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# An Investigative Study for the Commercialization of Anion Exchange Membrane-based Unitized Regenerative Fuel Cell

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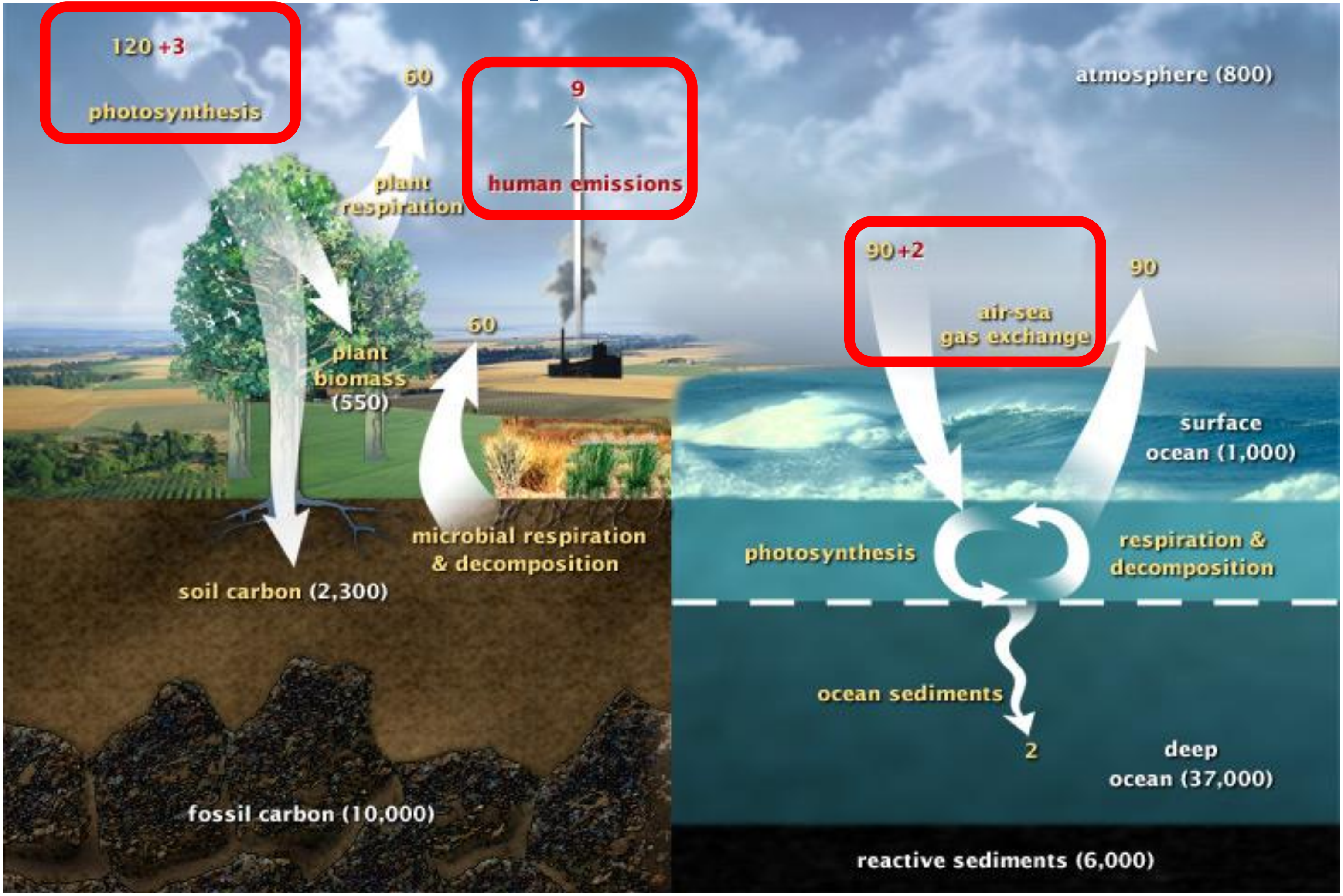
# Introduction of Sustainable Energy

## Movement of carbon between land, atmosphere, soil and oceans in Gt/y of carbon.

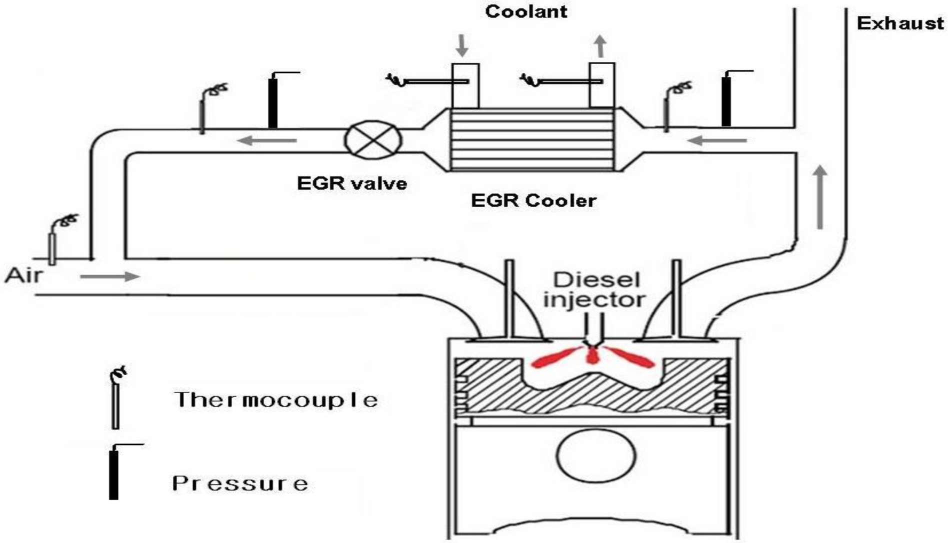
Yellow numbers: Natural fluxes, Red: Human contributions, White: Stored carbon

Atmospheric Carbon Net Annual Increase 4 Gt/y



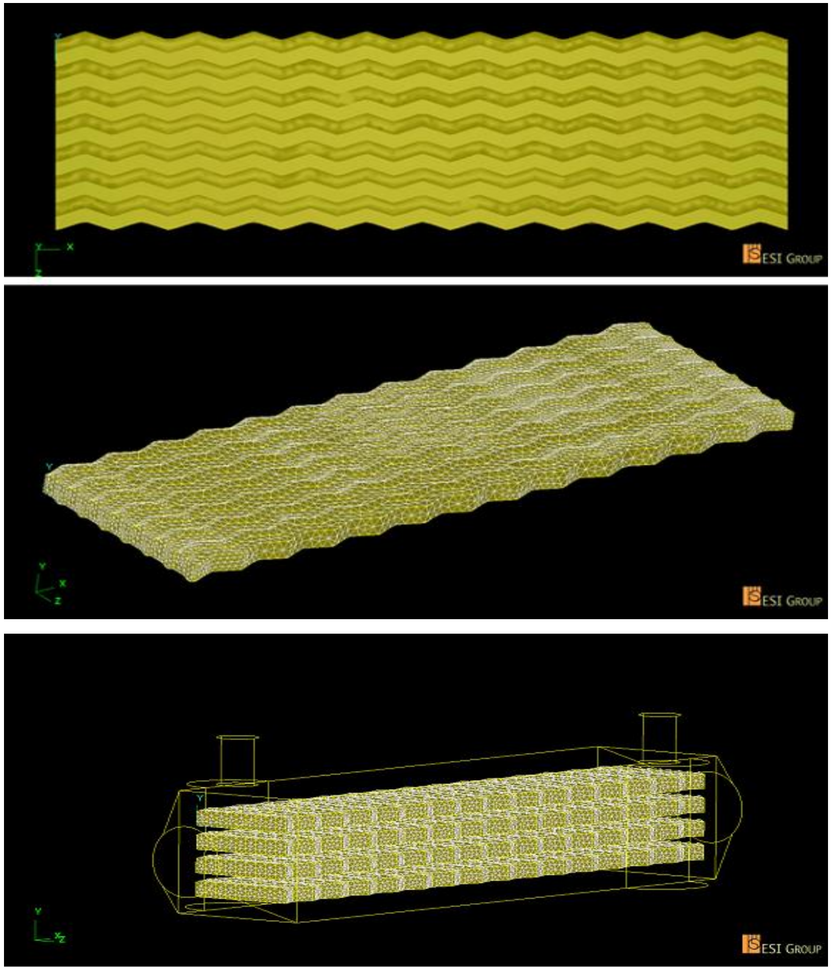

U.S. DOE, Biological and Environmental Research Information System.

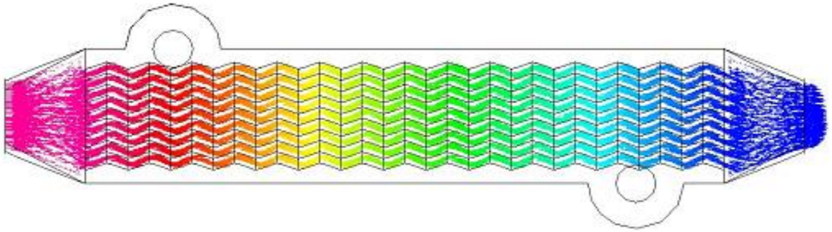
# R&D of EGR Cooler in Diesel Engine

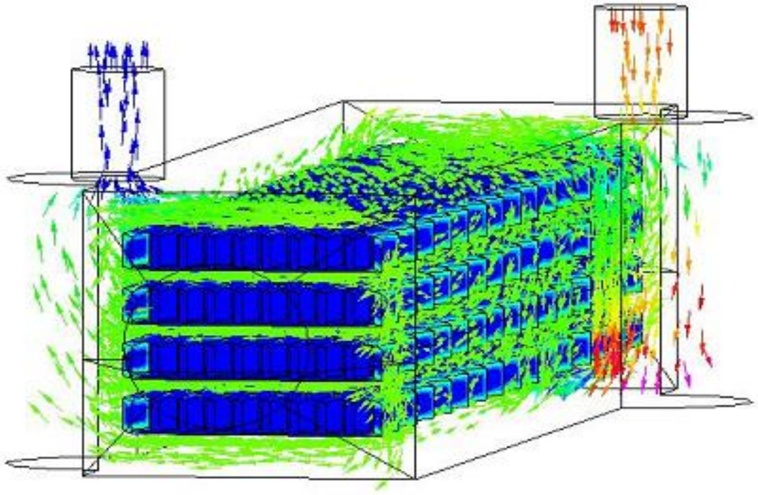



Effects of PM fouling on the heat exchange effectiveness of wave fin type EGR cooler for diesel engine use, Heat and Mass Transfer Vol. 48, pp. 1081-1087, 2012.

# CFD Simulation of EGR Cooler

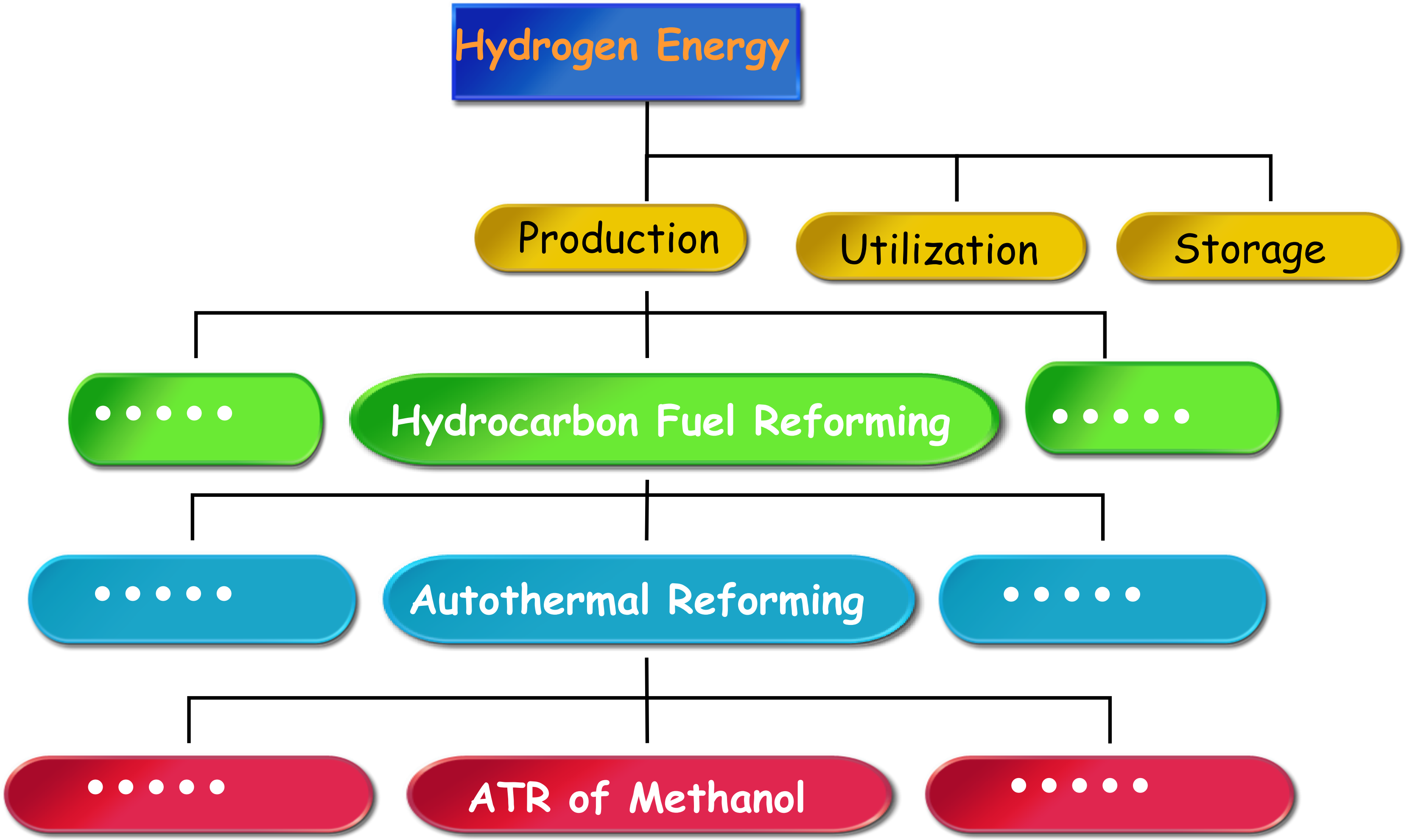






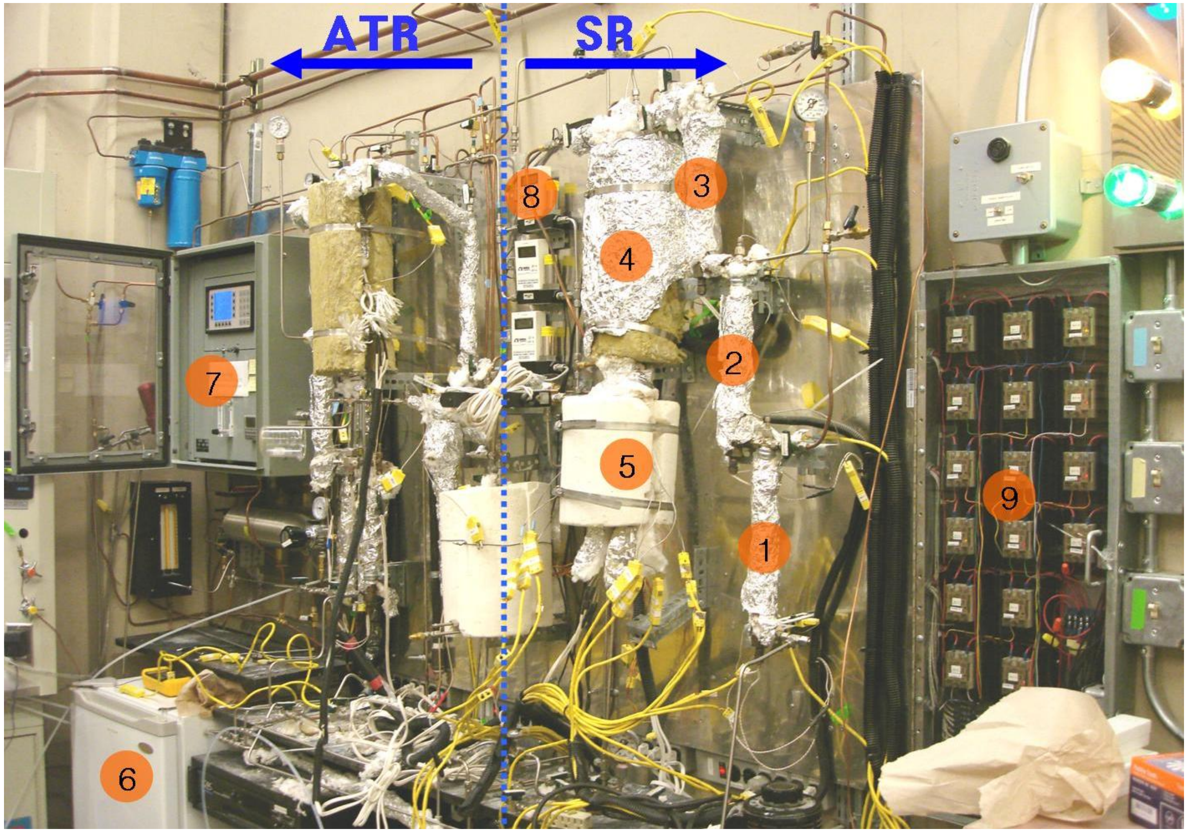
Influence of PM fouling on effectiveness of heat exchanges in a diesel engine with fin-type EGR coolers of different sizes, Heat and Mass Transfer Vol. 46, pp. 1221-1227, 2010.

# R&D of Autothermal Reforming




Lowering the O2/CH3OH ratio in autothermal reforming of methanol by using a reduced copper-based catalyst," International Journal of Hydrogen Energy Vol. 33, pp. 6619-6626, 2008.

# Experimental Set-up of Autothermal Reforming



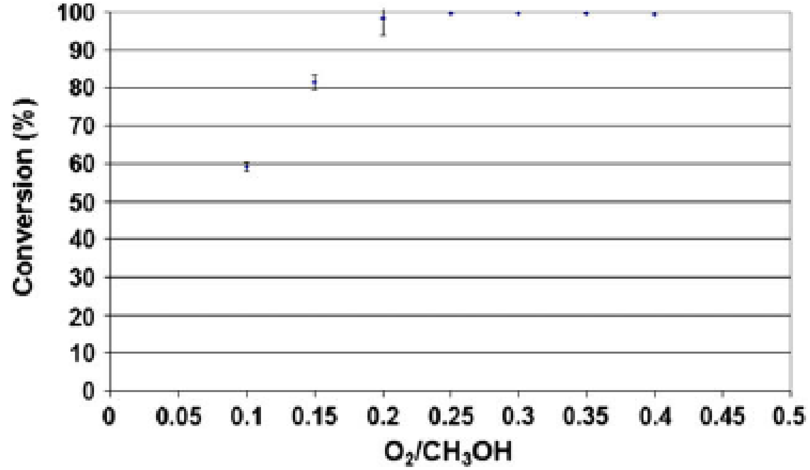

① Vaporizer-1 ② Vaporizer-2 ③ Vaporizer-3

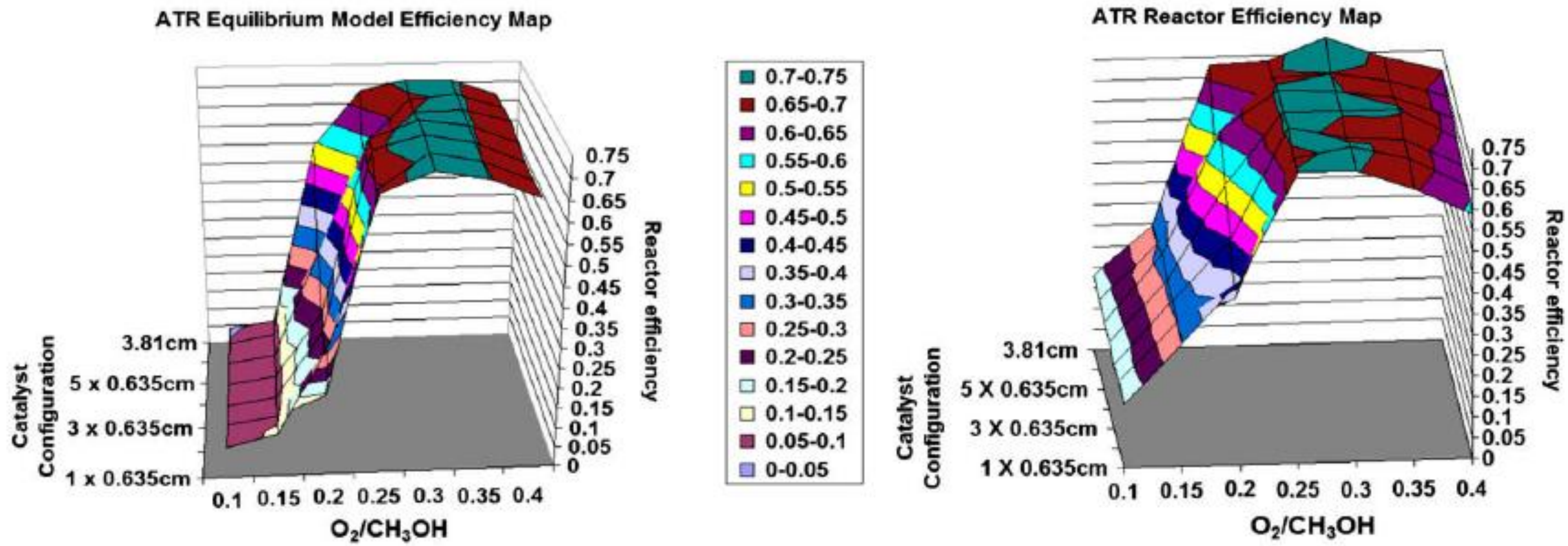
④ Super-heater ⑤ Catalyst reactor ⑥ Condensing unit

⑦ Gas analyzer ⑧ Mass flow controller ⑨ Control rely box

An experimental study of methanol autothermal reformation as a method of producing hydrogen for transportation applications, International Journal of Hydrogen Energy Vol. 35, pp. 6210-6217, 2010.

# Research Results of Autothermal Reforming




Equilibrium model validation through the experiments of methanol autothermal reformation," International Journal of Hydrogen Energy Vol. 33, pp. 7039-7047, 2008.

# R&D of Discrete Regenerative Fuel Cell

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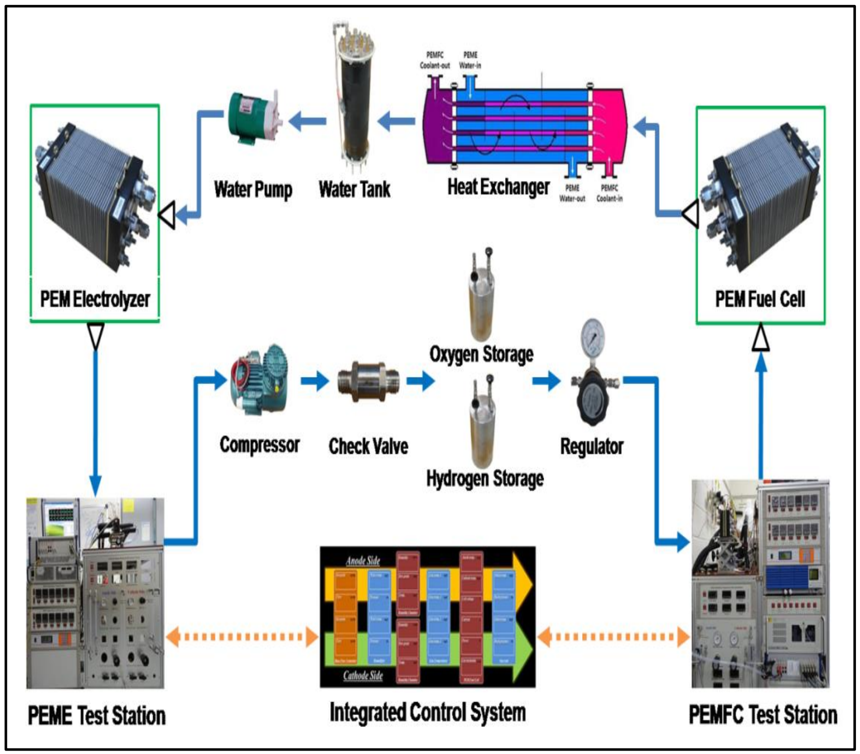
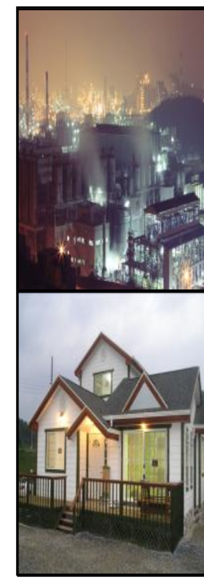
Renewable Energy

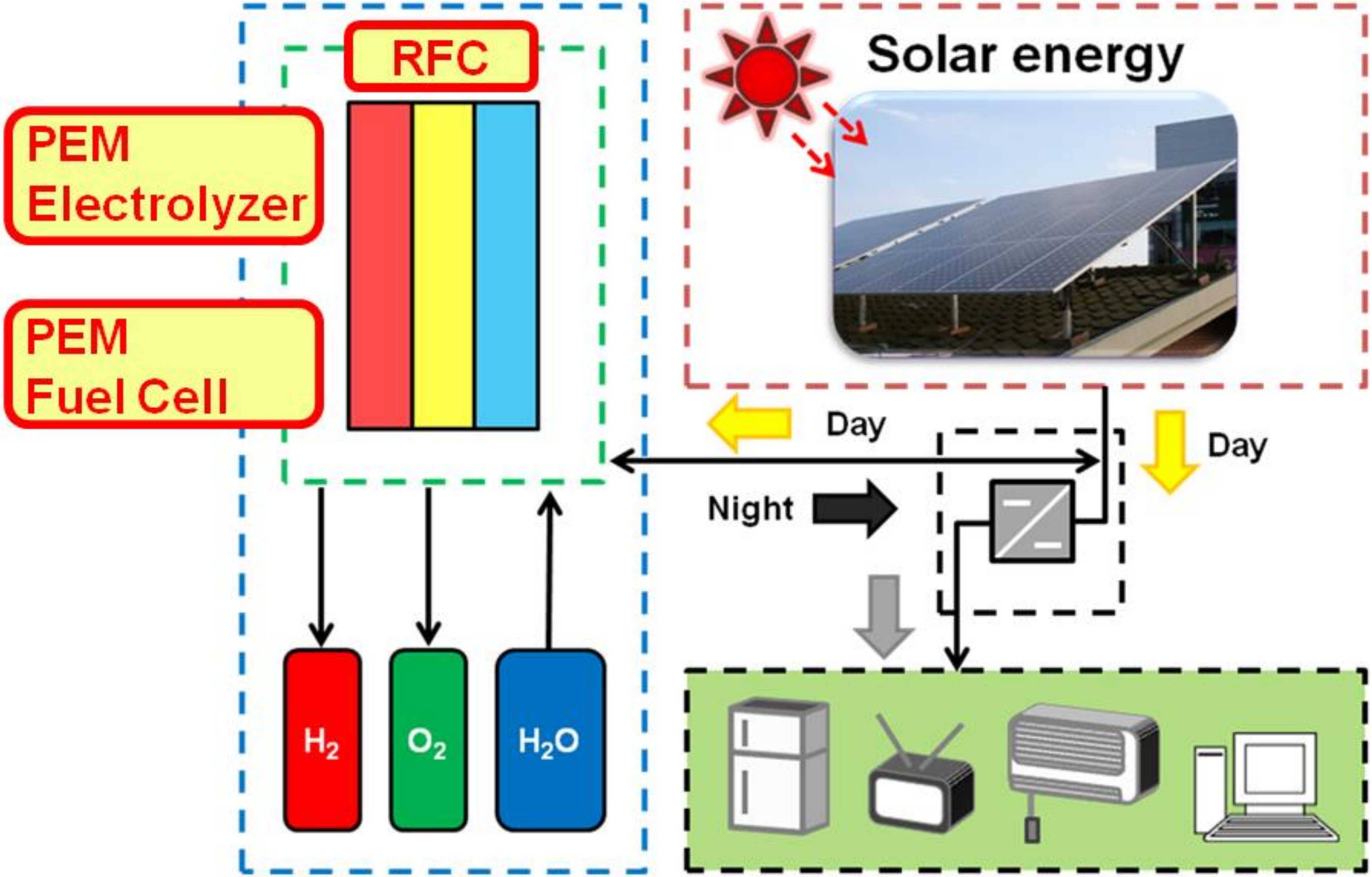


Distributed Power Supply

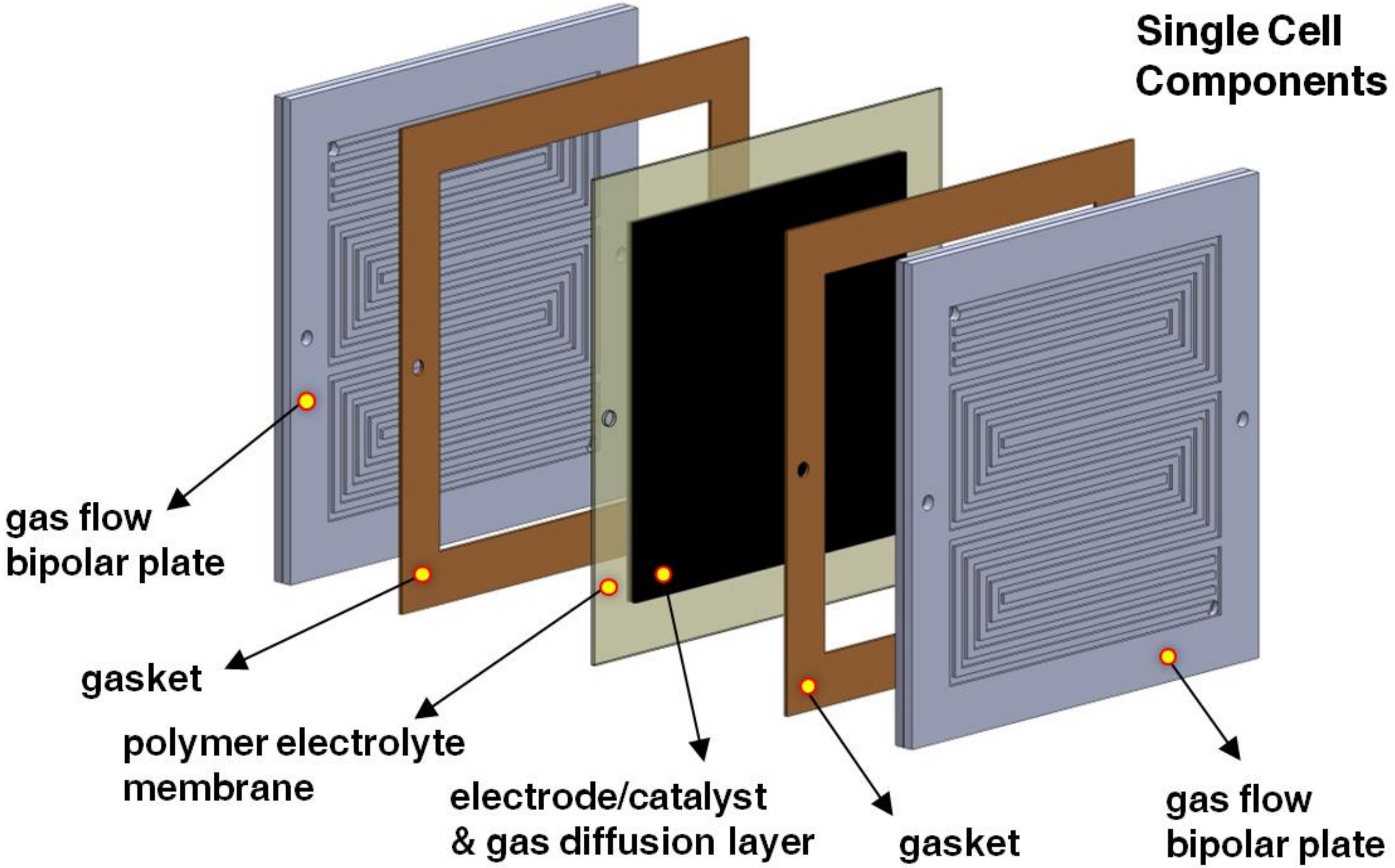
Current advances in polymer electrolyte fuel cells based on the promotional role of under-rib convection," Fuel Cells, Vol. 12(6), pp. 908-938, 2012.

# Operating Principle of Discrete Regenerative Fuel Cell



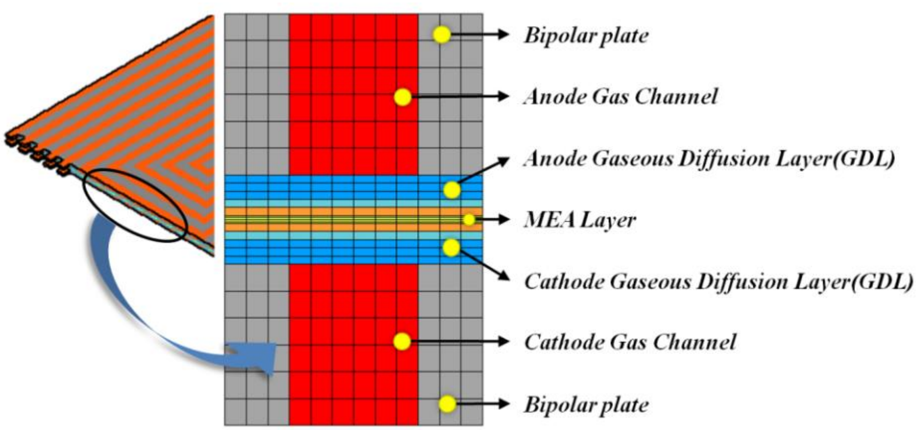

An experimental study on the enhancement of the water balance, electrochemical reaction and power density in a polymer electrolyte fuel cell by under-rib convection," Electrochemistry Communications Vol. 13, pp. 1387-1390, 2011.

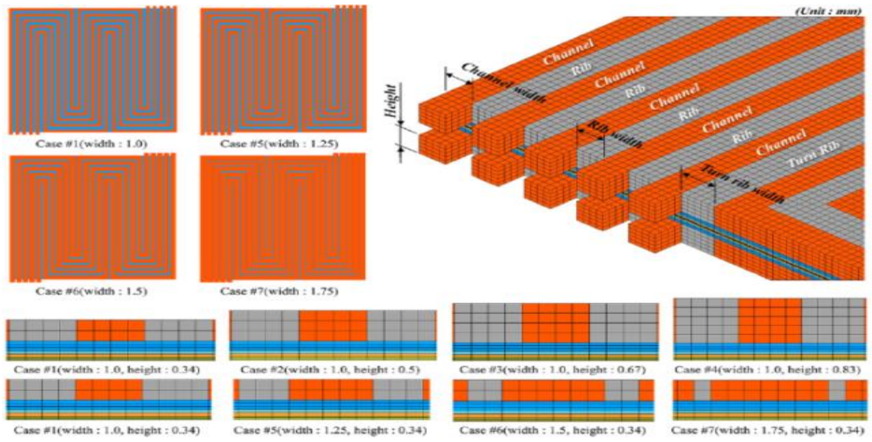
# Regenerative Fuel Cell Components

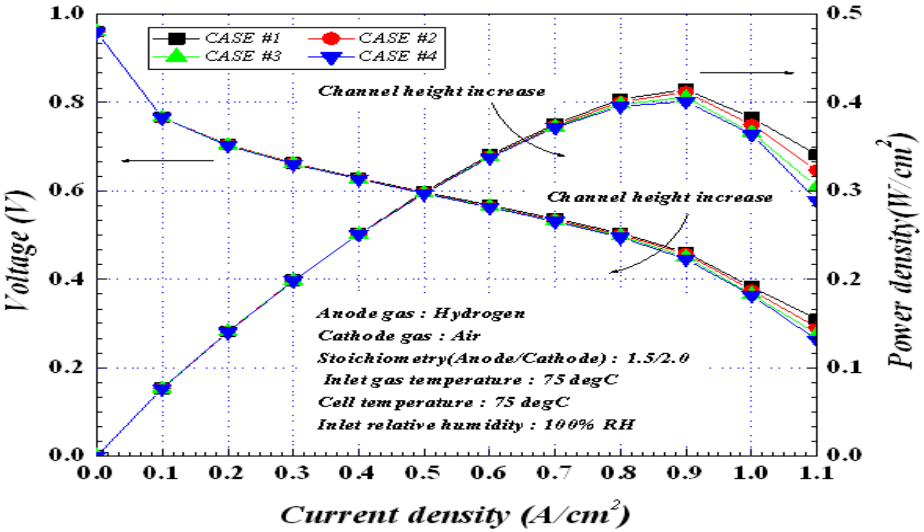


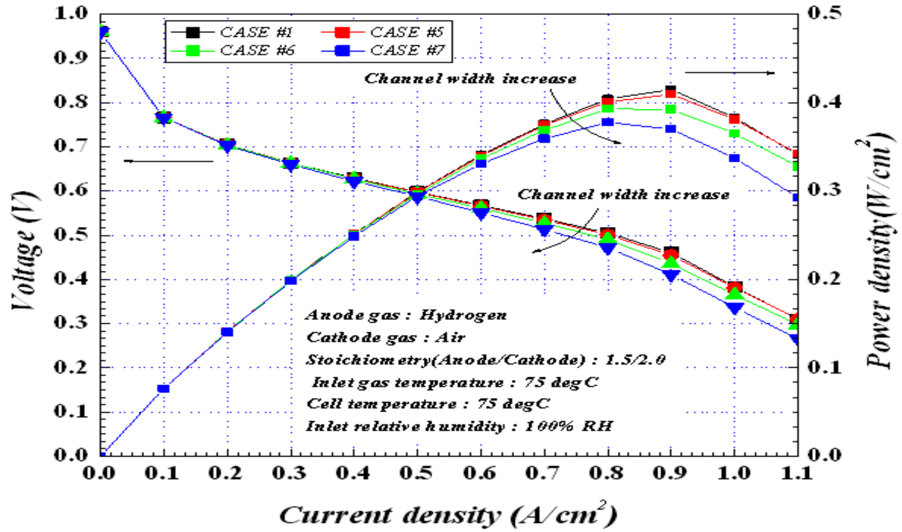

Comparison of numerical and experimental studies for flow-field optimization based on under-rib convection in polymer electrolyte membrane fuel cells," Energies Vol. 9, 844 pp. 1-17, 2016.

# Numerical Characterization of Bipolar plate



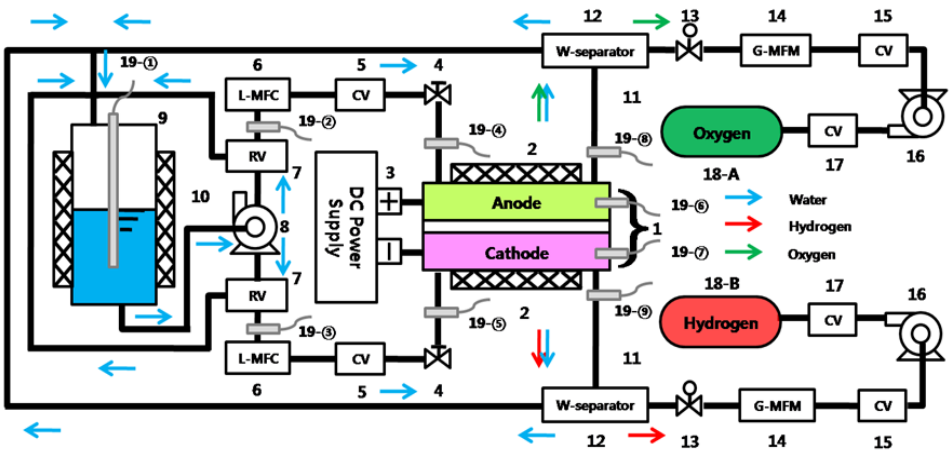



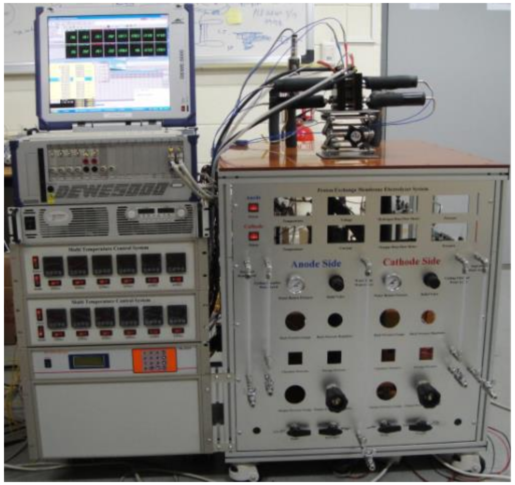



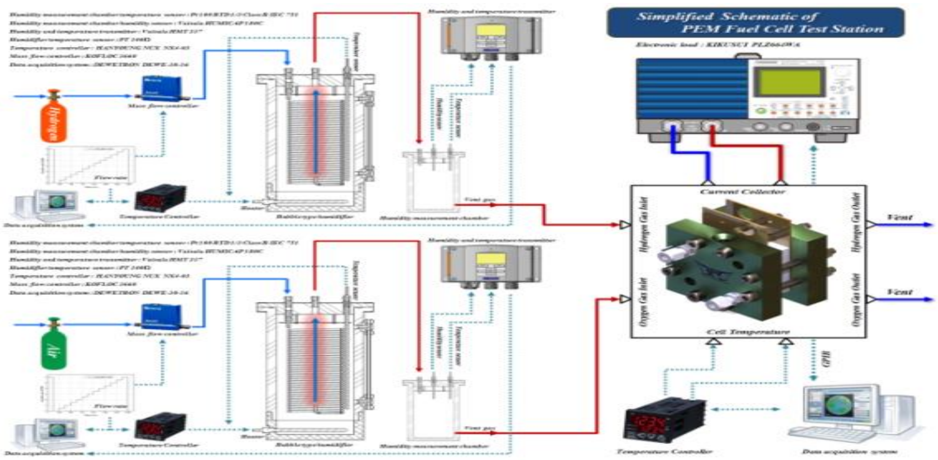



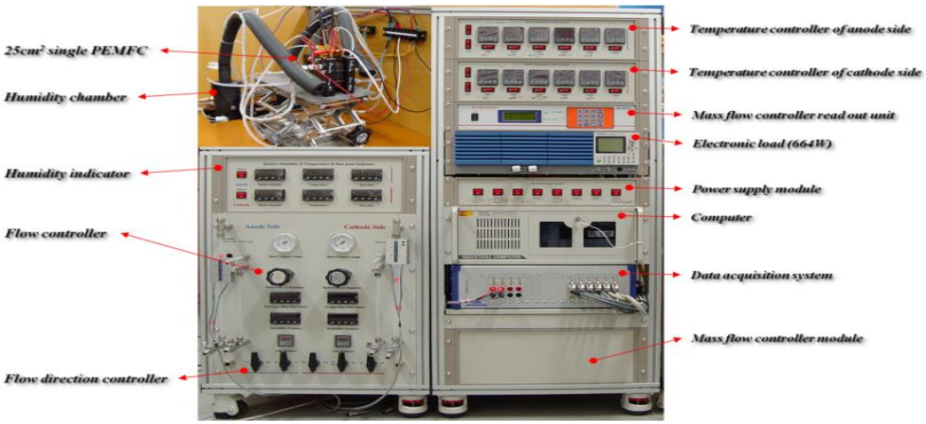

Numerical studies on the geometrical characterization of serpentine flow-field for efficient PEMFC, International Journal of Hydrogen Energy Vol. 36, pp. 1613-1627, 2011.

# Regenerative Fuel Cell Experiment Setup



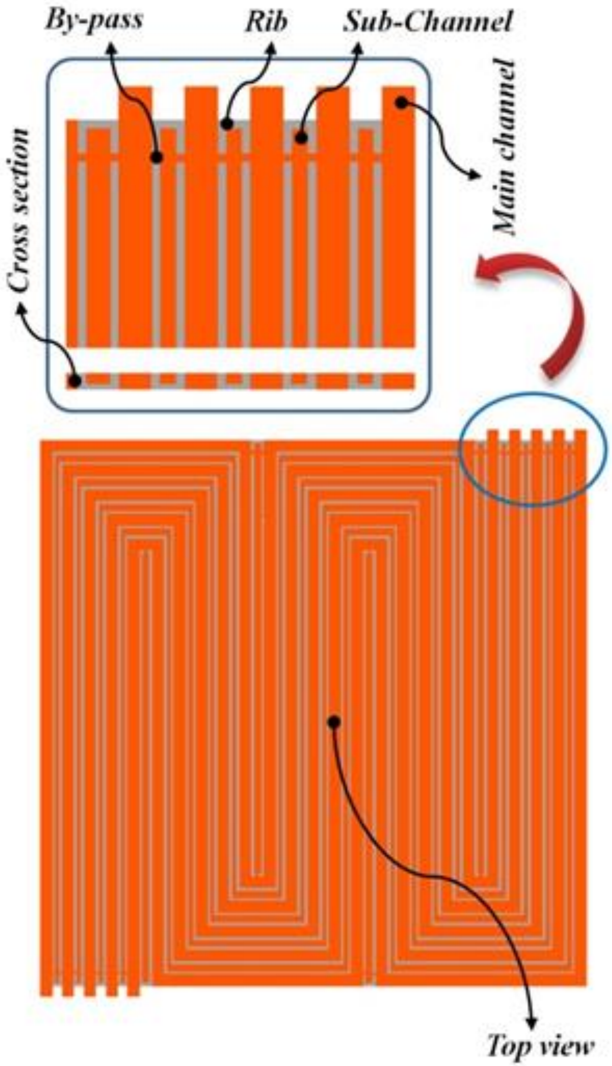



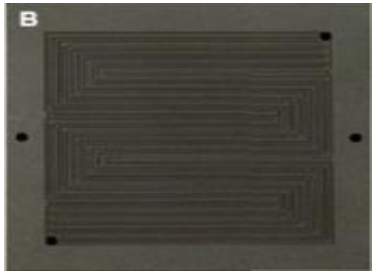

Dynamic simulations of under-rib convection-driven flow-field configurations and comparison with experiment in polymer electrolyte membrane fuel cells, Journal of Power Sources Vol. 293, pp. 447-457, 2015.

# Fuel Cell Performance Improvement

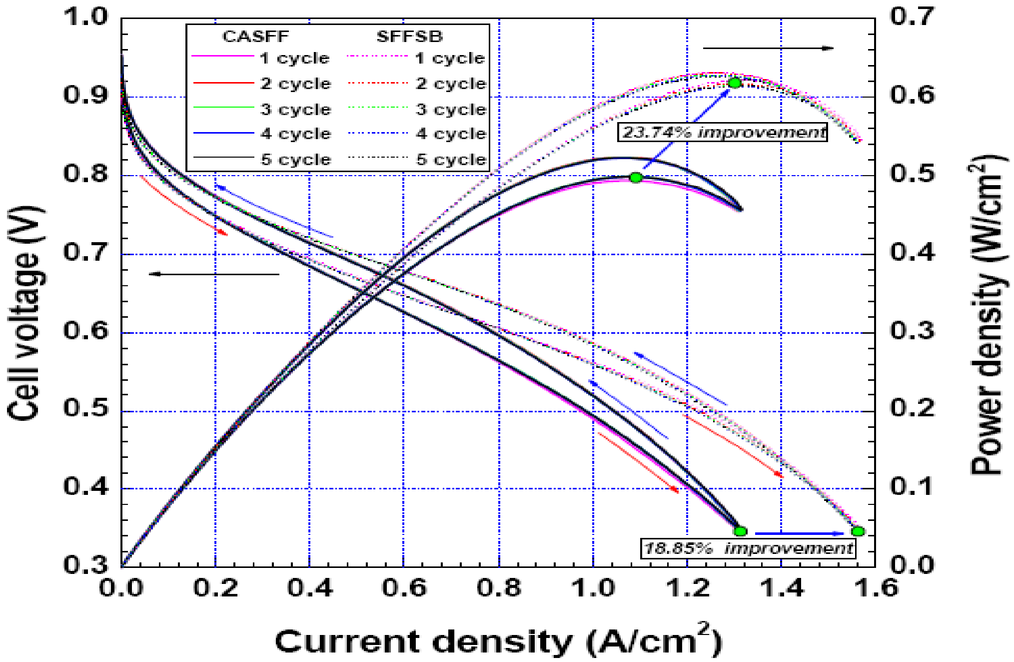




A - CASFF

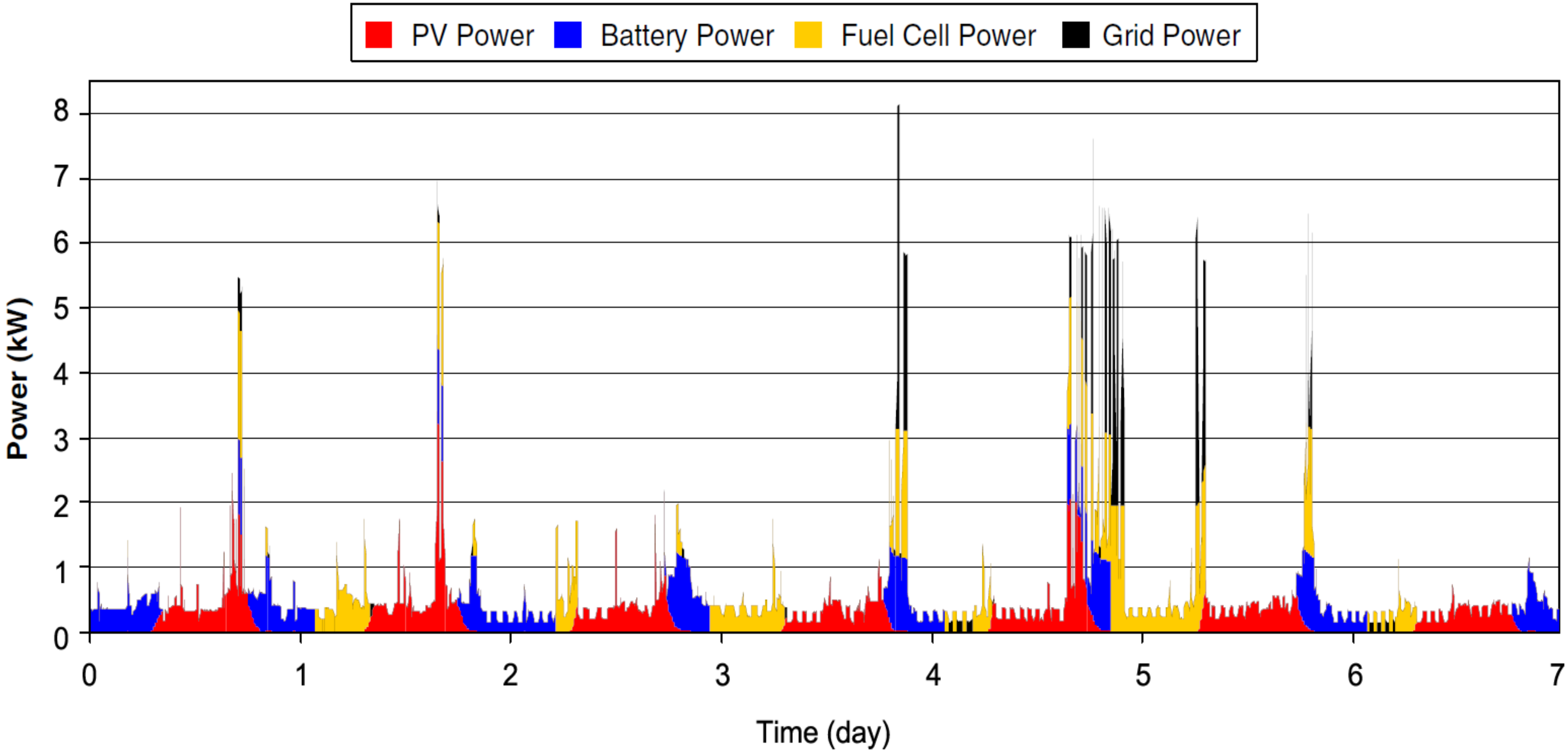



B- SFFSB




An Experimental Study of Scale-up, Oxidant, and Response Characteristics in PEM Fuel Cells, IEEE Transactions on Energy Conversion Vol. 29(3) 727-734, 2014.

# Smart Grid Operation with Regenerative Fuel Cell




Discrete regenerative fuel cell reduces hysteresis for sustainable cycling of water, Scientific Reports Vol. 4 4592, 2014.

# PEM Fuel Cell for Unmanned Aerial Vehicle

- Unmanned Aerial Vehicle: Wing Span 7m, Length 3m
- Hybrid Power Sources
  - PEM Fuel Cell 700W + Li-Polymer Battery 900W
  - Hydrogen of 3L in Carbon Composite Tank 300 atm
- Take-Off: Hybrid PEMFC 700W + L-P Battery 900W
- Orbit-Injection: L-P Battery 900W
- Cruise Flight: PEMFC 700W
- 6hr 40min/454km Fright Completion
- Landing & Successful Flight
- Hydrogen Fuel Cell Powered Long-Term Unmanned Aerial Vehicle

# Flight of Unmanned Aerial Vehicle

# Thank you for consideration


## Acknowledgments

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