Development of residential 700W PEFC micro-CHP system

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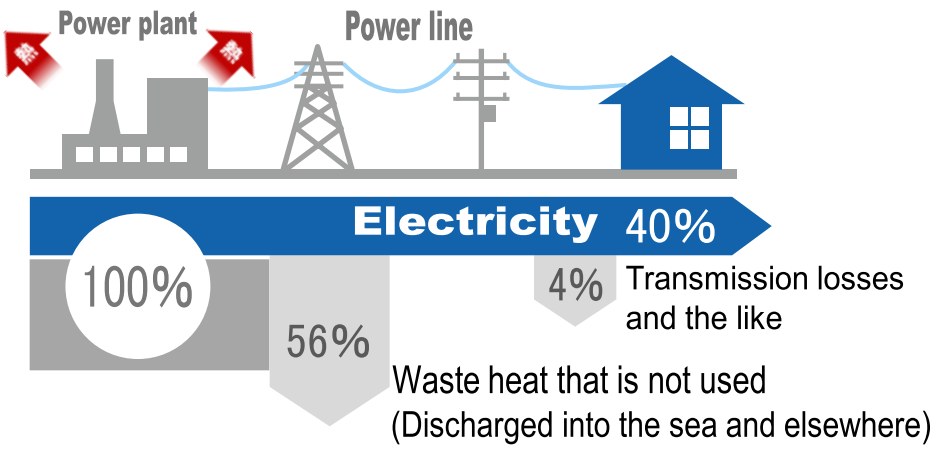
PEFC micro-CHP Development Team
Residential Energy Business Unit
Osaka Gas Co., Ltd.

Contents

Advantage of Residential Cogeneration System

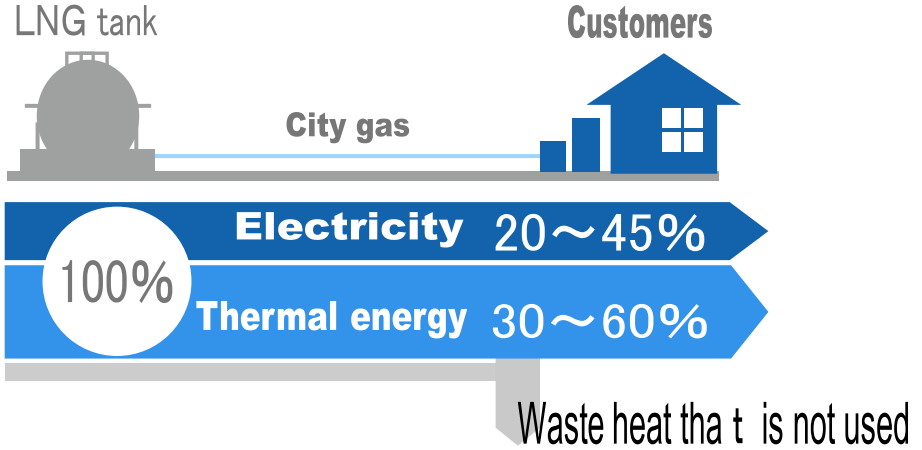
Cogeneration system is an energy efficient power generation device

Conventional system



Energy efficiency 40%

Cogeneration system

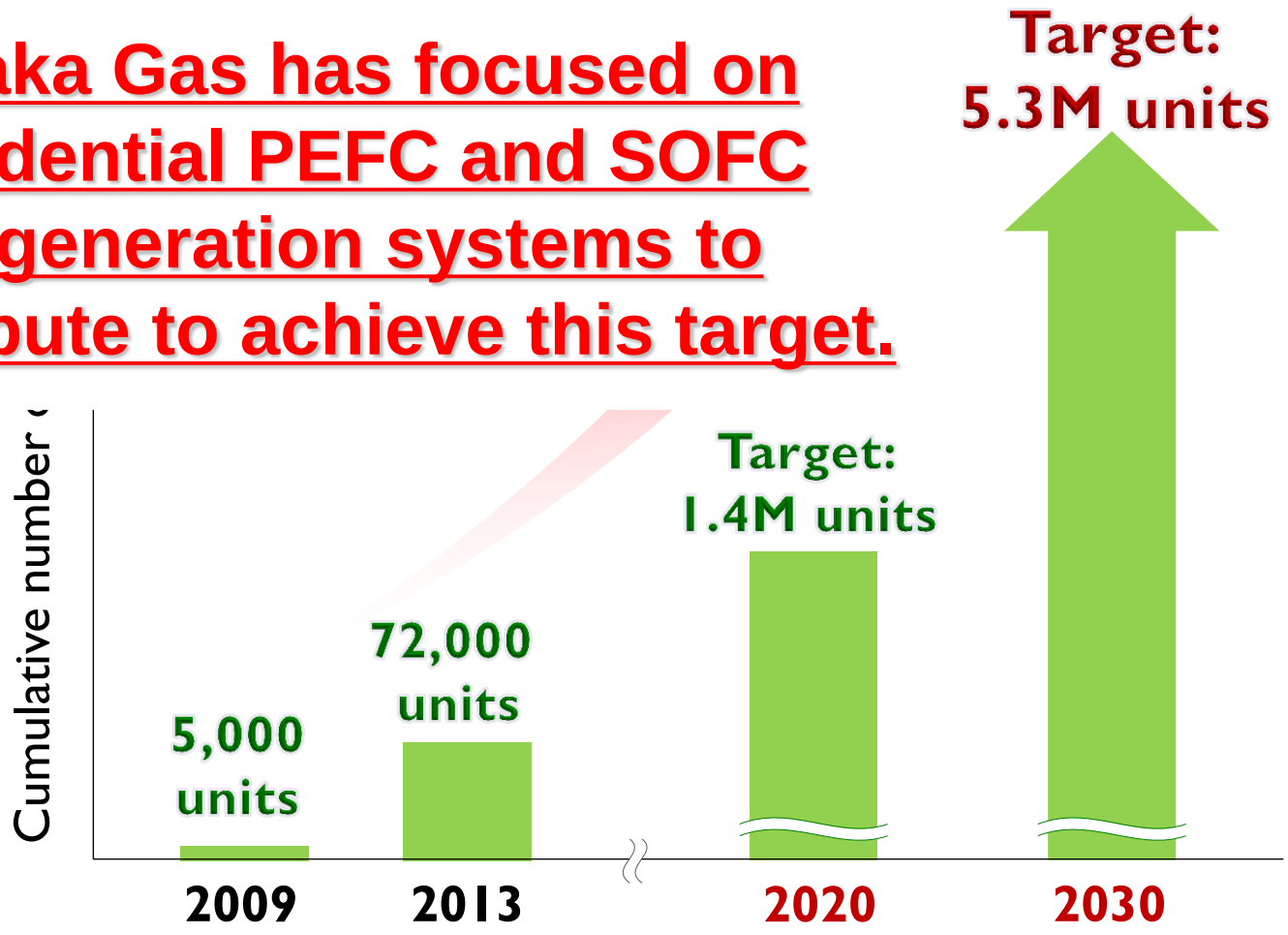


Energy efficiency 70～90%

Target of Japanese Government

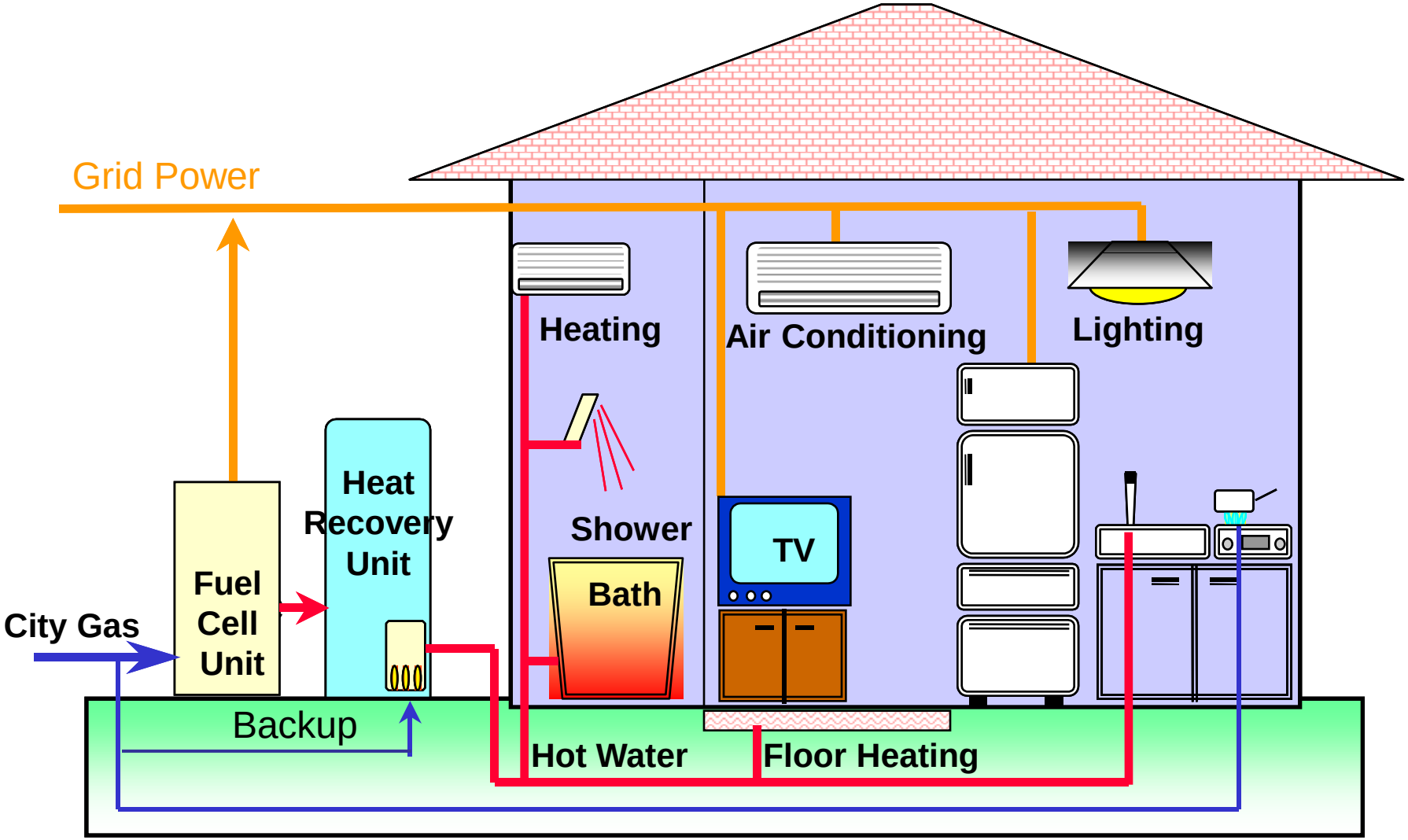
Target：5.3 million volume of residential Fuel Cell cogeneration system by 2030

Osaka Gas has focused on residential PEFC and SOFC cogeneration systems to contribute to achieve this target.



(Source) 2014 Basic Energy Plan issued by Ministry of Energy, Trade and Industry

Residential CHP System



PEFC System Unit

Evaluation of
Cell Reliability & Durability

Cell Stack

Inverter

H_2

DC

AC output

Fuel Processor

Heat

- Evaluation of Integrated System
- Improvement System Design

City Gas

Heat Recovery System

Heat

Hot Water output

- Catalyst Development
- Fuel Processor Development

Heat Recovery System & Operating Control Software Development

Fuel Processing Reactions

Steam Reforming Process

City Gas

⇩

Desulfurizer

Steam → ⇩

Reformer

⇩

Shift Converter

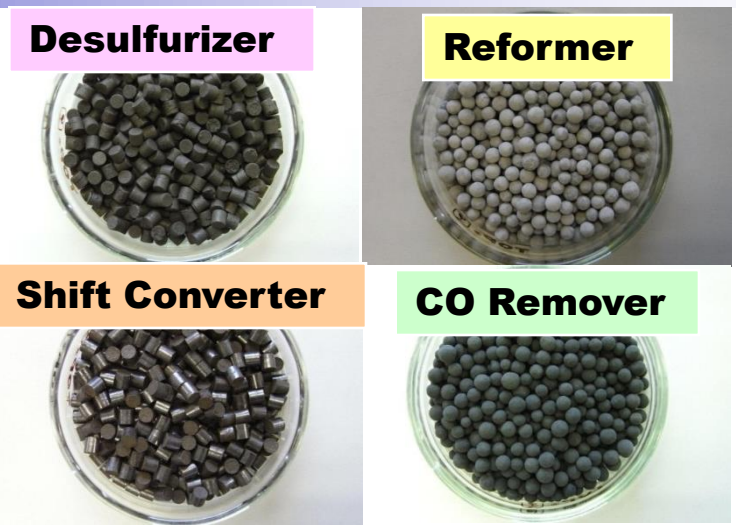
Air → ⇩

CO Remover

⇩

Reformed Gas

H_2 75.5%, CO_2 20%, CH_4 1.5%, N_2 3%, CO<1ppm



$$CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$$
$$(CH_4 + H_2O \rightarrow CO + 3H_2)$$

$$CO + H_2O \rightarrow CO_2 + H_2$$

$$CO + 1/2\ O_2 \rightarrow CO_2$$

Remaining CO

10 %

1%

< 1ppm

Fuel Processor Development

Characteristics of FPS

All reactors in one package

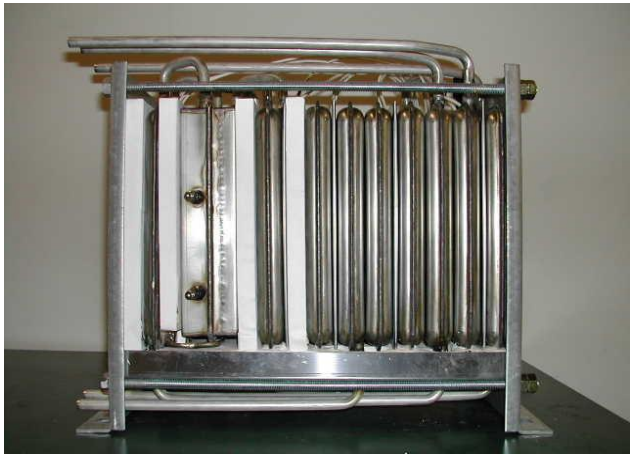
High thermal efficiency : > 82% (HHV)

Extremely low outlet CO concentration

: < 1 ppm

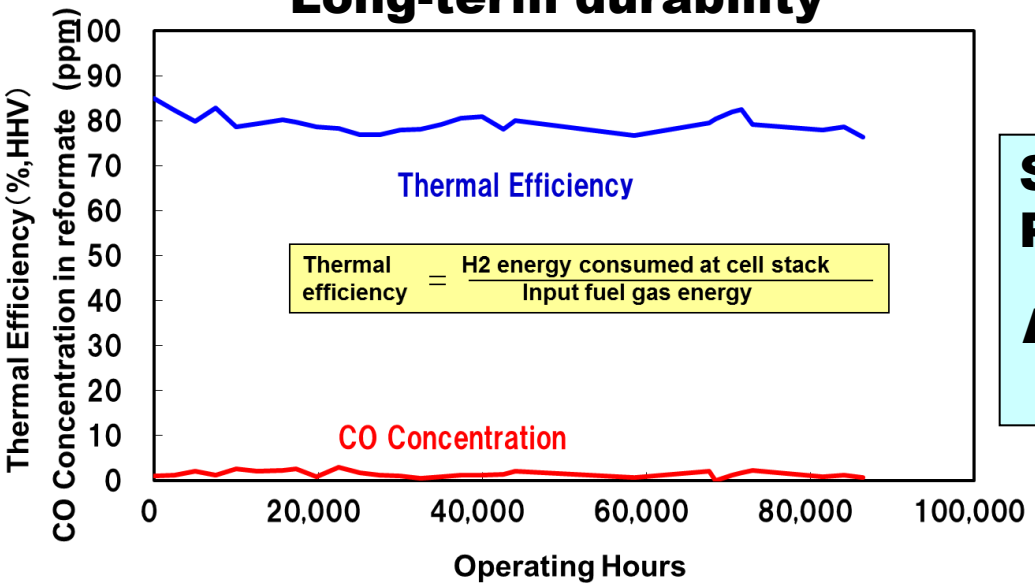
No catalyst exchange including desulfurizer

Long durability : > 90,000 hours



700W class FPS

Long-term durability



Fuel Processor: FPS-1000, Condition: S/C = 2.5～2.7, O_2/CO = 1.5

Sales of FPS : > 36,000 units

Patents : 117 registered

Licensed to

9 PEFC Manufacturers

Evaluation of PEFC Reliability & Durability

◇ Durability test under the various Condition

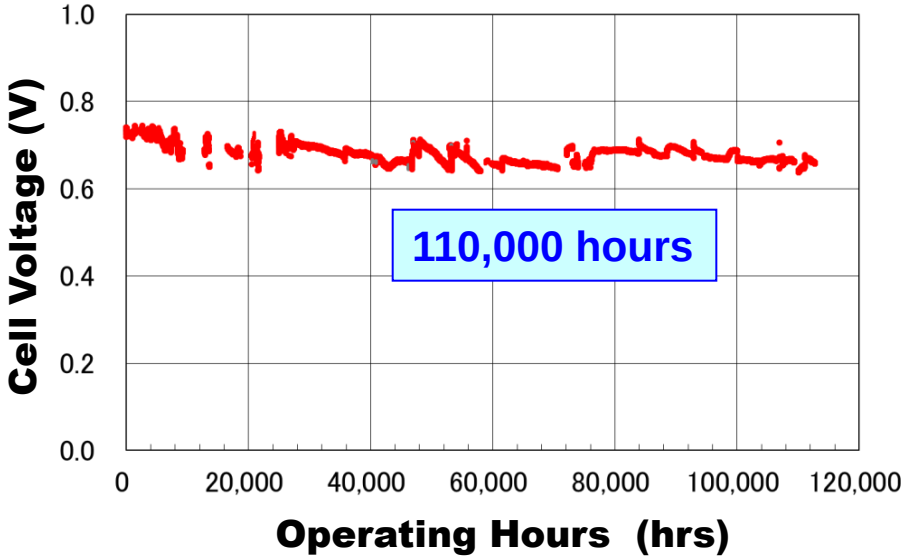
◇ Elucidation of Degradation Mechanism

⇨ Established Accelerated Evaluation Method

Evaluation of the durability of cell for 110,000 hours under the actual condition

Single Cell Evaluation Equipment

Single Cell



Background of PEFC Technology Development

1999 | 2002 | 2003 | 2005 | 2008 | 2009 FY | 2012 FY

700W PEFC micro-CHP system "ENE-FARM" was commercialized in 2009

Commercialization

Model Change

Fuel processing system developed in 2003

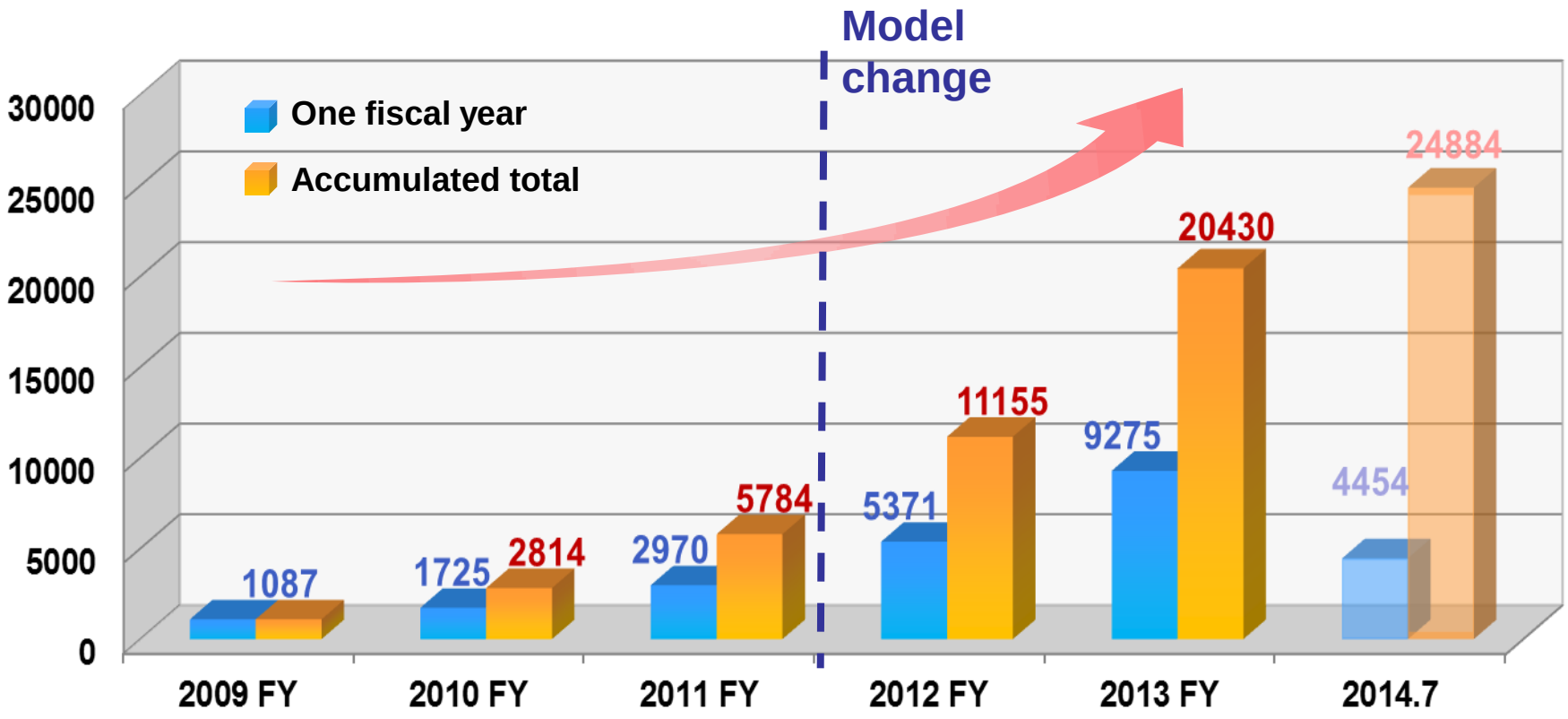
Joint Development with Toshiba Fuel Cell Power Systems Corp.

large-scale demonstration

2009 Model 2012 Model

Transition of the volume of sales at Osaka Gas

- The sales volume has been increasing every year since 2009 FY.
- Accumulated total volume broke through 20,000 units in 2013 FY.



In order to spread ENE-FARM as a normal commodity, it is required to reinforce marketability.

Challenging points for 3rd Generation ENE-FARM Development

【Cost reduction】

✓ Reduction of system cost

✓ Reduction of installation cost

【Enhancement of installation capability】

✓ Reduction of required distance from wall

【Improvement of performance】

✓ Improvement of efficiency

【Improvement of usability】

✓Development of high functional remote controller

Osaka gas has continued to develop, and new model ENE-FARM was released in April 2014

Contents

Specifications of New Model ENE-FARM

New model unit

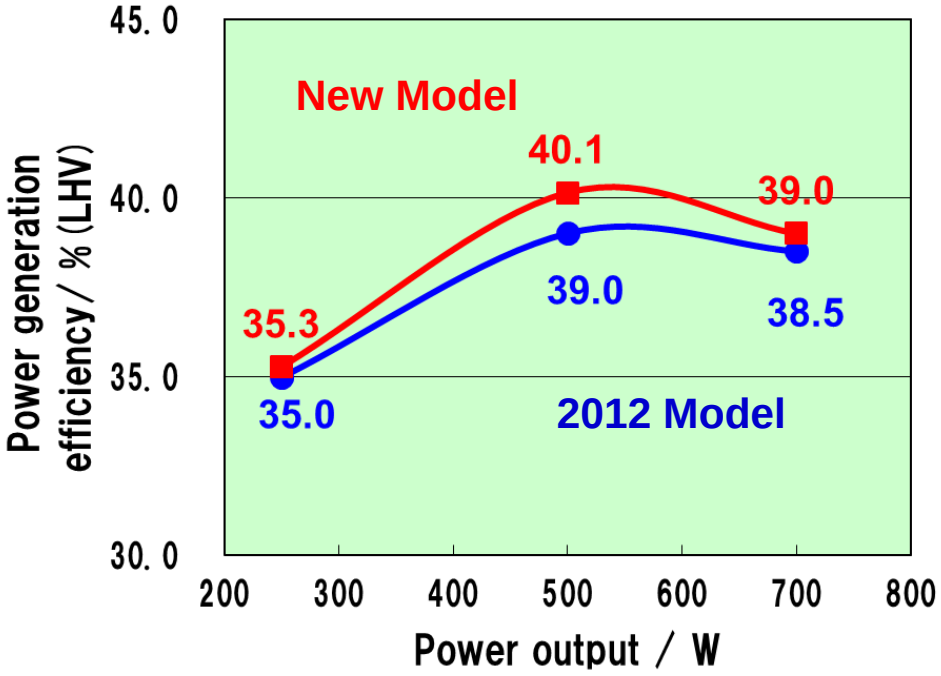
Color LCD remote control

		New model	2012 model
Release date		April 1, 2014	April 2, 2012
Performance	Power output range	250W～700W	
	Electrical efficiency(LHV)	39.0%	38.5%
	Total efficiency(LHV)	95.0%	94.0%
Dimension	Fuel cell unit	W780×H1,000×D300(mm)	
	Hot water storage unit (made in Chofu)	W750×H1,760×D440(mm)	
Dry weight	Fuel cell unit	94kg	94kg
	Hot water storage unit (made in Chofu)	92kg	100kg
Installation space		distance from wall 700mm	distance from wall 790mm
Acoustic noise	Fuel cell unit	37dB or less in all directions	38dB or less in all directions
List price		JPY 1,944,000	JPY 2,604,000

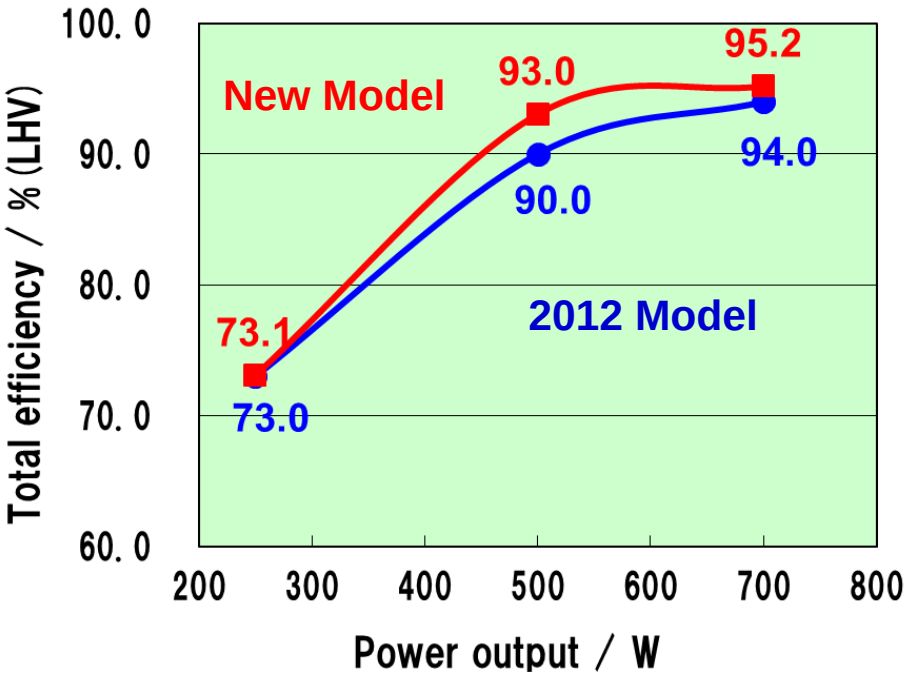
System Efficiency of New Model

New model achieved the highest total efficiency over 95%(LHV).

Power generation efficiency



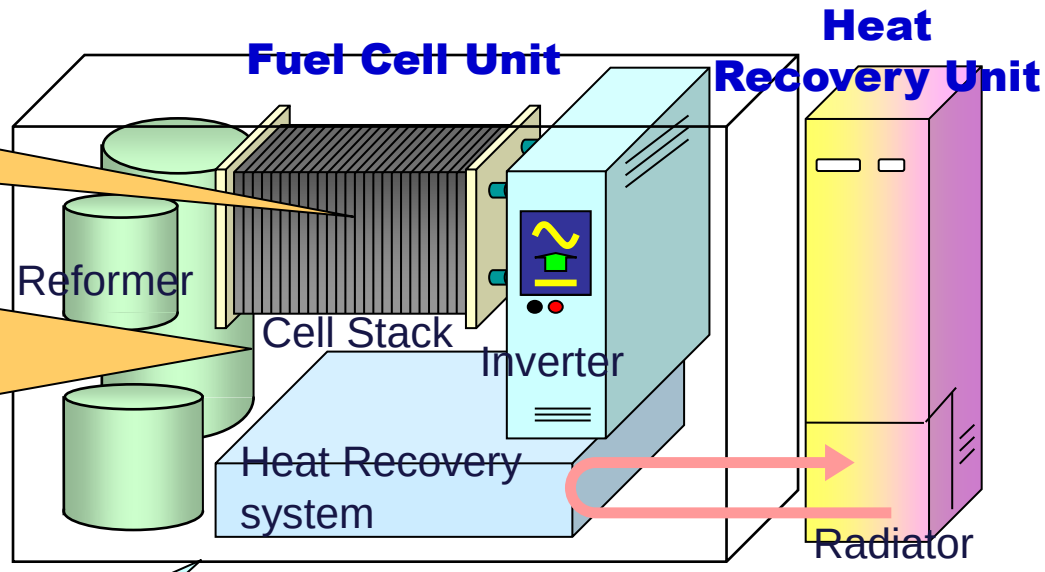
Total efficiency



Reduction of System Cost

Technical Development

- Adoption of low cost materials
- Low cost burner and desulfurizer
- Improvement of start-up and shutdown durability
  ⇨ Radiator Deletion



Assembling Process

- Increase in production capacity
- Automation of inspection process

Component Procurement

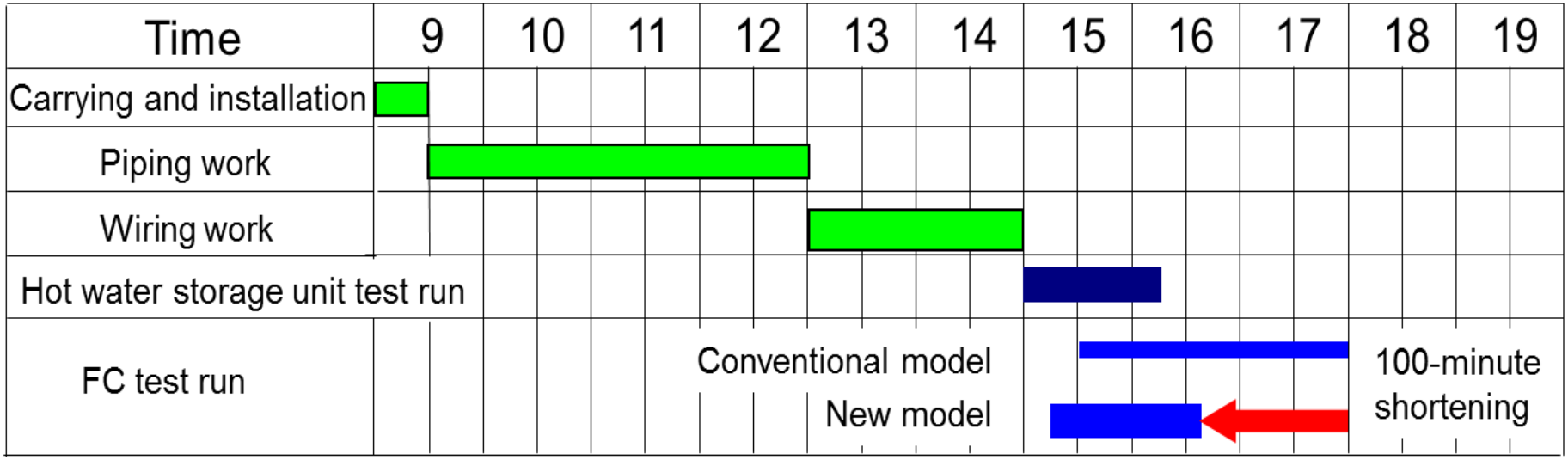
- Competition by multiple vendors

Reduction of Installation Cost

Test run duration : 3hours → 1hour 20miuntes

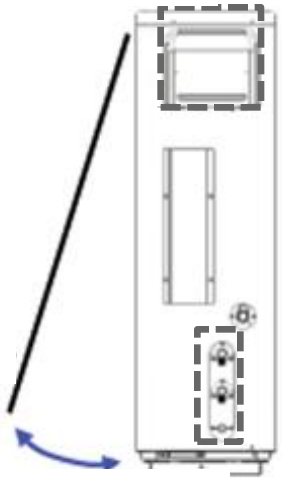
- ☐ **Shortening of start-up process : 40minutes**
- ☐ **Acceleration of FC test run start time : 10minutes**
- ☐ **Reduction of shut-down sequence : 50minutes**

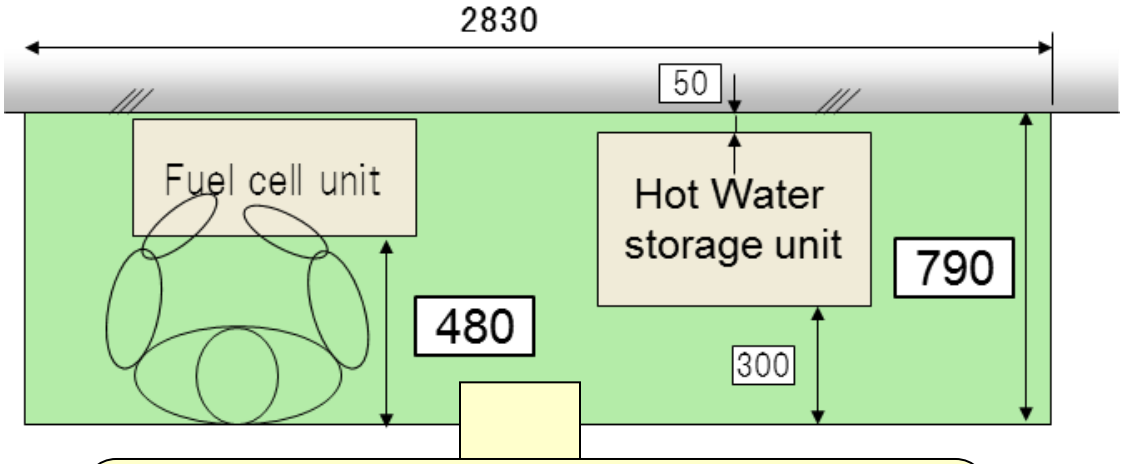
Time schedule image of the process of construction and test run



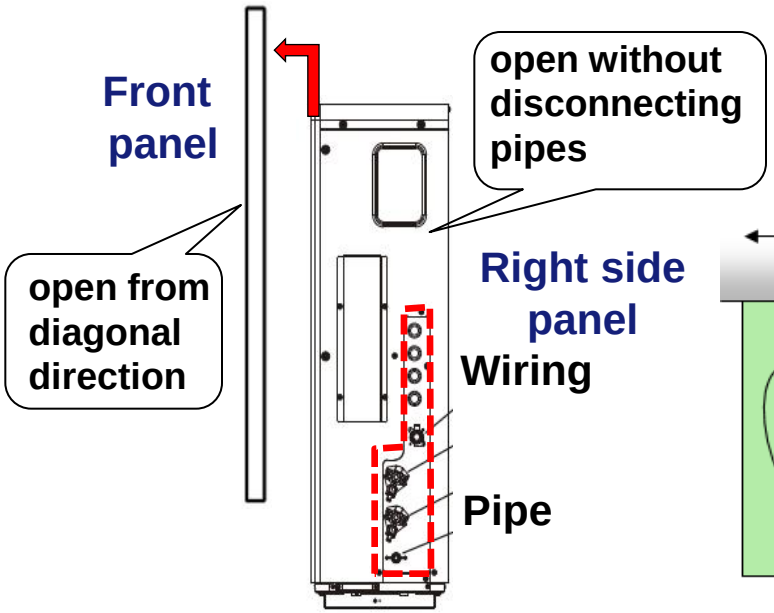
Reduction of Installation Space

2012 Model

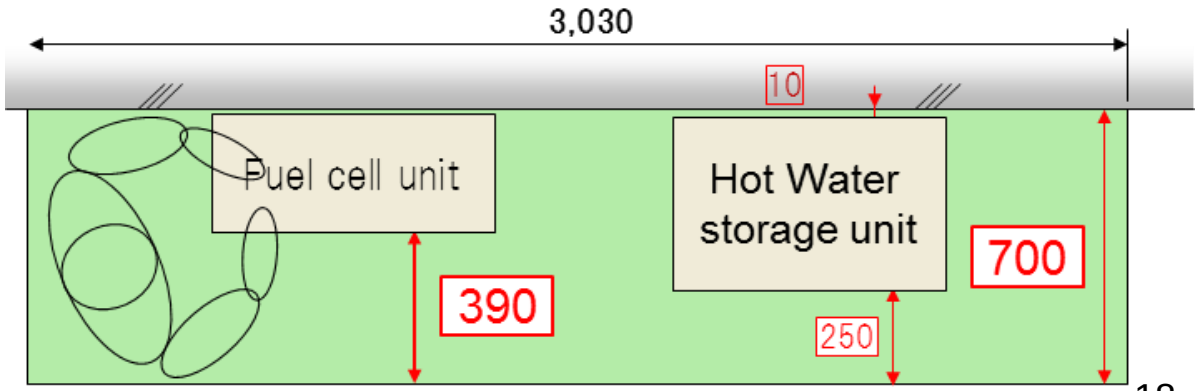




New Model



Distance from the wall
790mm → 700mm

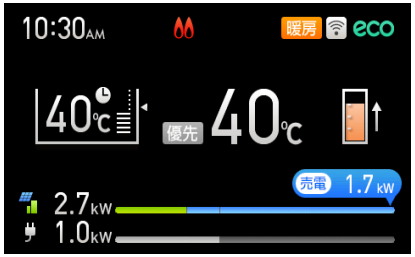


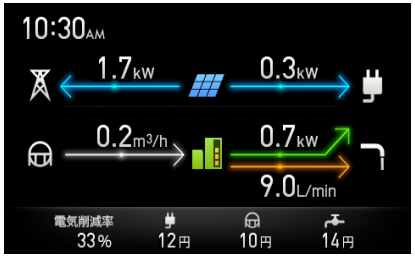
High Functional Remote Controller

Features

- **4.3 inches color LCD monitor**
- **Wireless LAN module**
  - **operation and check from smart phone**

Top monitor



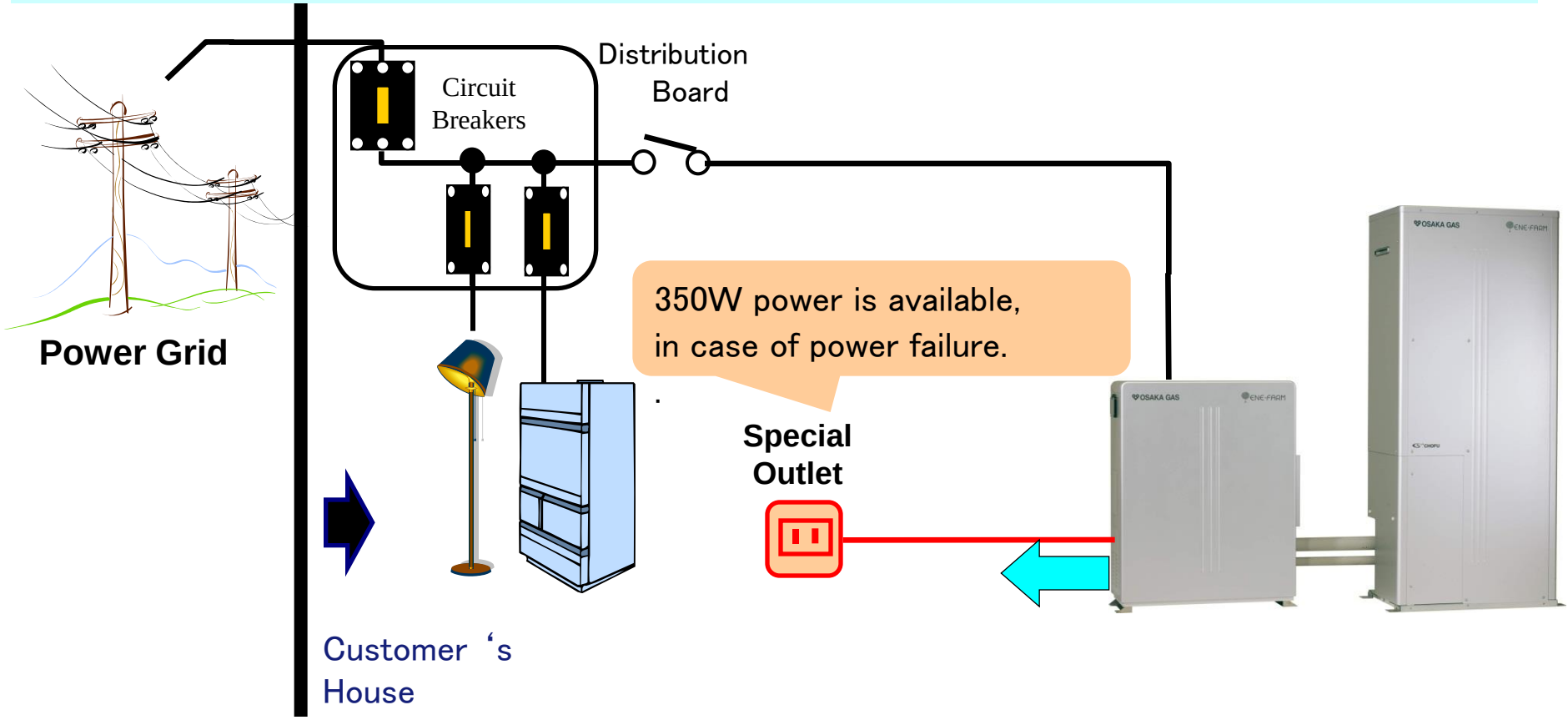


Energy monitor

Smart phone display about energy status

Grid Independent System Development

Grid Independent system can supply 350W for special outlet, in case of power failure.



Power consumption Examples of Appliances

- Electric Lights：50W
- Laptop PC：50W
- LCD TV：150W
- Shower：100W
- Mobile Phone ：15W
- Electric Fan : 40W
- Floor Heating : 130W etc.

Conclusion

- Osaka Gas has continue to develop residential PEFC cogeneration system since 1999, and has released a new model “ENE-FARM” in April 2014.

- The new model ENE-FARM has following features.

✓ Significant reduction of system cost
✓ Improvement of system efficiency
✓ Reduction of installation cost
✓ Reduction of installation space
✓ Adoption of high functional remote controller

Osaka Gas continues to develop more marketable ENE-FARM to contribute to customer’s comfortable life and improvement of the global environment.

Thank you for your attention.

家庭用燃料電池コージェネレーションシステム

ENE・FARM

エネファーム