

Development of Residential PEFC Cogeneration System in Osaka Gas

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Contents

1. Concept & Background of Residential PEFC Cogeneration System

2. Elemental Development of Residential PEFC Cogeneration System

- Cell Stack Evaluation**
- Fuel Processor**
- Heat Recovery System**

3. Development of Integrated PEFC Cogeneration System

Gas Engine Cogeneration System for Residential Application “ECOWILL”

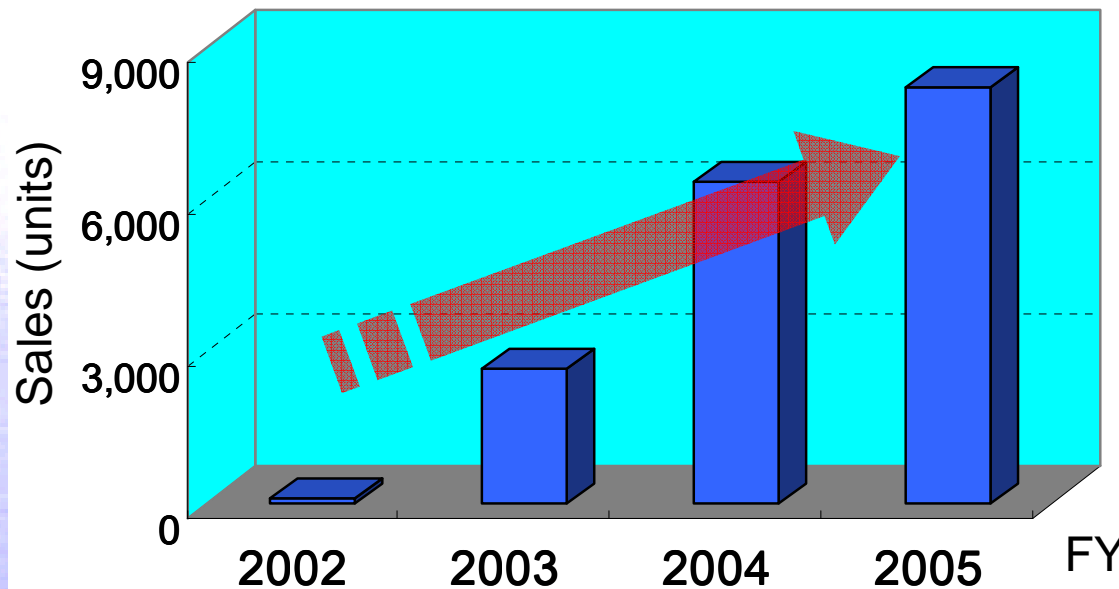


Heat Recovery System



Gas Engine System

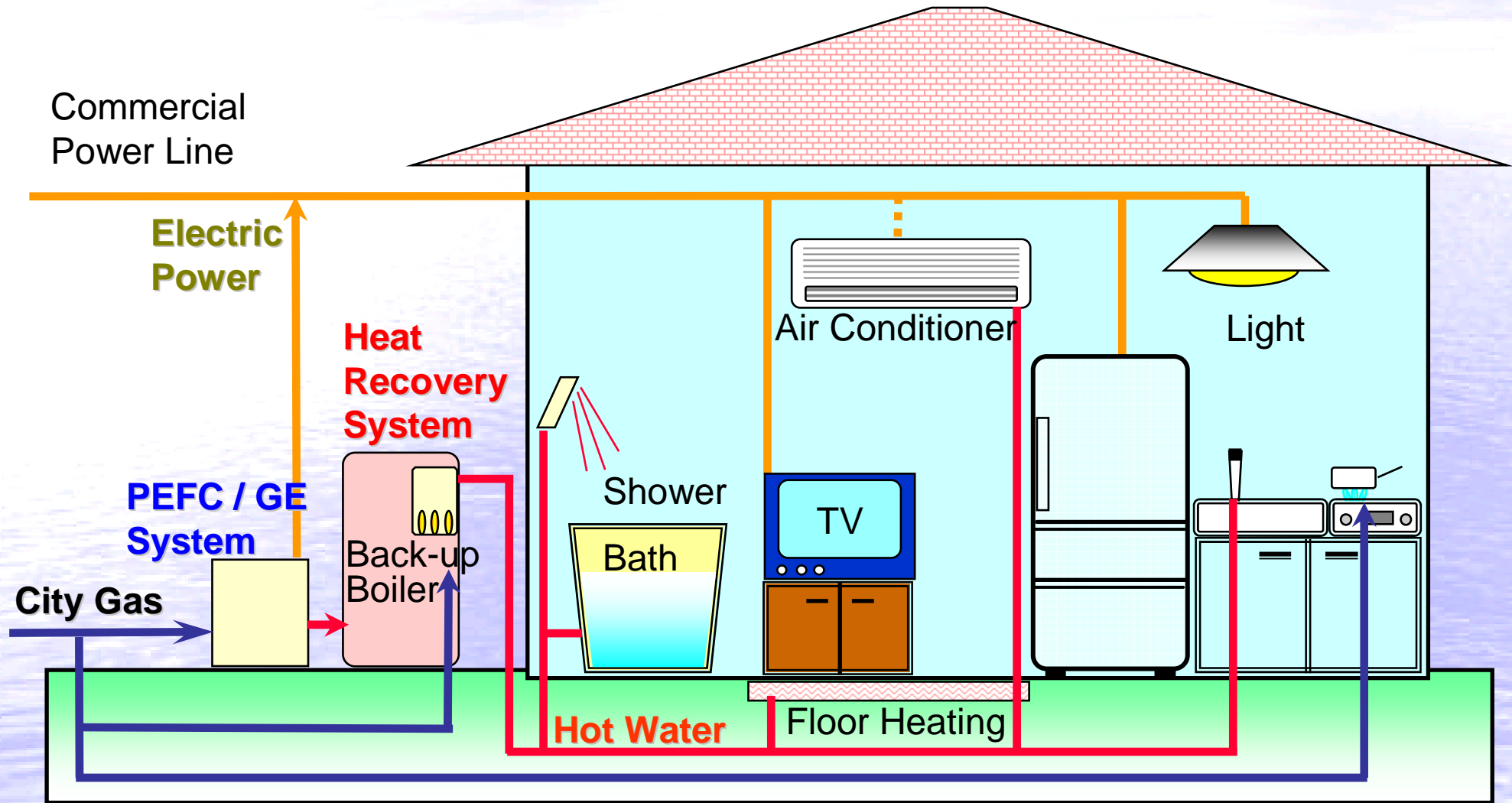
In Osaka Gas's area



	Gas engine System
Rated Power	1 kW
Heat Output	3.25 kW
Electric Efficiency	20% (LHV)
Thermal Efficiency	65% (LHV)
Dimensions (mm)	D380 × W580 × H880
Durability	20,000 hours or 10 years

Osaka Gas has created market for residential cogeneration system

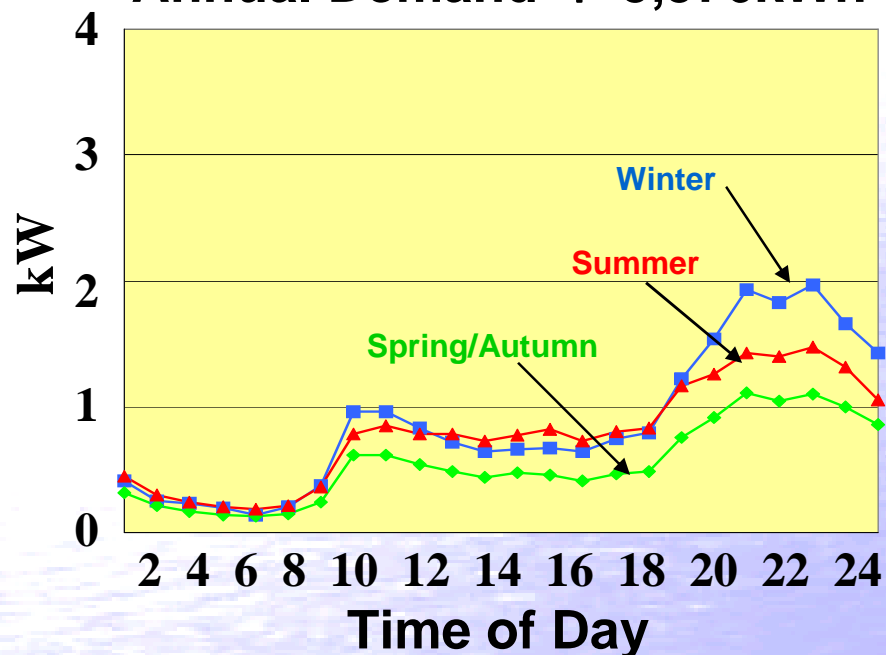
Concept of Residential Cogeneration System



Demand of a Standard Japanese Household

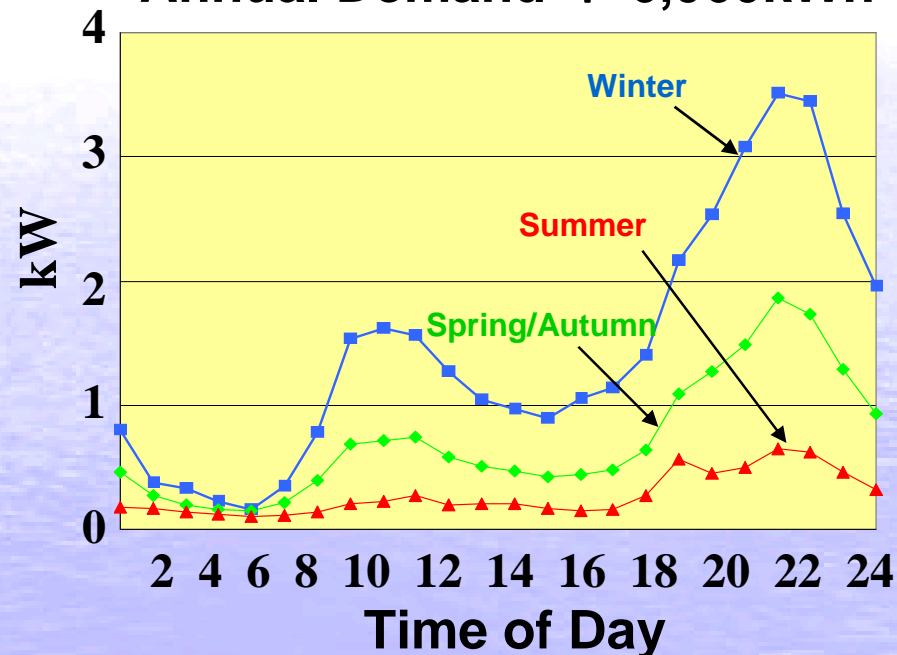
Electric Power Demand

Annual Demand : 5,576kWh



Hot Water Demand

Annual Demand : 6,060kWh



The Source : Surveyed by Institute of Research & Innovation in 1998

Total electric power demand is almost equal to that of hot water



Fit for PEFC Cogeneration System

Targeting Specifications for Commercial Units

Rated Power	700, 750 W
Turn Down (W)	250 / 500 / 700, 750
Electric Eff. (HHV%)	>27.0 > 30.5 >31.5 (@250W @500W @700,750W)
Heat Recovery Eff. (HHV%)	>23.0 > 34.0 >39.0 (@250W @500W @700,750W)
Operation Mode	Continuous (Start&Stop :Summer Season)
Durability	10 years

System Advantage

For Environment

(Comparison with Conventional system)

- Reduction of Primary Energy Consumption; **20%**
- Reduction of CO₂ Emission; **30%**
- Reduction of NO_x Emission; **70%**

For Consumer Benefit

Annual Savings of Energy Cost

; **JPY50,000 ~ 60,000 (EUR360 ~ 430)**

= Total Annual Utility Costs **20%** Saved

Target Sales Price

JPY600,000 (EUR4,300)

Allowable Cost Increase ; JPY150,000 ~ 300,000

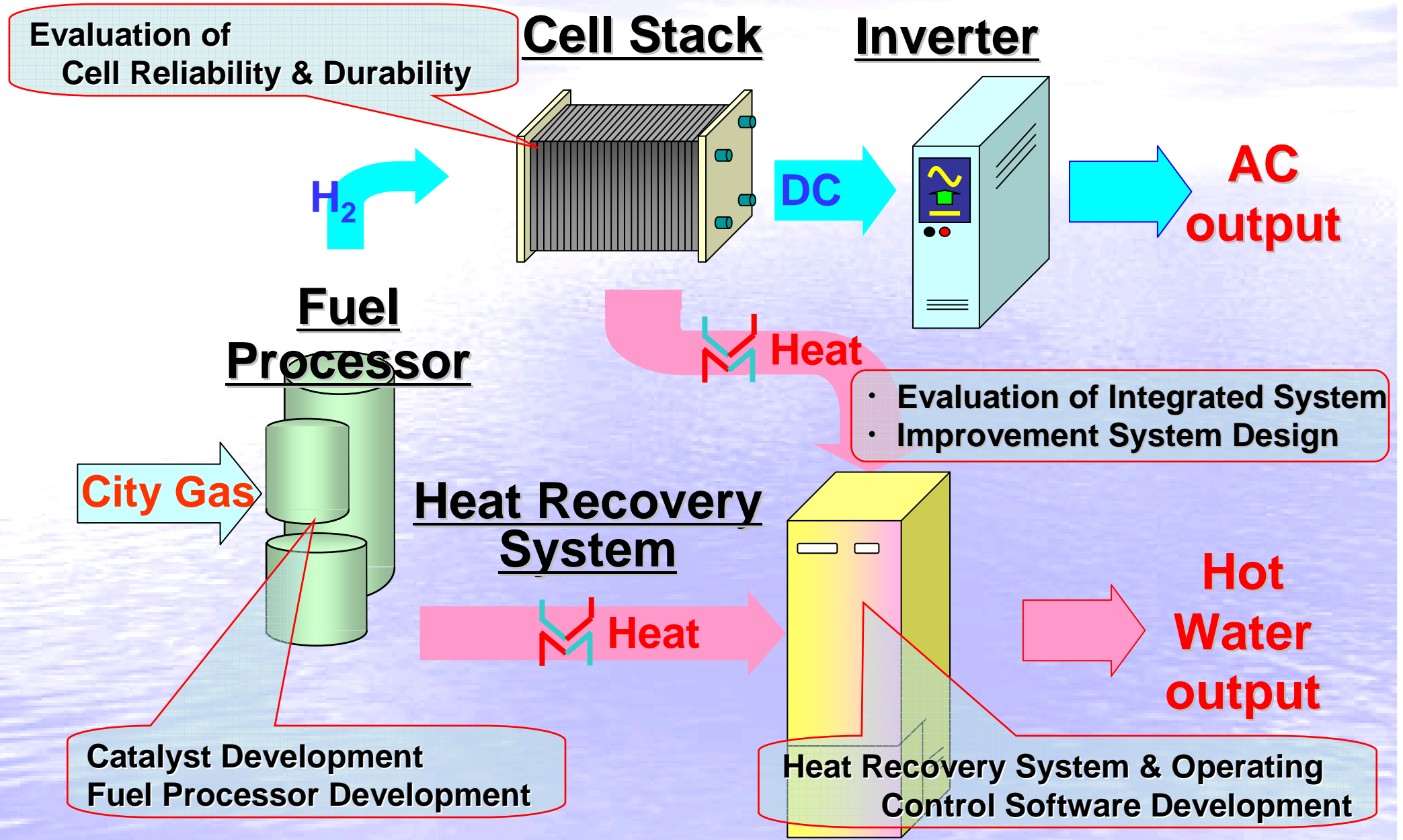
(EUR1,100 ~ 2,100)

Comparison with Conventional System (=Central Heating Boiler)

• • • **Payout ; 3 ~ 5years**

In the case of PEFC installation at the single-family house (Floor Area; 150m²)

PEFC Cogeneration System



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The Evaluation Study of PEFC Cell

Cell Durability Target

Transportation Application ; 5,000 hrs
Stationary Application ; 90,000 hrs

- Cell Durability is the most important factor
- No cell durability data was available

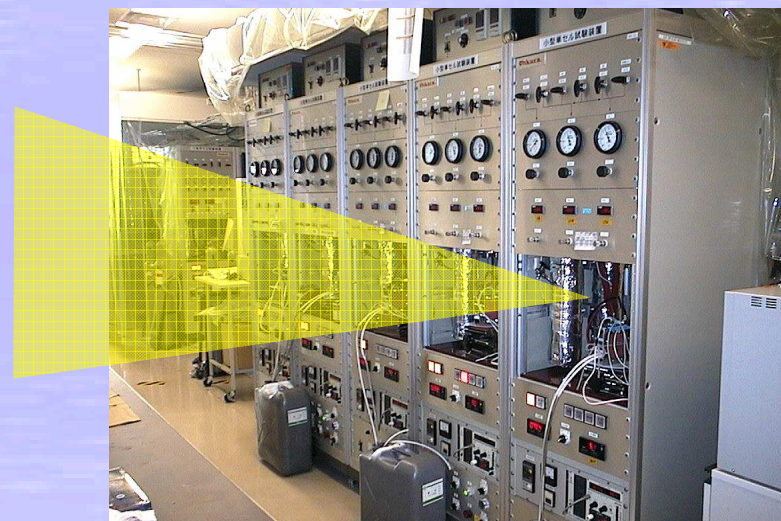
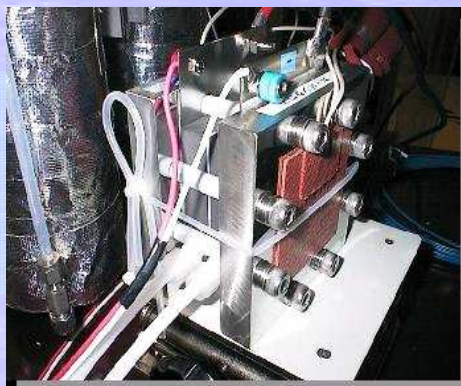


Evaluation study of PEFC single cells started in 1998

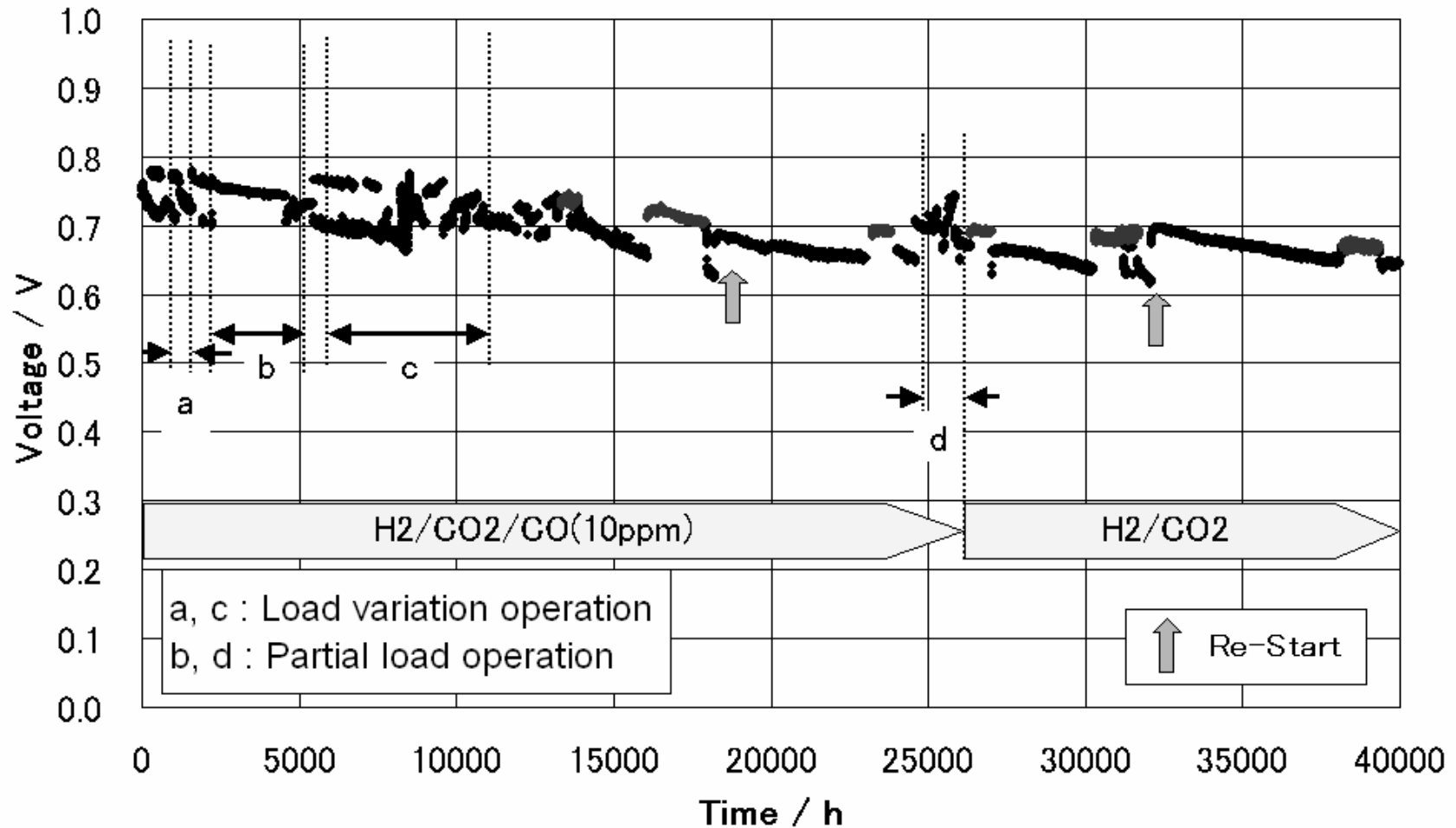
Durability Test under Various Conditions

Evaluation of Single cells

- Using 37 Apparatuses
- Cumulative Operation Time
: 1,500,000 hrs



Durability Test of Single Cell



More than 40,000 h durability was verified

Characteristics of Fuel Processor

For Stationary Application:

Long durability & low manufacturing cost are most important

Catalysts;

50,000hrs durability was already verified in PAFC systems in 1998



Fuel Processor for Residential PEFC system

◆ **Plate-shape Elements & Integrated in one Package**

◆ **High Thermal Efficiency**

> **82% (HHV)**

◆ **Low CO Concentration**

< **1 ppm (initial)**

◆ **Long Durability**

> **90,000 hours**

No catalyst exchange including Desulfurizer

◆ **Cost Reduction Capability at Mass Production Stages**

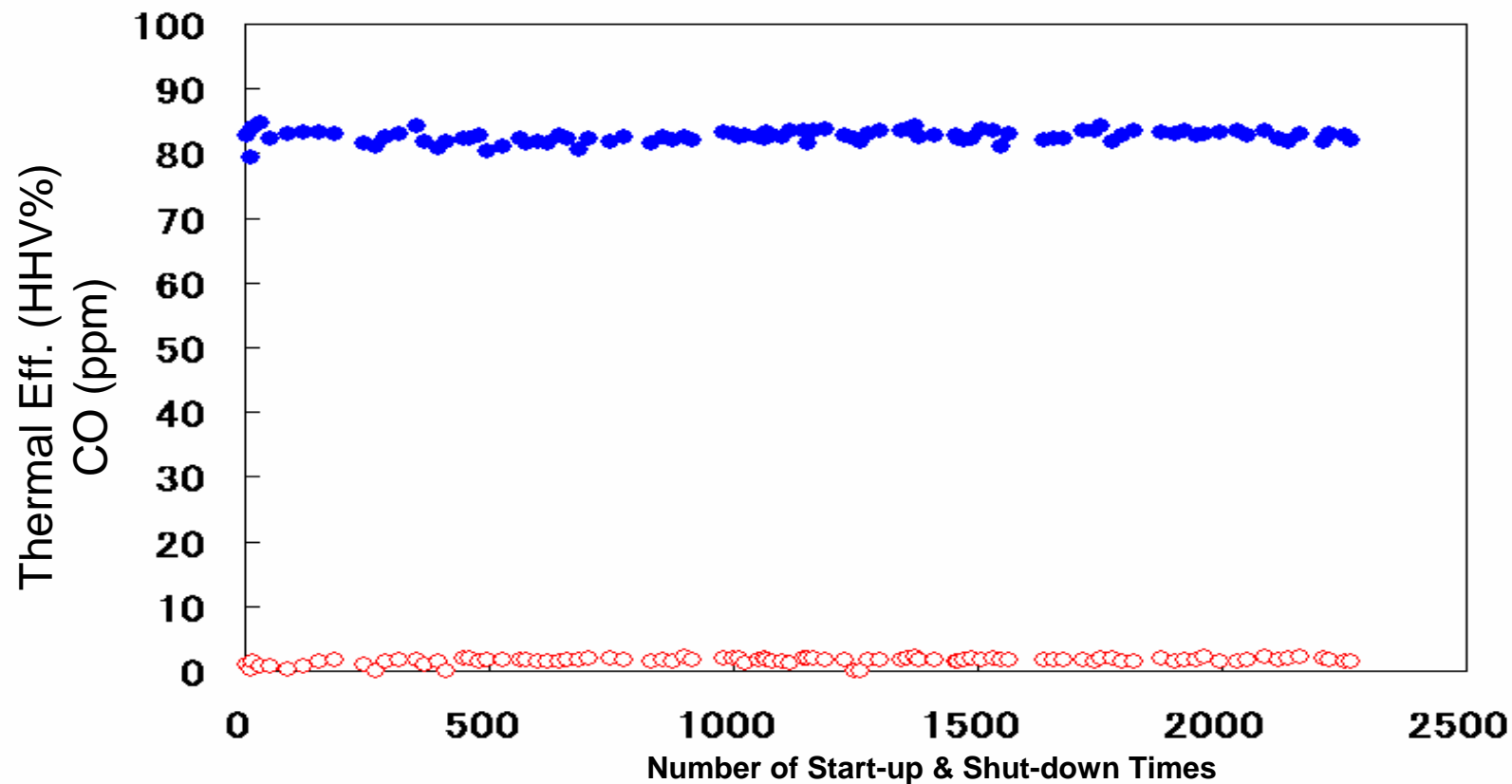
750W - class
Fuel Processor



Shipped for 330 units

For Domestic and Overseas companies

Start & Stop Endurance Test of FPS



Stable performance for more than

- 2,200 SS-times (Start & Stop test)
- 28,000 hours (Continuous Durability test)

Heat Recovery System

Running Efficiently for Any Residents, All Seasons
by **Self-Learning Control Software**

1. Accumulate Historical Data
(Electric & Heat Demand)
2. Predict Demand
(Electric & Heat Demand of Next Day)
3. Determine the Operation Mode
(Output Power etc.)



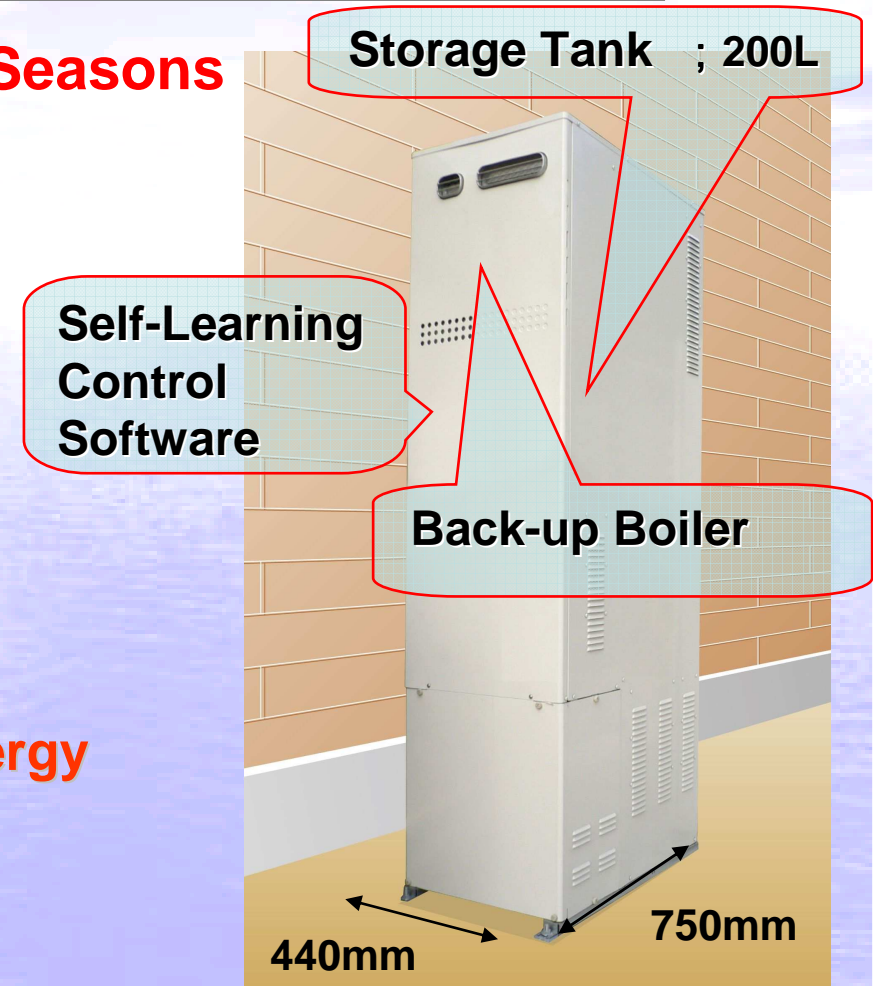
Self-Learning Control can enhance energy saving ratio up to 4 points

Compact Size

D440×W750×T1900mm

Suitable for Small Residential Space in Japan

Shipped for 7 Companies/ 400 Units



Remote Controller

Contents

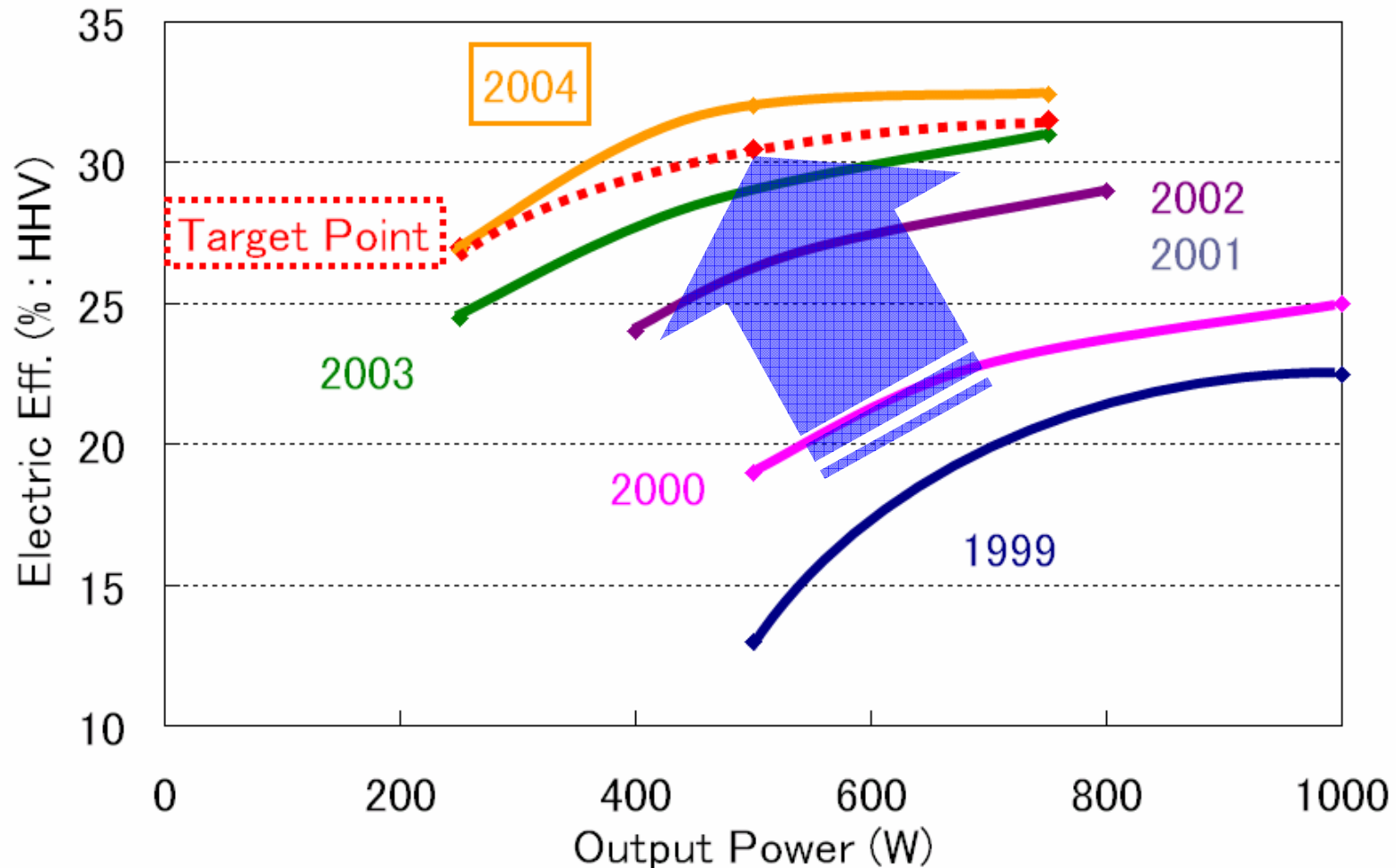
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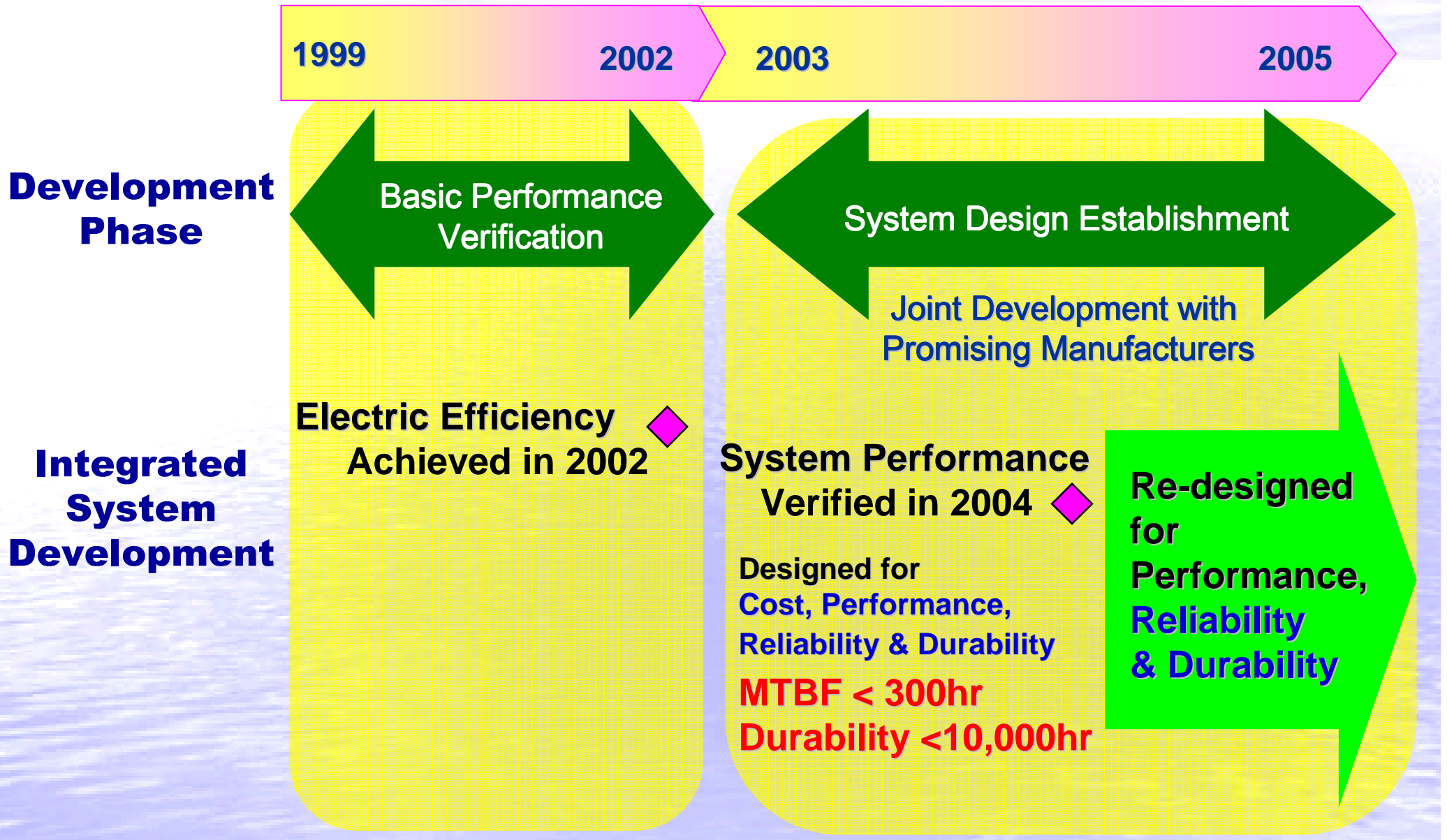
Progress in PEFC Cogeneration System Development



Electrical efficiency over 31.5% (Max 33%), even at minimum load over 27%

Target system performance has been achieved by 2004

Schedule for PEFC Technology Development



Field Testing at Real Residence

To Evaluate Energy Savings, System Reliability & Durability

➔ **Field Testing at Real Customers' Houses (more than 85 units)**

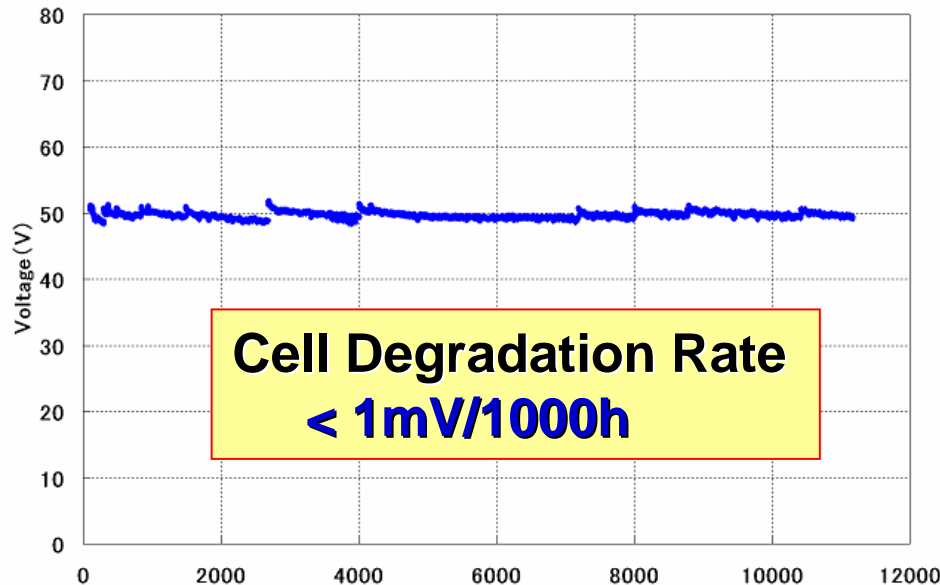


Verified

Total primary energy consumption was saved more than 15%

Durability & Reliability of Integrated PEFC Cogeneration System

System Durability



System Operation > 10,000hrs

System Reliability

MTBF < 300 hrs in 2004

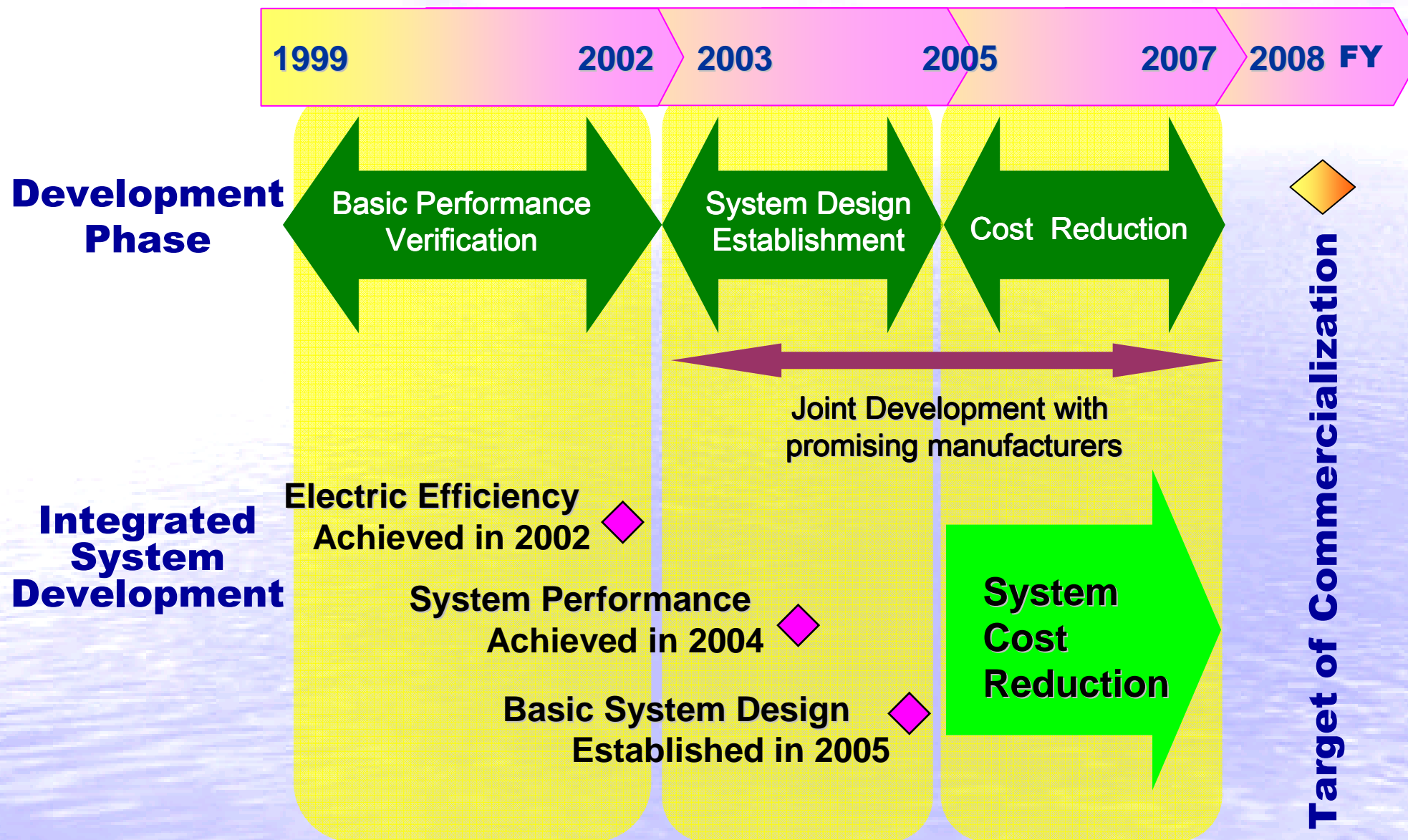


MTBF > 3,000 hrs in 2005

**Satisfied Requirements simultaneously
for System Performance, Reliability & Durability**

Basic system design was established in 2005

Schedule for PEFC Technology Development



Conclusions

- ◇ **Osaka Gas has been developing the residential PEFC cogeneration system with the core technologies**
 - **Demonstrated Cell Durability over 40,000hrs**
 - **Developed Durable & Low Cost Fuel Processor**
 - **Developed Compact & Efficient Heat Recovery System, which Fits for Any Seasons & Residents with Self-Learning Control Software**
 - **The system performance, reliability & durability has been demonstrated through field testing**

Basic system design was established in 2005

- ◇ **Collaborating with PEFC manufacturers, Osaka Gas is exerting all efforts**

To reduce system cost with satisfied reliability for the commercialization in 2008