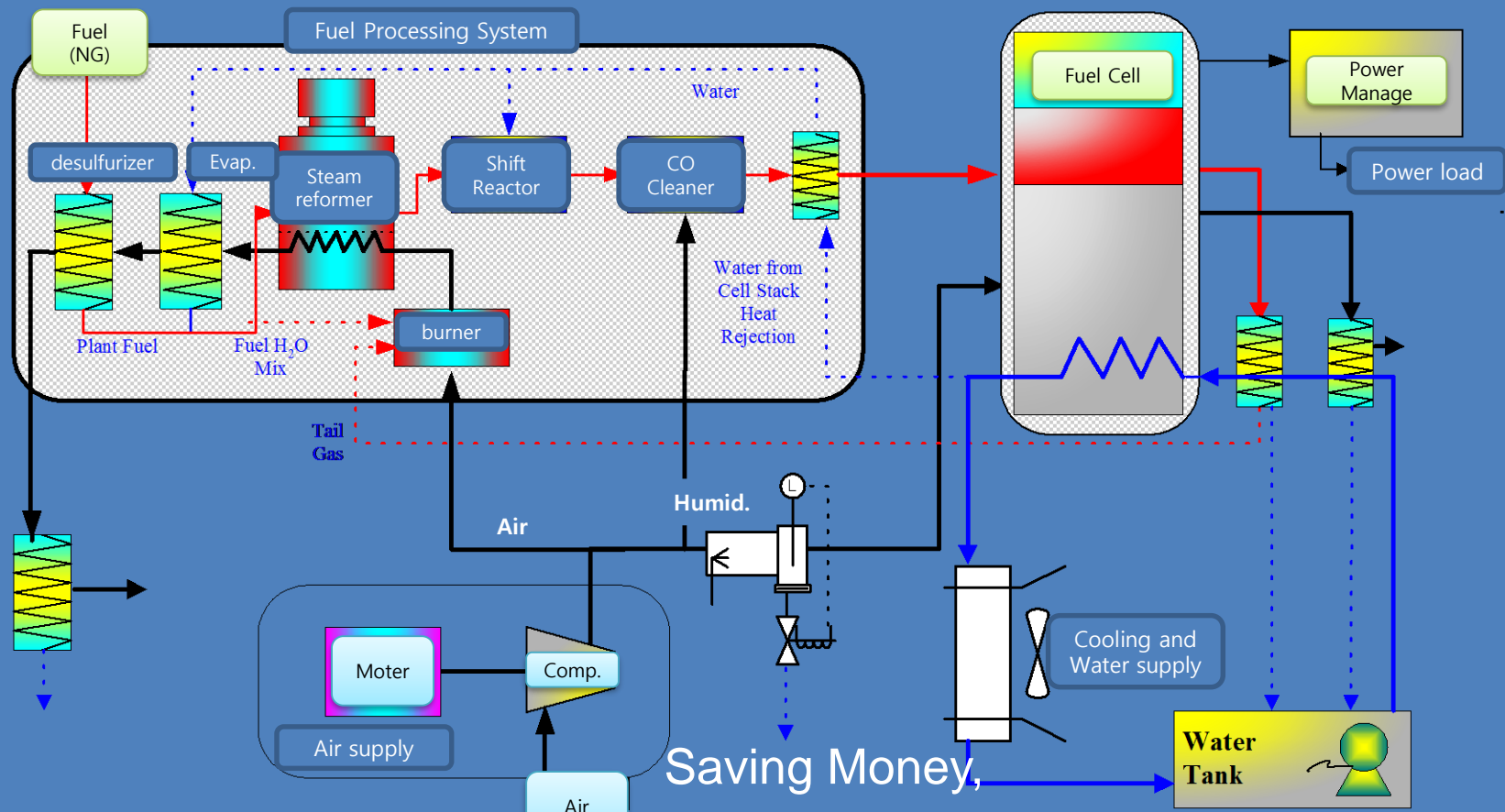
## Fuel Process Performance







# Fuel cell system for building



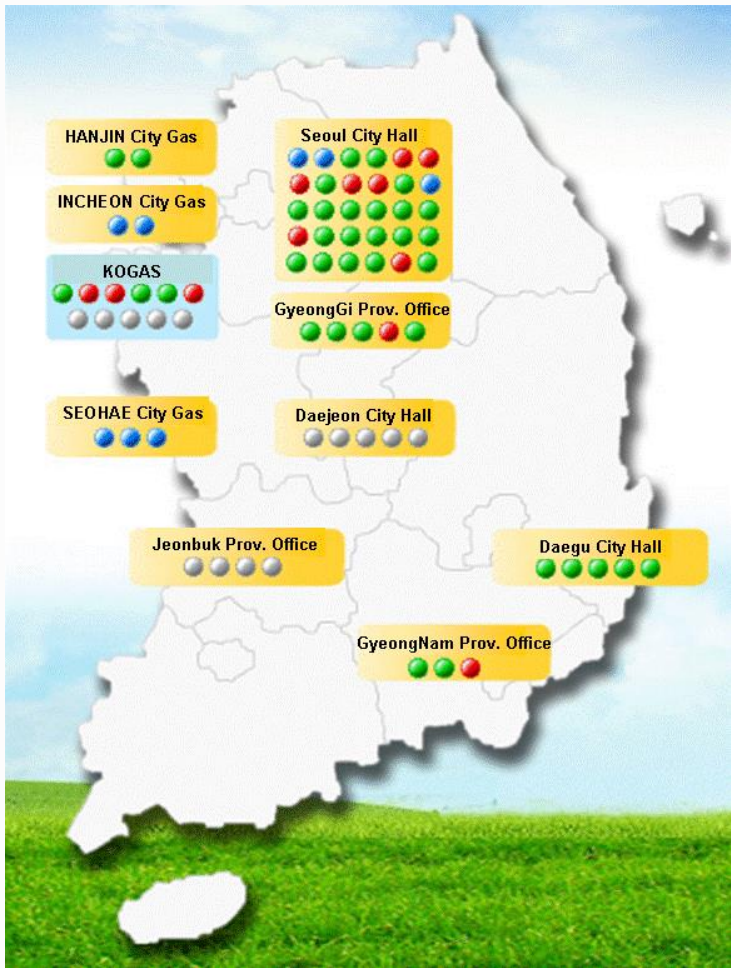
Saving Money,  
Reducing Greenhouse Gases,  
Enhancing Energy Independence

# Expected effects



- **Primary energy reduction by 26% based on the basic unit for thermal power sources**
- **CO<sub>2</sub> emissions cutting by 38% based on the basic unit for thermal power sources**
- **3,500 kWh of primary energy savings with year-round operation**
- **CO<sub>2</sub> emissions reduction by 1,200 kg with year-round operation**
- **Cost savings of US \$600 to US \$800 per year**

# RPG Monitoring sites in KOREA



- 2008 installed RPG : 70
- 2009 target : 100
- Objectives
  - Real operation & monitoring
  - Durability improvement
  - Cost reduction



1kW PEMFC System (GS Fuel Cell)    1kW PEMFC system (퓨얼셀파워)

Web-based Monitoring ([www.cleanfc.co.kr](http://www.cleanfc.co.kr))

1kW RPG installation

# National FC evaluation center in KIER



FC Evaluation Center



Electric Safety Test



Windproof Test



Surface Temp. Test



Efficiency Test



Waterproof Test



**THANK YOU!**



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