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Current Situation and Integration Potential in Gas Area in Japan

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R&D division
Engineering department
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Contents of Today's Presentation

1. Osaka Gas Corporate Profile

2. Background of Japan's energy industry

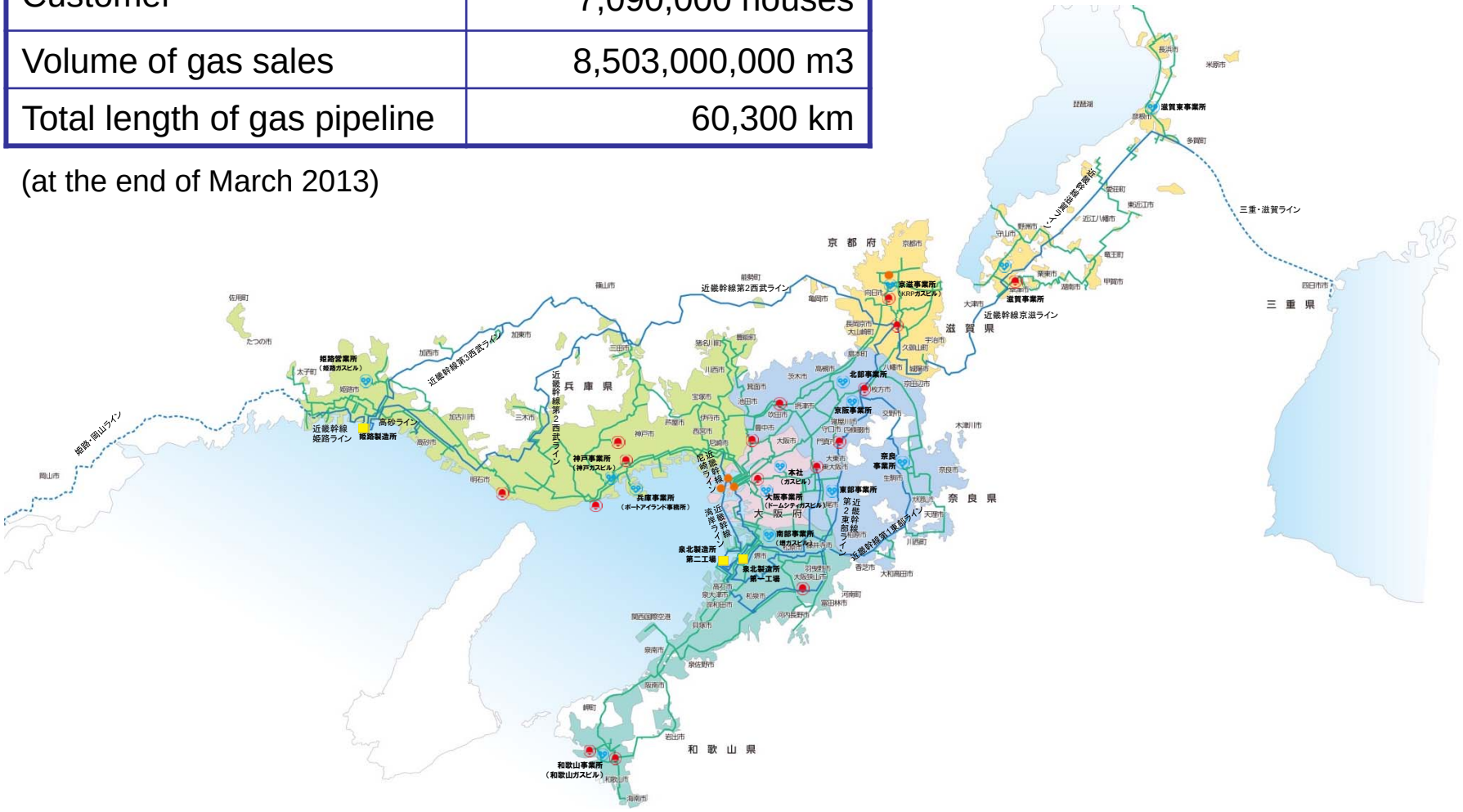
3. Introduction of the integration projects

- > Smart Energy Network Demonstration
- > Demand Response by CHP
- > Smart Energy Network in Iwasaki area
- > Community Energy Management System Demonstration
  (Waste heat utilization project)

Osaka Gas in brief: Gas Business

Service area	6 prefectures (79 cities and 30 towns)
Customer	7,090,000 houses
Volume of gas sales	8,503,000,000 m3
Total length of gas pipeline	60,300 km

(at the end of March 2013)



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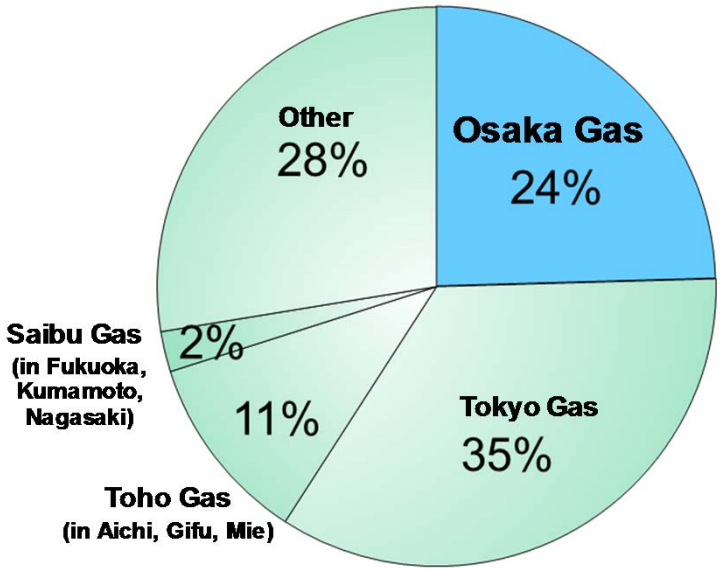
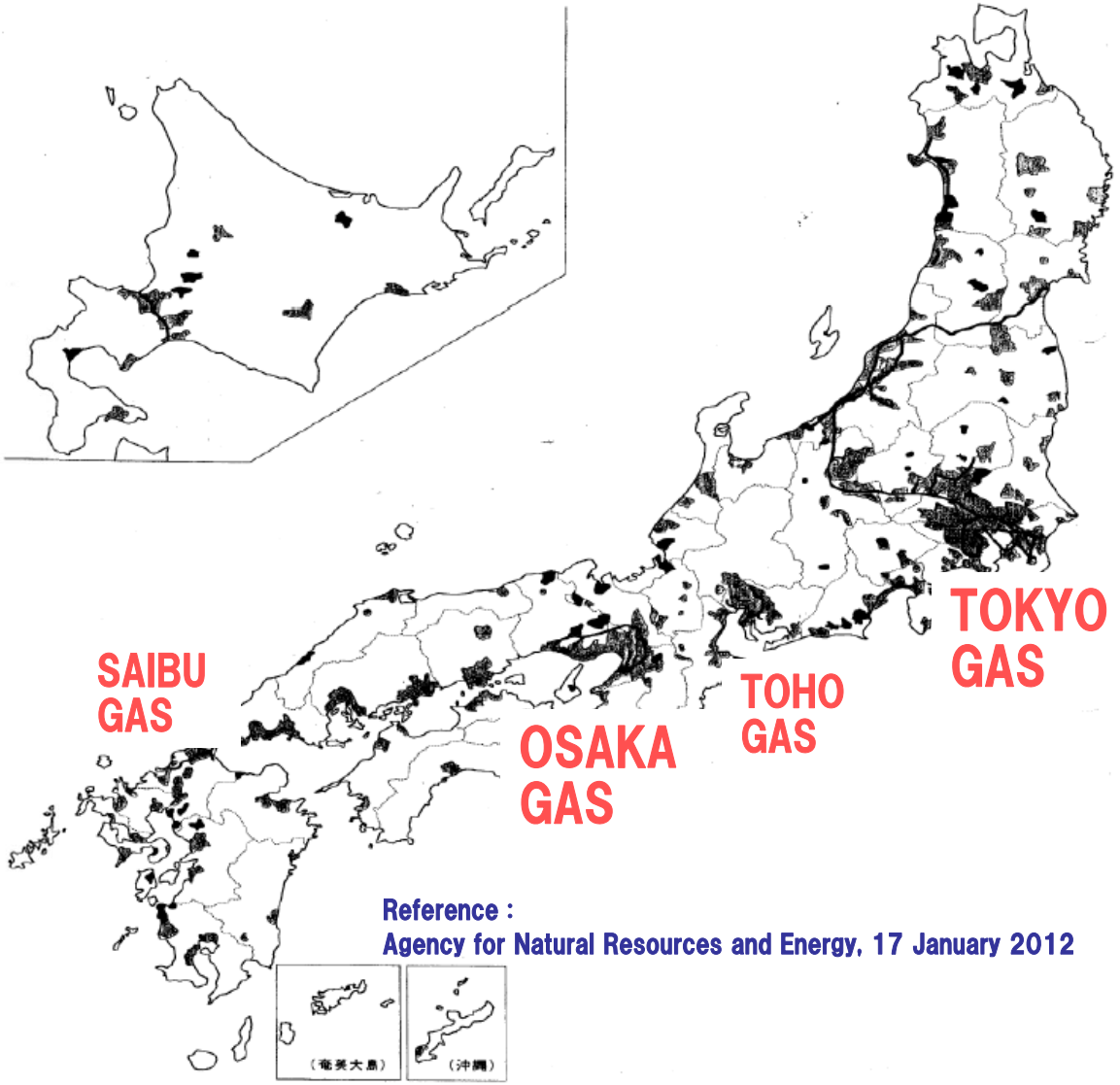
City Gas Utility Service Areas in Japan >

Over 200 Gas Utilities have been presented in Japan.

Share of city gas sales in Japan



Reference: Gas industry handbook published by The Japan Gas Association (2012)

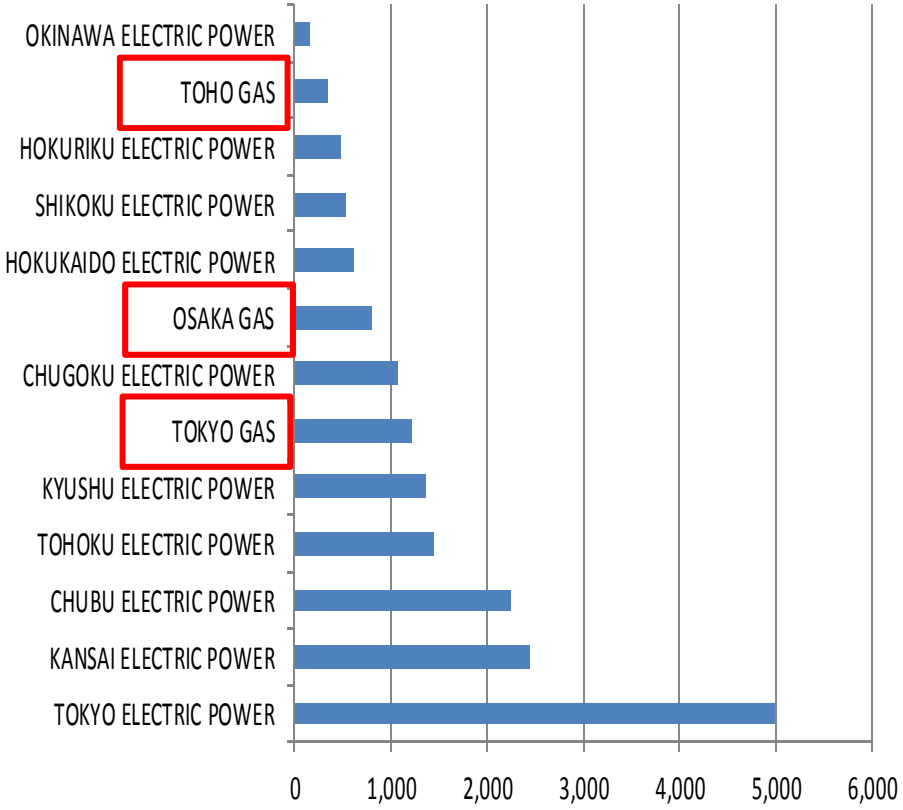


Reference :
Agency for Natural Resources and Energy, 17 January 2012

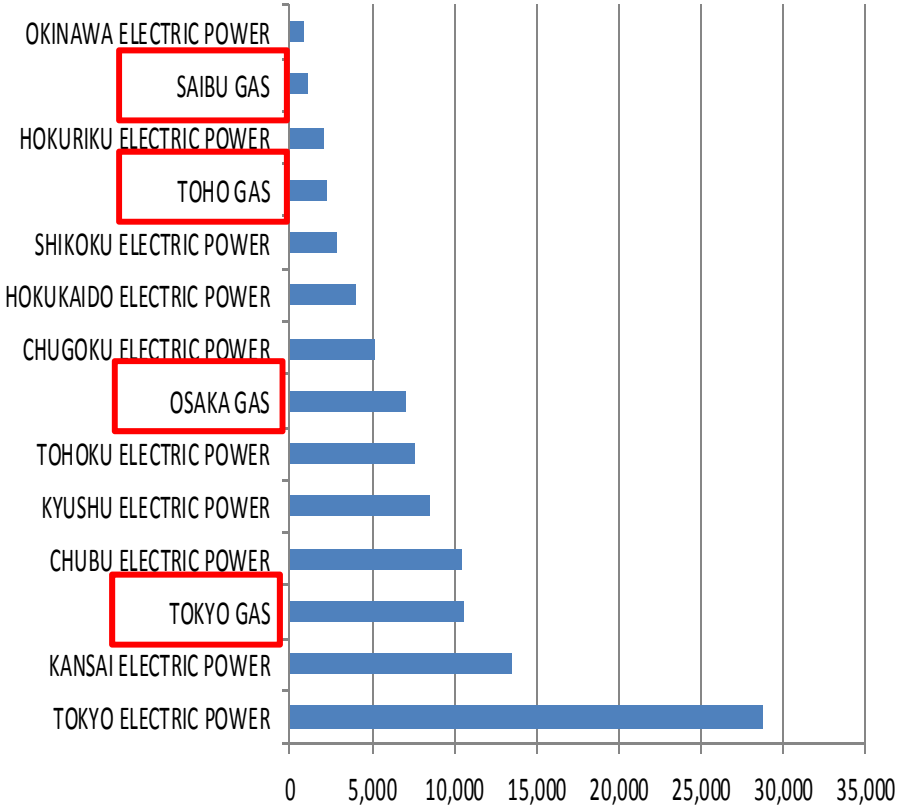
Electric vs. Gas Utility >

Most of Electric Utilities are bigger than Gas Utilities

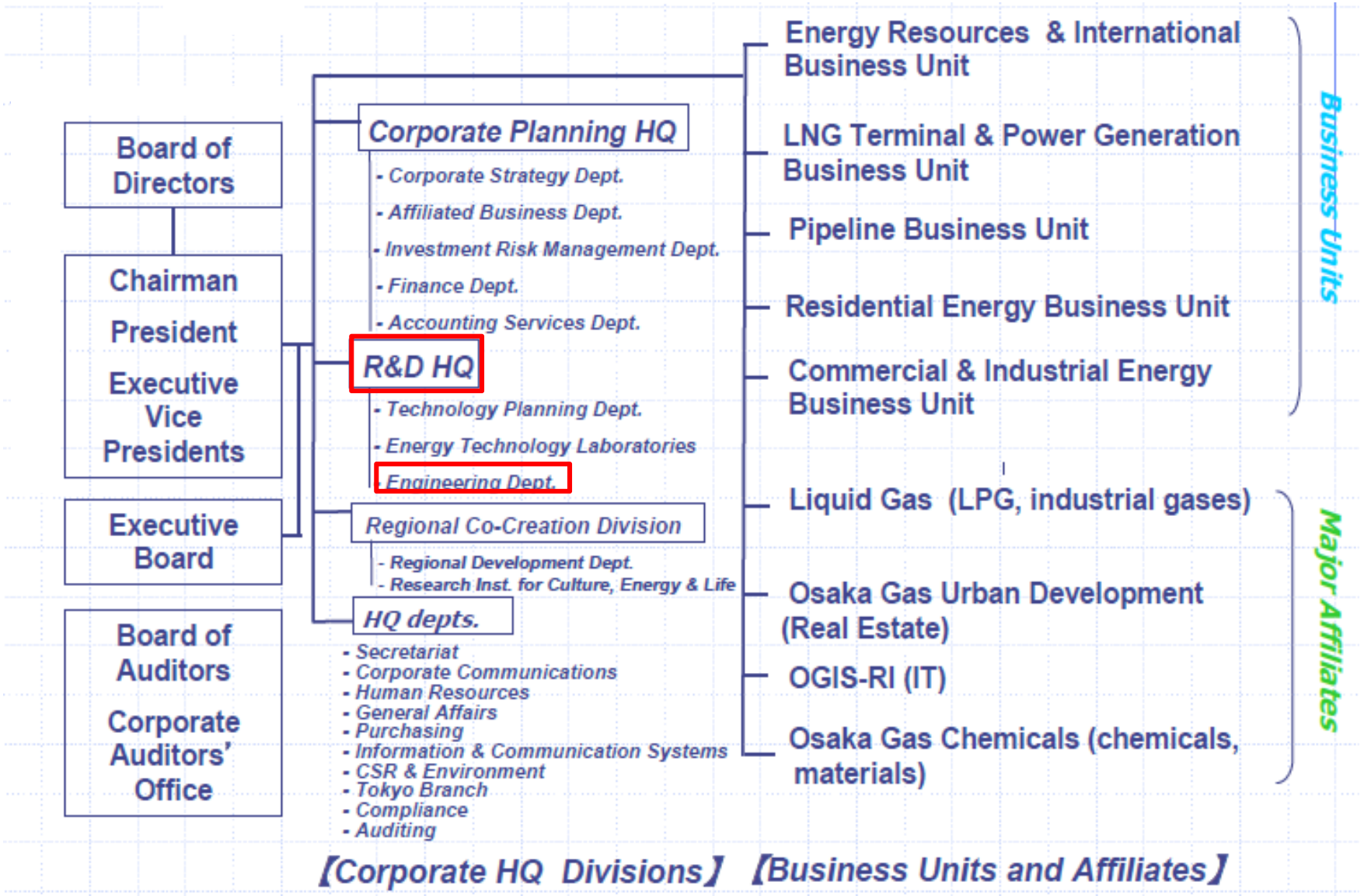
AMOUNT OF SALES <billion of YEN> (2011)



NUMBER OF CUSTOMERS <thousand> (2011)

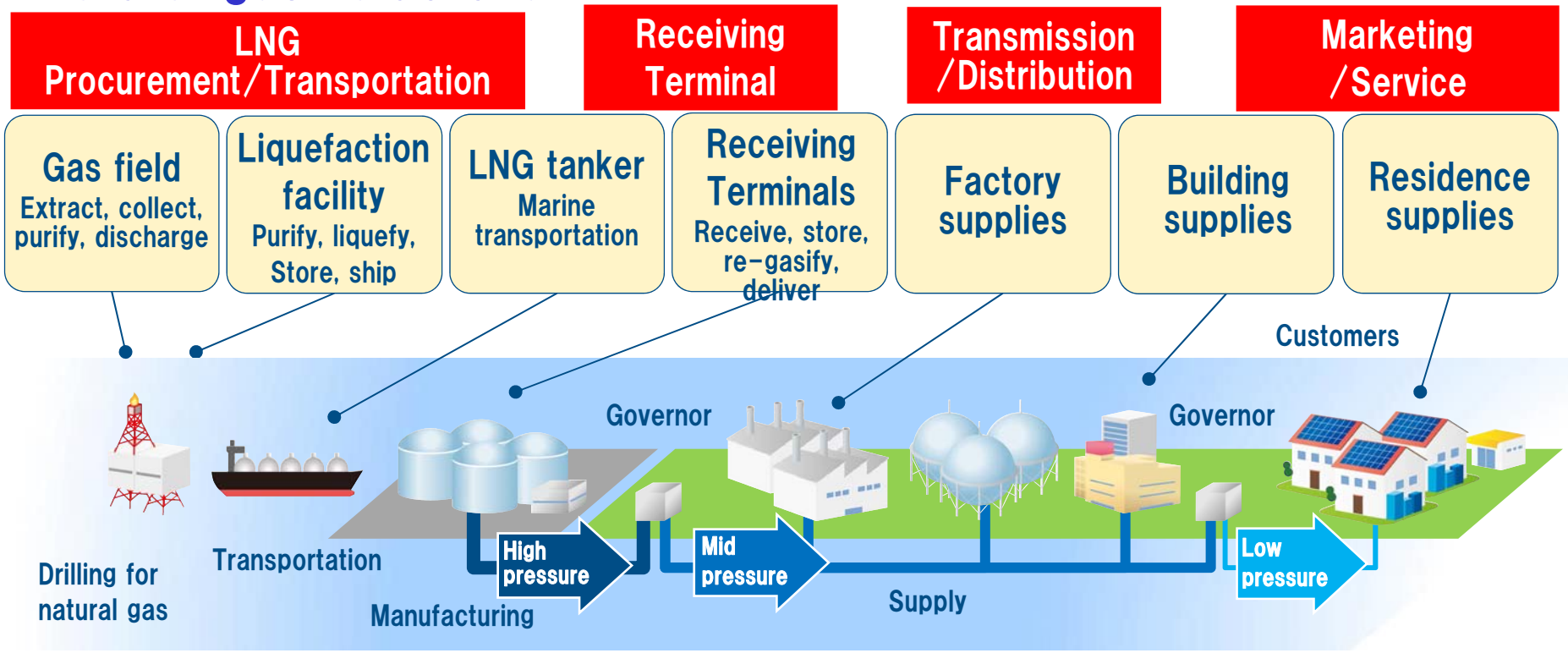


【Reference】>
Organization Chart of Osaka Gas April1, 2013 >



Gas Business: natural gas Value Chain

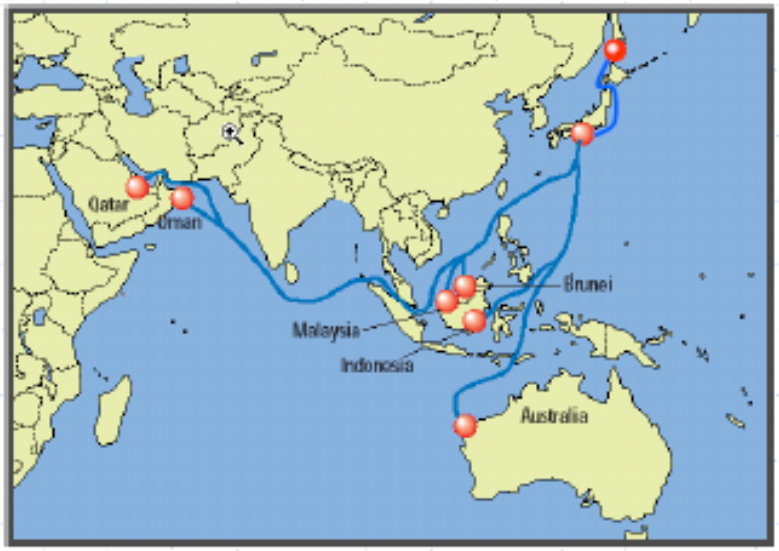
Natural gas value chain



- Natural gas is a raw material of city gas.
- Osaka Gas imports 100% of natural gas because there is little natural gas to be produced in Japan.
- Natural gas is cooled and liquefied to transported as LNG (liquefied natural gas).
- Osaka gas receives LNG at the terminals in Senboku and Himeji.
- Gas is supplied to customers from our manufacturing facilities through pipelines.

Gas Business: Procurement/Transportation

- Imports about 8 million ton/year of LNG from 7 countries (Indonesia, Malaysia, Brunei, Australia, Oman, Qatar, and Russia)
- Has interest in six LNG carriers* used not only for OG demand but also for trading purposes.



LNG vessels (interest: %)


LNG Flora (35%)

LNG Vesta (10%)

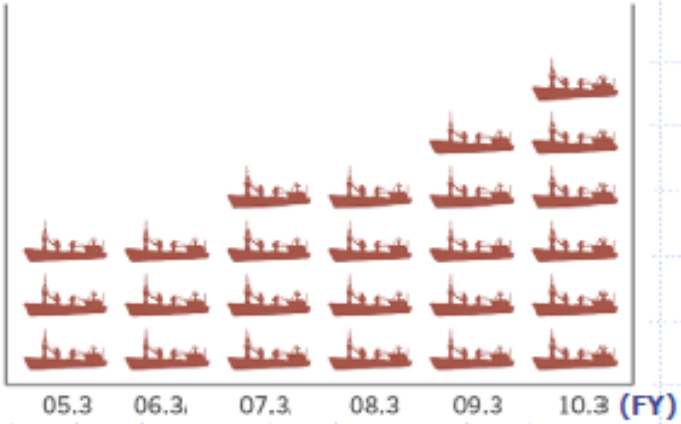
LNG Jamal (60%)


LNG Dream (60%)


LNG BARKA (51%)


LNG Jupiter (60%)

Number of LNG vessels



Gas Business: LNG Terminal >

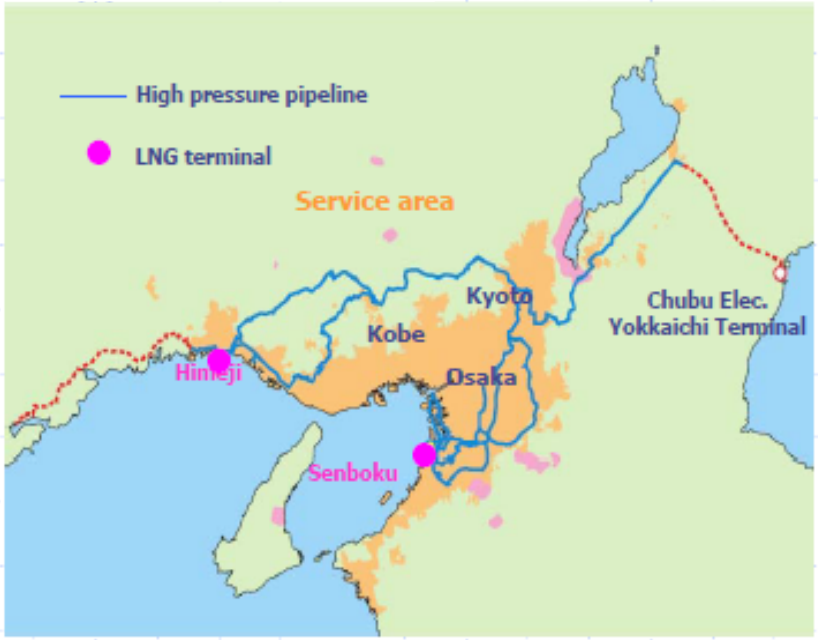
Owner and operator of world-class LNG terminals

- Construction and operation of LNG receiving terminals
- Technological innovations
- Overseas consulting experiences in LNG terminal and LNG cold utilization

Terminal	Semboku I & II	Himeji
Vaporizers (Capacity)	20 units (1,775 ton/h)	6 units (600 ton/h)
LNG tanks (Capacity)	22 units (1.8 mil m3)	8 units (0.74 mil m3)

Gas Business: Transmission & Distribution

Managing 60,000km pipeline network



- Expanding pipeline networks
- Integrated central-control monitoring system
- Advanced safety monitoring system for efficient dispatching
- High preparedness against earthquakes and other disasters

Gas Business: Service & Customers >

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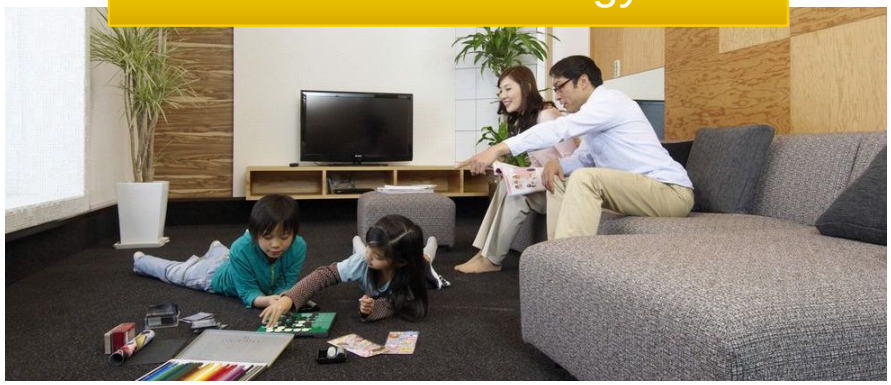
Household energy



MISTKAWAKKU
(Steam/drying bath)

Gas hot water floor heating system

Stove burner

直火匠

Gas rice cooker

Energy for urban office/industry

Factory

Office building

Hospital

Restaurant

Centurial history of Osaka Gas >

Stimulating demand in a competitive market

Osaka Gas progresses with customers

The corporate motto:
Convincing satisfaction of customer needs

Cogeneration

ENE・FARM

Electric power business

CHP

Gas air conditioner

Gas air conditioner

Industrial furnace

Heat/steam for industrial use (boiler, industrial furnace)

Gas light

Stove burner

Gas range

Gas stove

Household/commercial use (kitchen, heating, hot-water)

Gas light

Gas from coal — **Gas from petroleum** — **Natural gas**

Meiji	Taisho	Showa	Heisei	(era)

1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 (year) >

District Heat and Cooling system (DHC) Operation >

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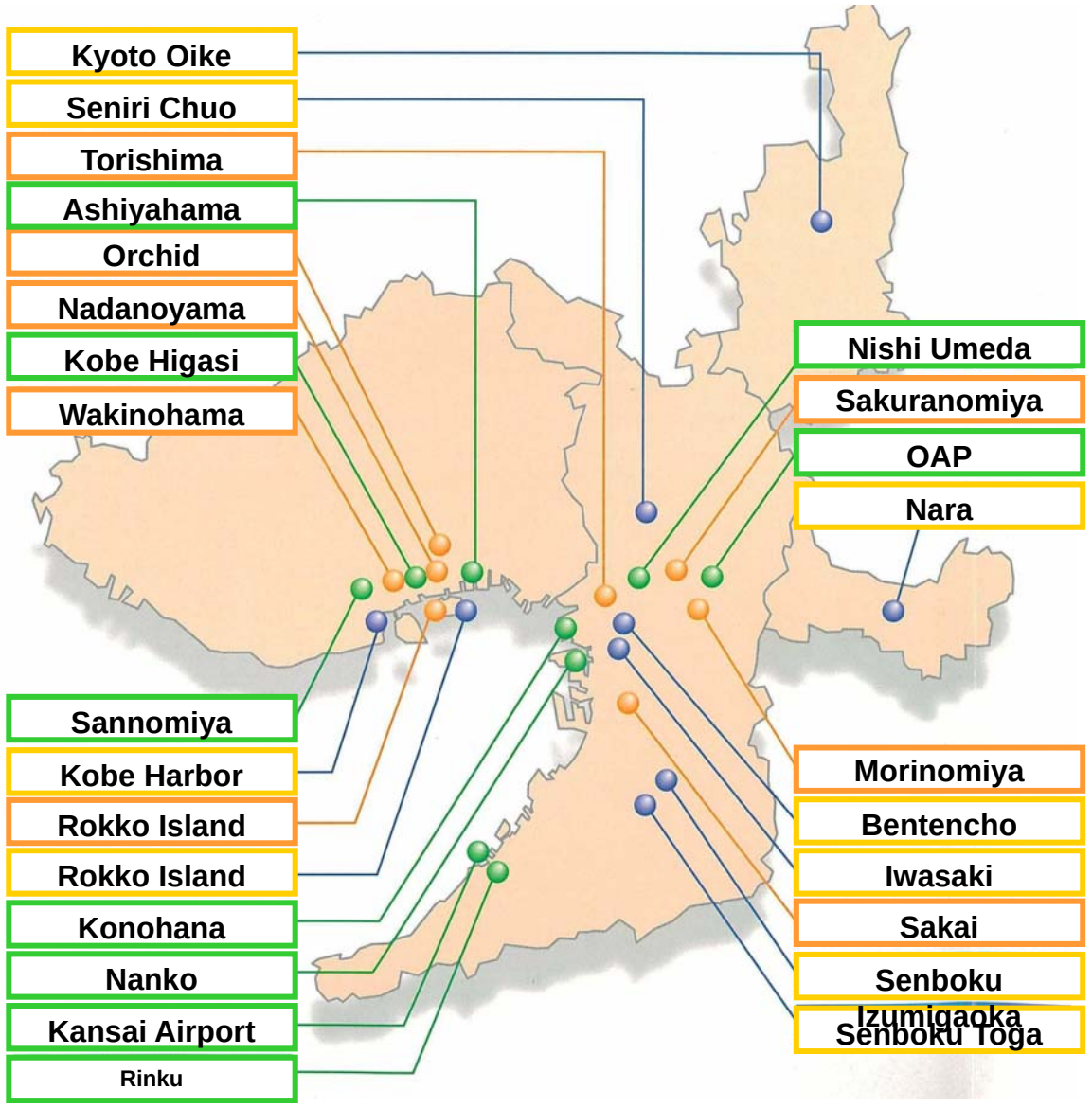


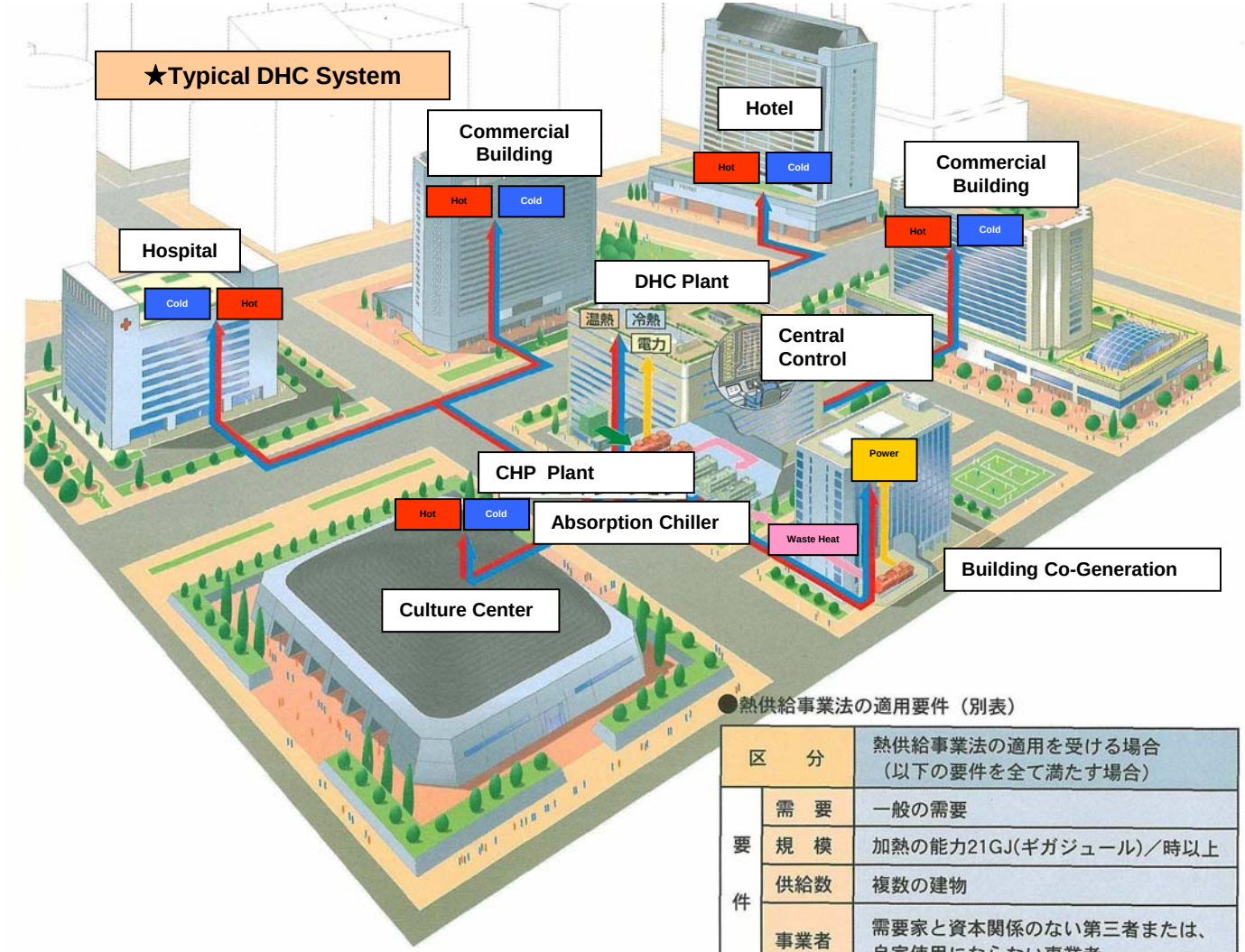
Osaka gas 100%

JV with partner

Residential

Total:26 site

Typical DHC Configuration



●熱供給事業法の適用要件（別表）

区　分		熱供給事業法の適用を受ける場合（以下の要件を全て満たす場合）
要件	需　要	一般の需要
	規　模	加熱の能力21GJ(ギガジュール)／時以上
	供給数	複数の建物
	事業者	需要家と資本関係のない第三者または、自家使用にならない事業者

Power Generation Business >

2nd Core Business of Osaka Gas

Power Generation

Area	Fuel	Plants	Net capacity owned (MW)
Japan	Thermal	9	1,718
	Wind	5	85
	Solar	3	4
	Total	11	1,807
International	Thermal	13	1,334
	Wind	1	53
	Solar	1	45
	Total	15	1,432
Grand total		26	3,239

Power Retail

- Osaka Gas formed a power marketing company "ENNET" with Tokyo Gas and NTT. ENNET is the largest independent power marketer in Japan.

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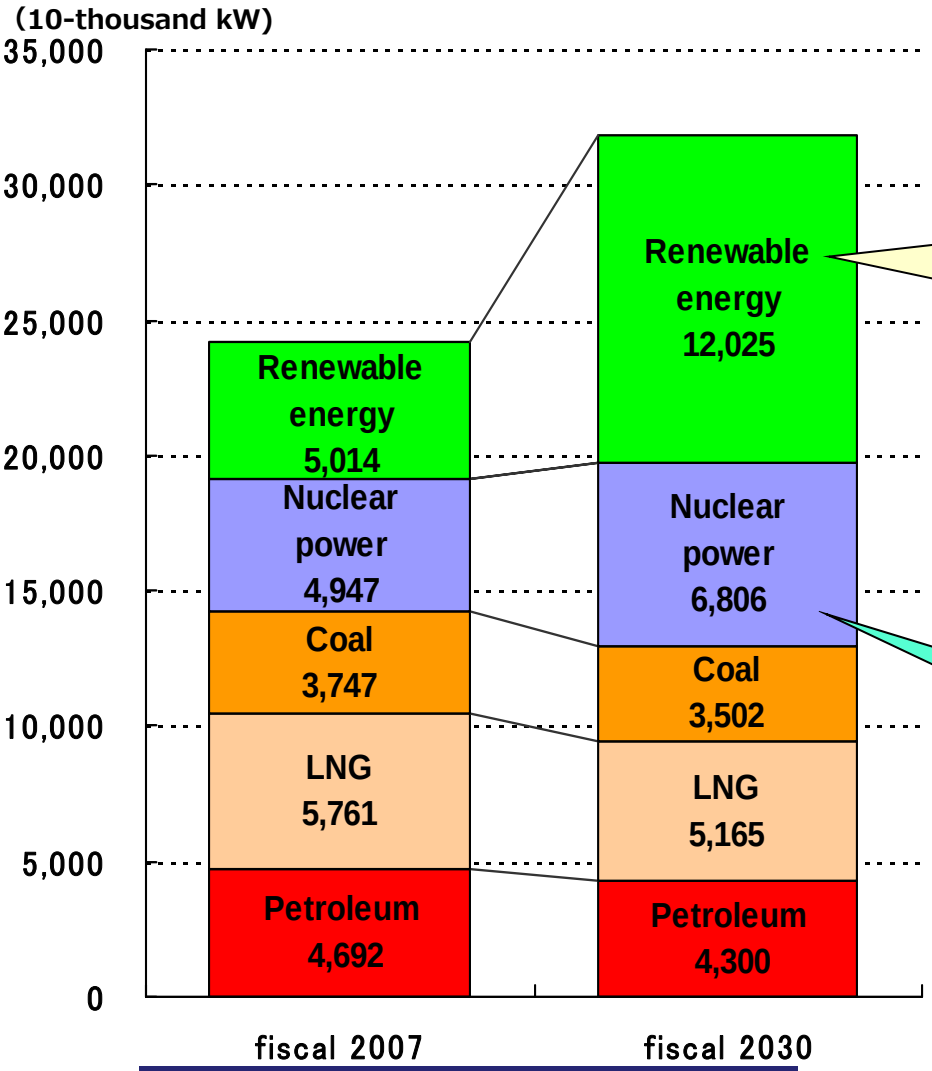
Current situation of energy – supply side–



Assumed electric capacity in 2030
(Reference: the material issued in June, Resources Energy Agency)

Installation of renewable energy is necessary to achieve the CO2 emission reduction targets. And application of FIT system proceeds the installation of renewable energy rapidly.

There is a possibility of of "balancing power shortage" problem

There is a concern about supply capability shortage because of the suspension of nuclear power plan.

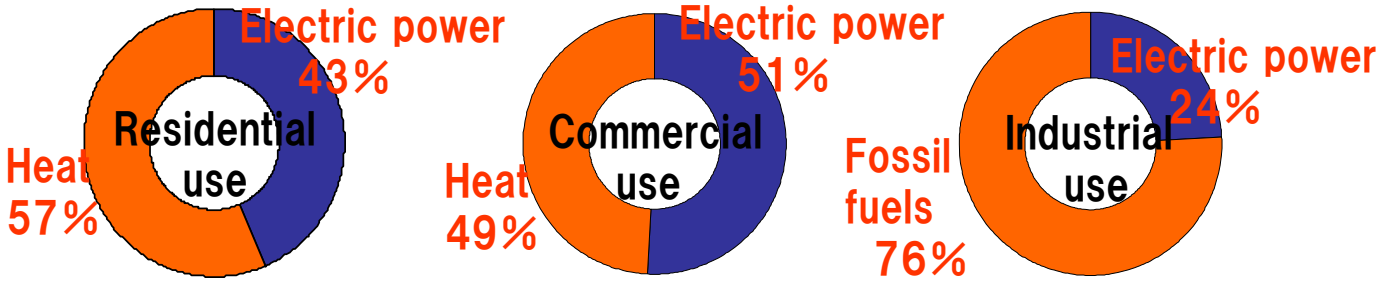
There is a possibility of "supply capacity shortage" problem

Current situation of energy – demand side –

In order to accomplish a 25% reduction in CO_2 emissions by 2020, it is important to focus efforts on achieving low carbon not only in electric power generation but also in heat energy resources, which account for more than half of the total energy demand.

Percentage of heat and electric power in total energy consumption

Source: Handbook of Energy & Economic Statistics in Japan (2008)



Efforts for low carbon

Heat energy

- Promotion of cogeneration system installation
- Promotion of conversion to natural gas and its advanced utilization
- Diffusion of high-efficiency water heaters (latent heat recovery type)

Electric energy

- Promotion of renewable energy usage
- Improvement of efficiency of thermal power generation and promotion of CGS

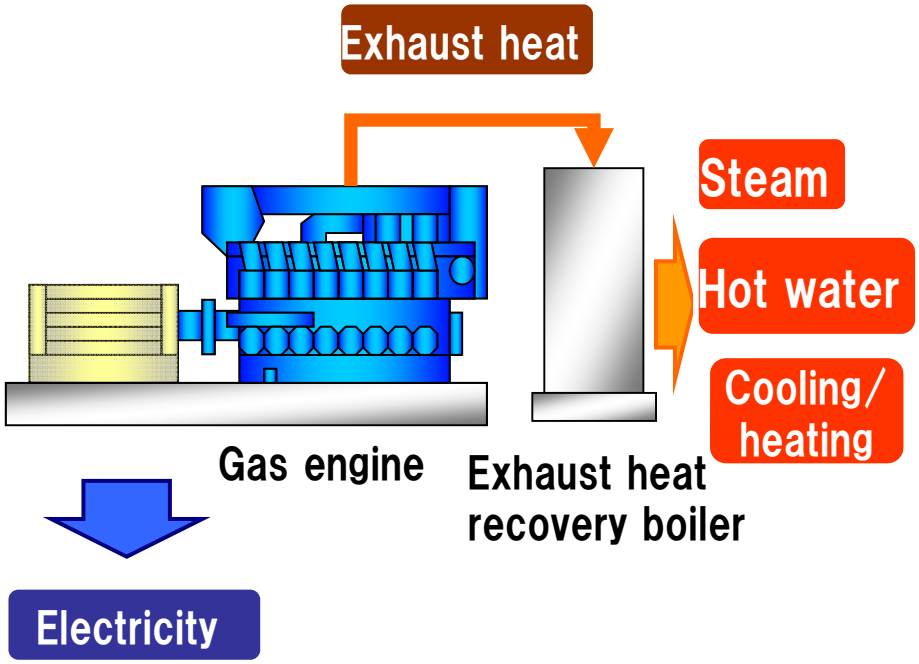
*) The graph for industrial use indicates the percentage of electric power and fossil fuels in final energy consumption.

Effectiveness of CHP >

Cogeneration contributes to energy conservation and CO2 reduction by efficiently generating both electricity and heat.

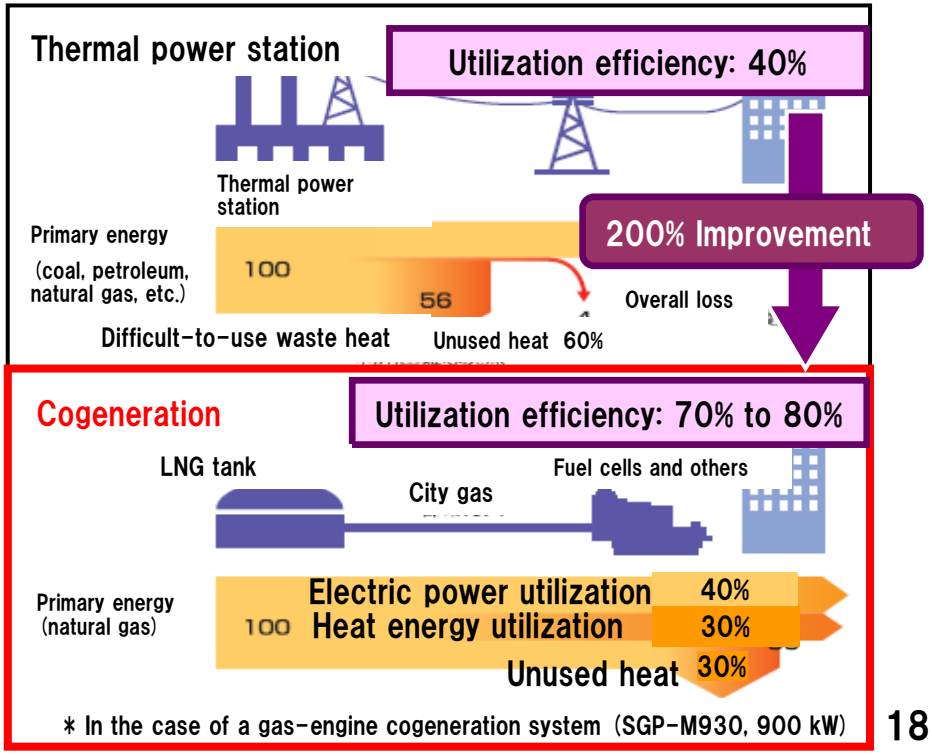
Operating principle of cogeneration

Recovering heat produced by electric power generation and using it as a heat energy source for steam and hot water generation, and cooling/heating, etc.



Effectiveness of distributed systems

Installation at energy consuming sites enables the effective use of electricity and heat, energy savings, and CO_2 reduction (improving energy efficiency by about 200%).



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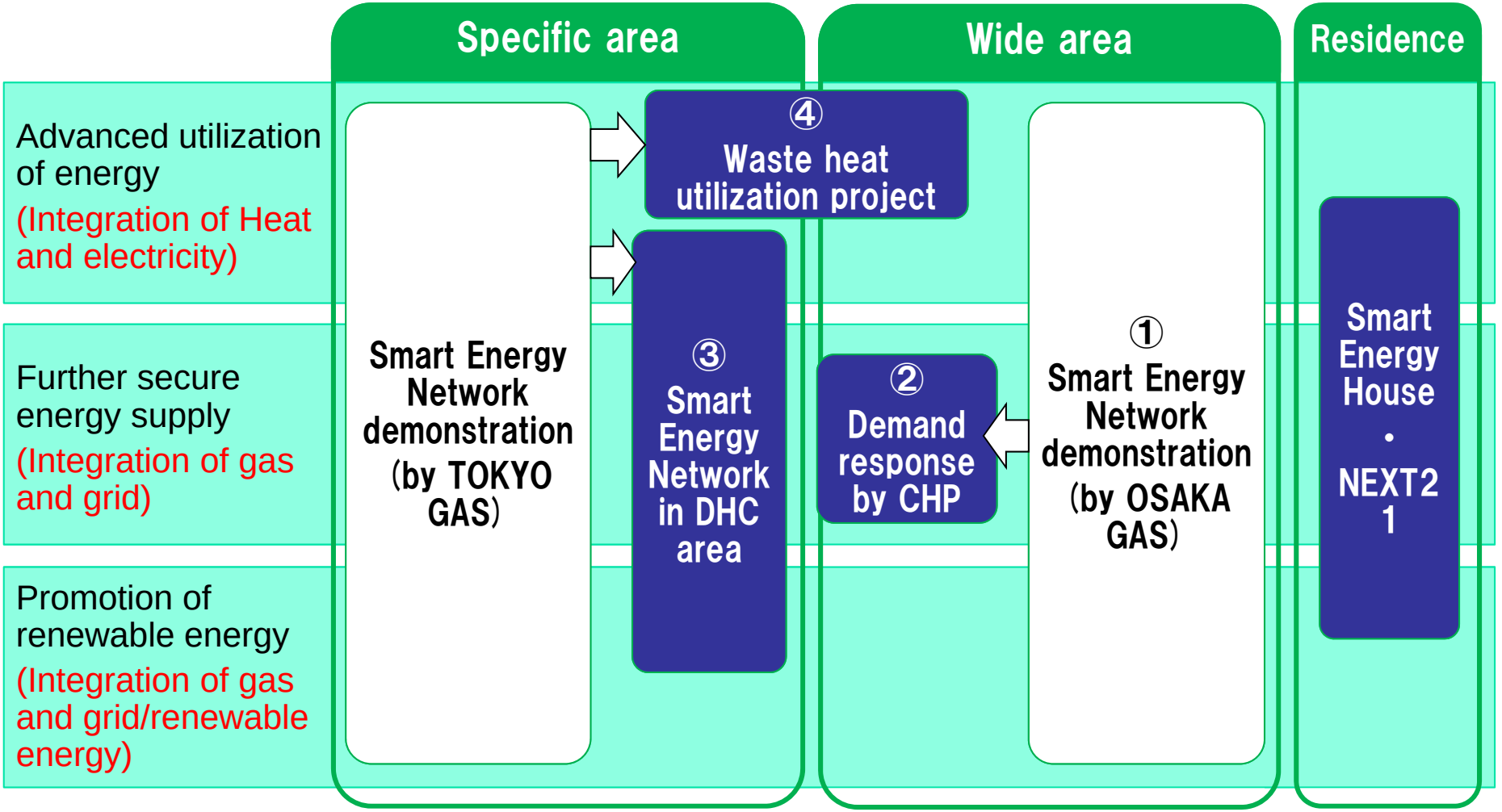
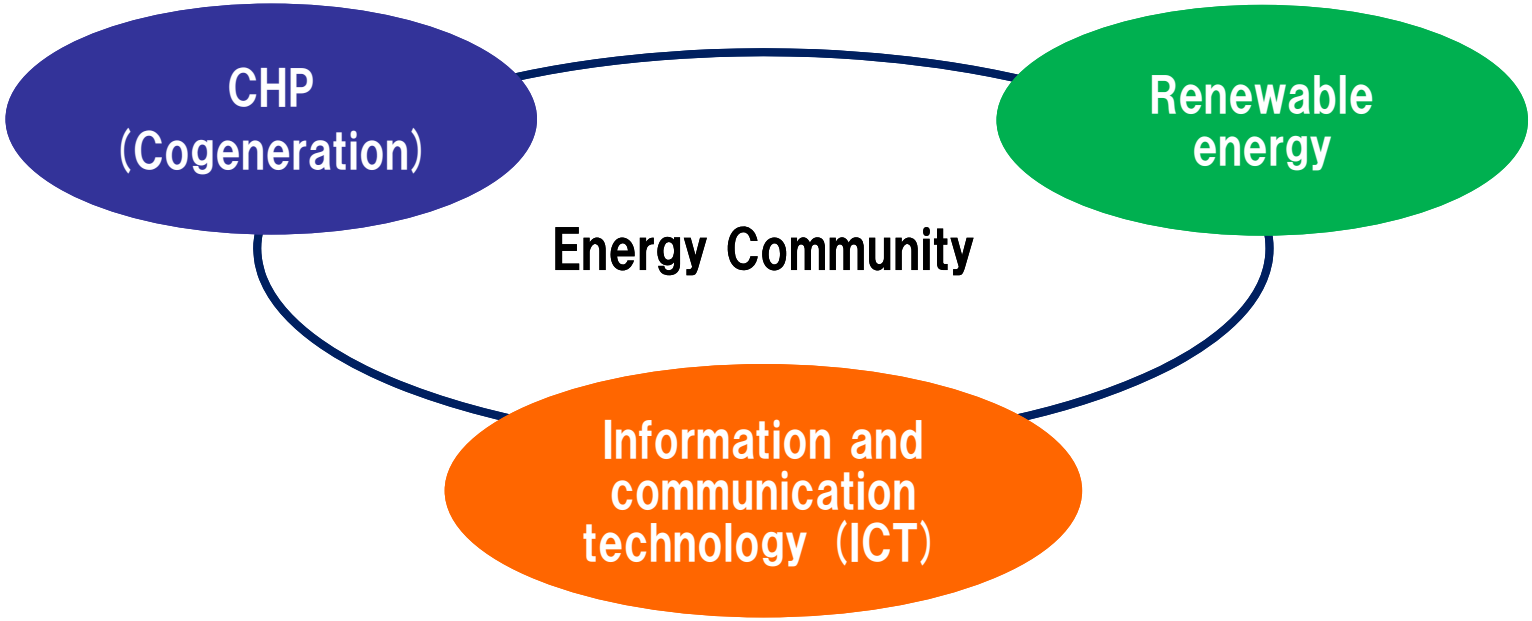
Approaches to Smart Energy Network >

The demonstrations are under way to realize Smart Energy Network from the experimental stage to practical use in the field.



Concept of “Smart Energy Network”



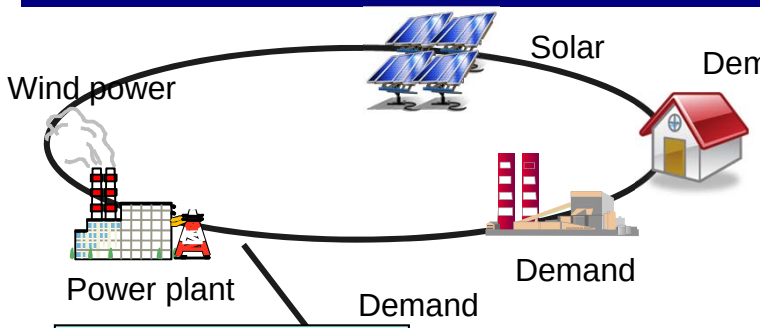
Advanced utilization of energy

Further secure energy supply

Promotion of renewable energy

Whole image of demonstration project

The fluctuation suppression function in SEN system contributes to frequency adjustment within a network.

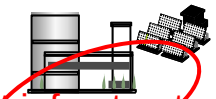


The fluctuation suppression function contributes to frequency adjustment in the system (and it can contribute to the whole network).

Whole power grid

Regulated power supply (District heating/cooling area)

Solar heat panel

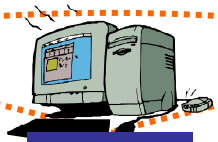


Heat infrastructure

CGS Total 6380kW
PV Total 300kW

Power company
Central supply control center

Cooperation
(AR command)



CEMS

Information communication network

Electricity network

Heat utilization

PVs installed in 5 facilities

6 CGS customers are participating.

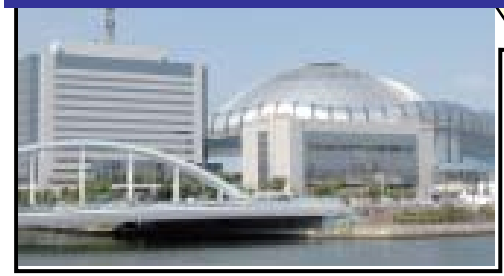
Photos of SEN CHP Customers

Total Capacity of CGS about "6400kW"

"K R P" Commercial Customer

"N T T WEST" Commercial Customer

"C T S" District cooling/heating facilities



"A T R" Commercial Customer

"Matsumoto Yushi-Seiyaku" Industrial Customer

"NIHON PHARMACEUTICAL" Industrial Customer

"KINKI UNIVERCITY" Customer (SCHOOL)

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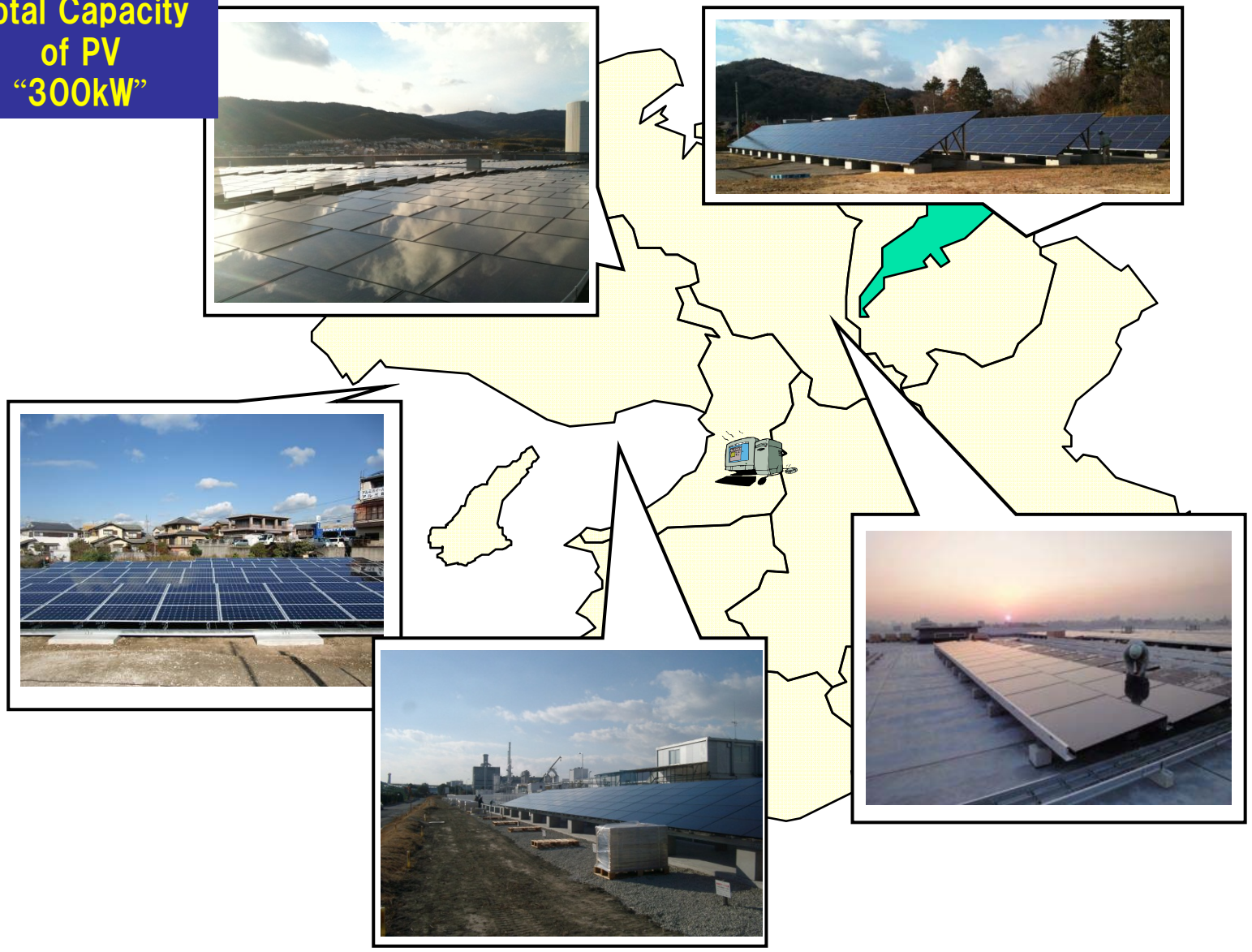
SEN PV sites >

Total Capacity of PV "300kW"

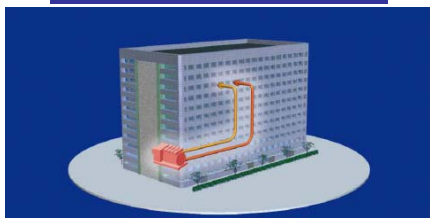


Contents of the Demonstration by SEN

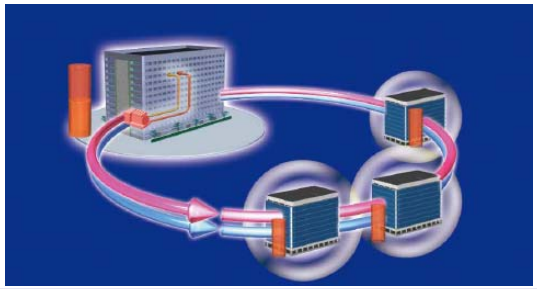
【Purpose of SEN Demonstration】

Test A

【Use fossil fuel more efficient】



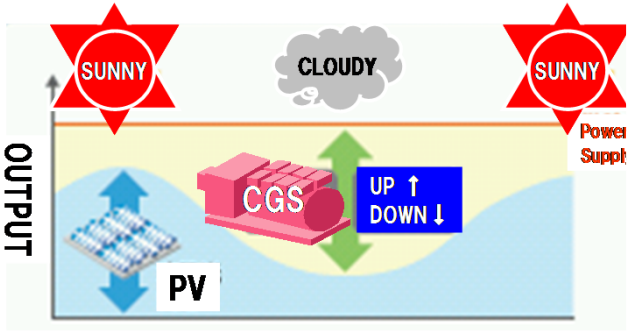
Typical use of CGS in Japan



Interchange heat and electricity generated by CGS to use the energy more efficient

Test B

【Smooth PV Fluctuation to contribute Power system stabilization 】



Control CGS outputs to smooth PV fluctuations

Test C

【Supply power at emergency and Electric shortage,etc】

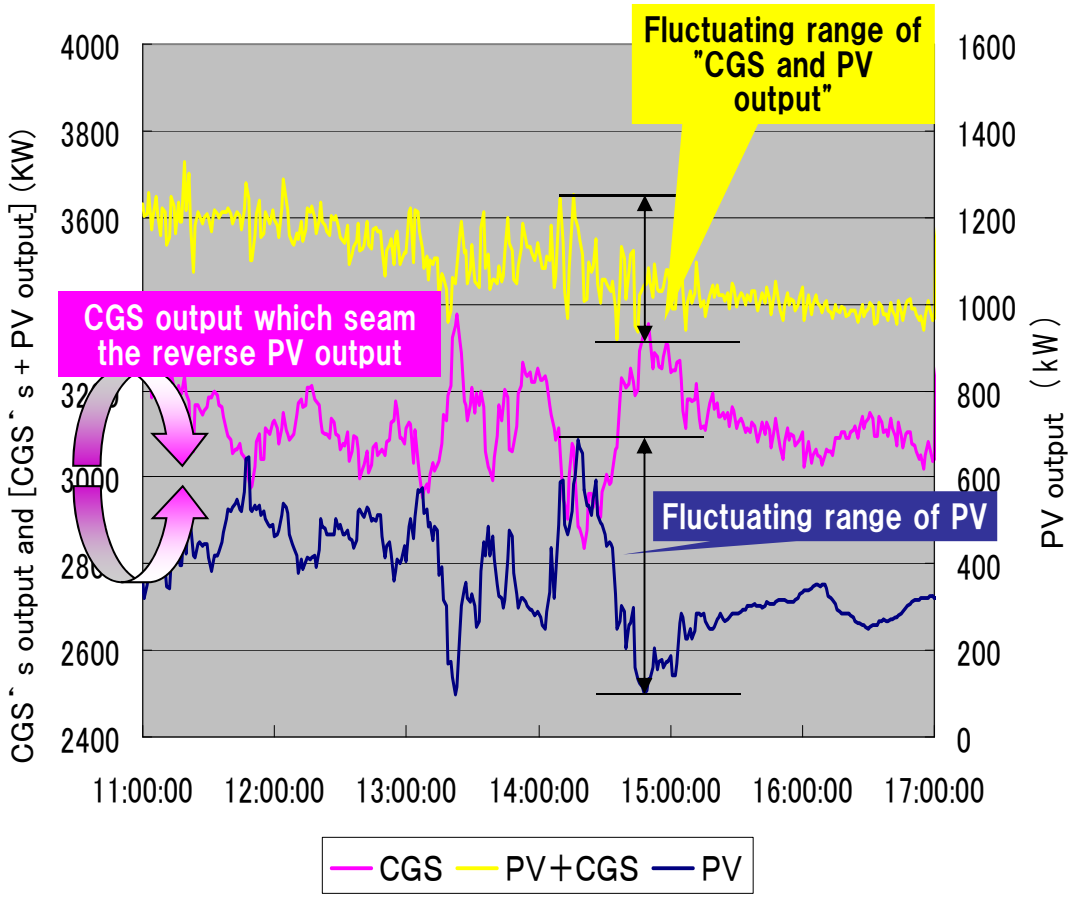
Huge Thermal Power Plant

Control numbers of CGS outputs and treat as virtual Power Plant

Result of Test B >

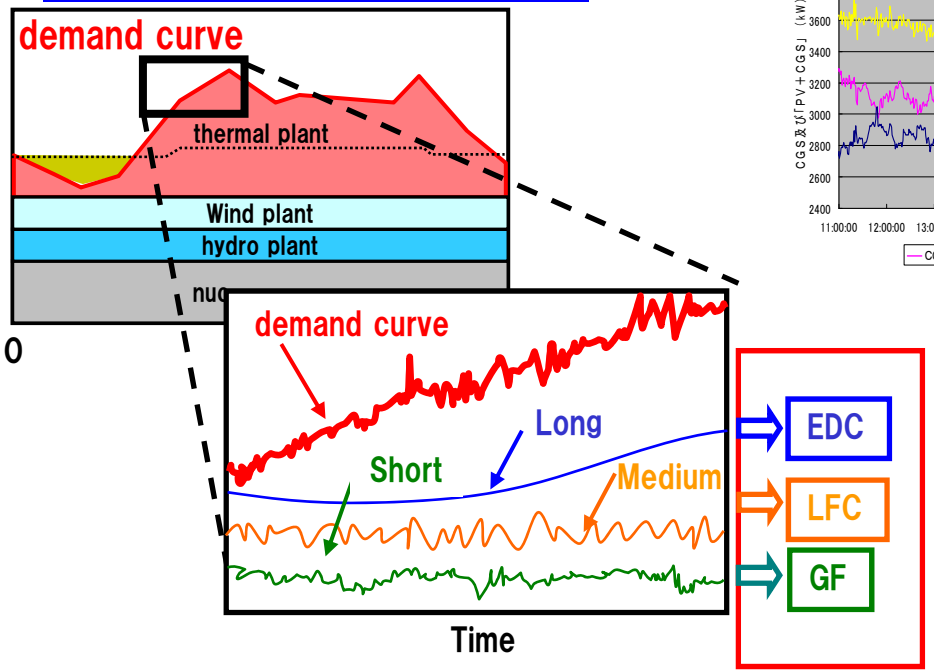
Controlled four CHP outputs which locate at the different customers' to smooth PV fluctuated outputs. Keep developing the control logic to control CHP more efficient.

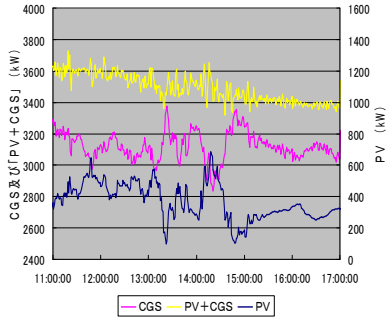
[Actual measurement value]



Test B Target fluctuations of PV outputs

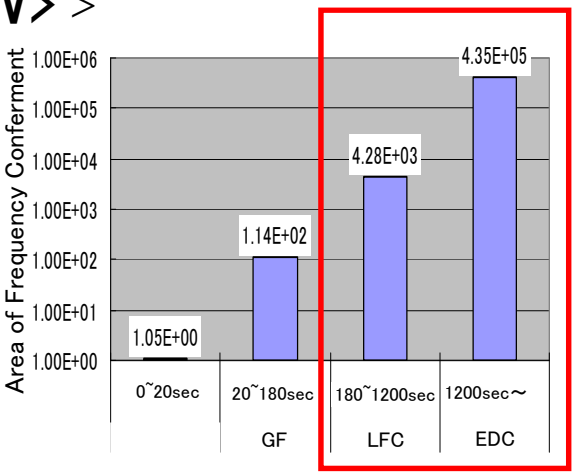
Demand Fluctuation Range



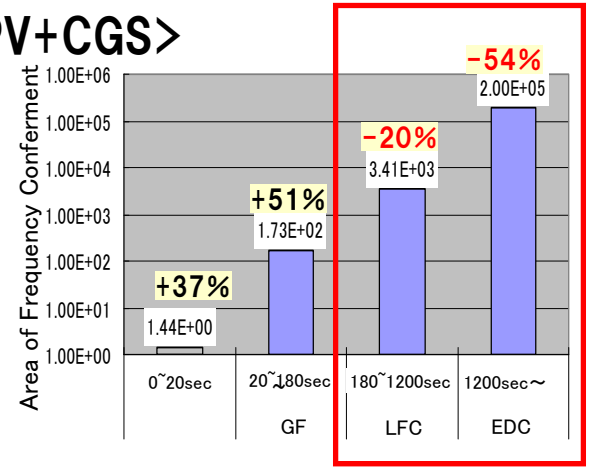


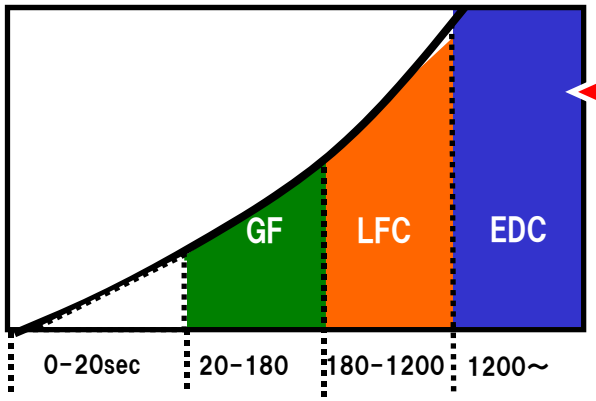
[Analysis's FFT.]

<PV> >



<PV+CGS>





EDC: Economy Dispatching Control
LFC: Load Frequency Control
GF: Governor Free

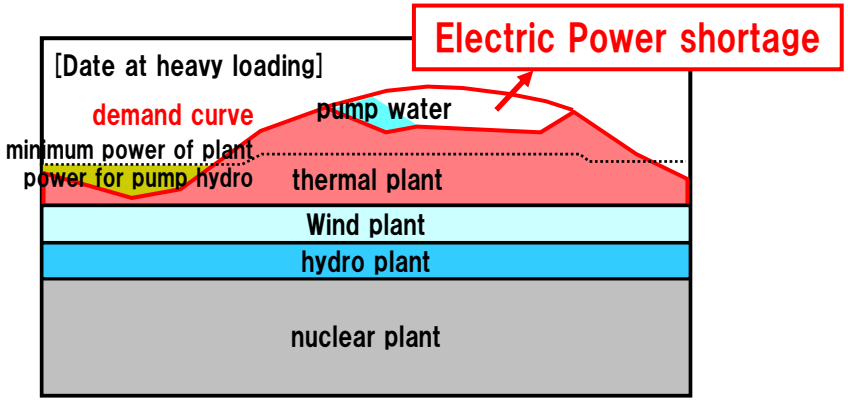
Resource: Electric Technology Research Association Vol.56,No.4,2001

Test C [Power Supply] Result >

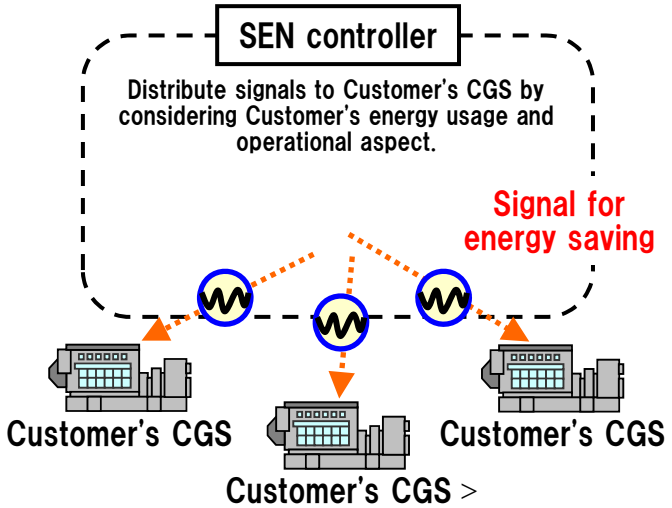
Provision of supply-and-demand adjustment capability by supplementing system power supply based on the integrated control of multiple CGS.

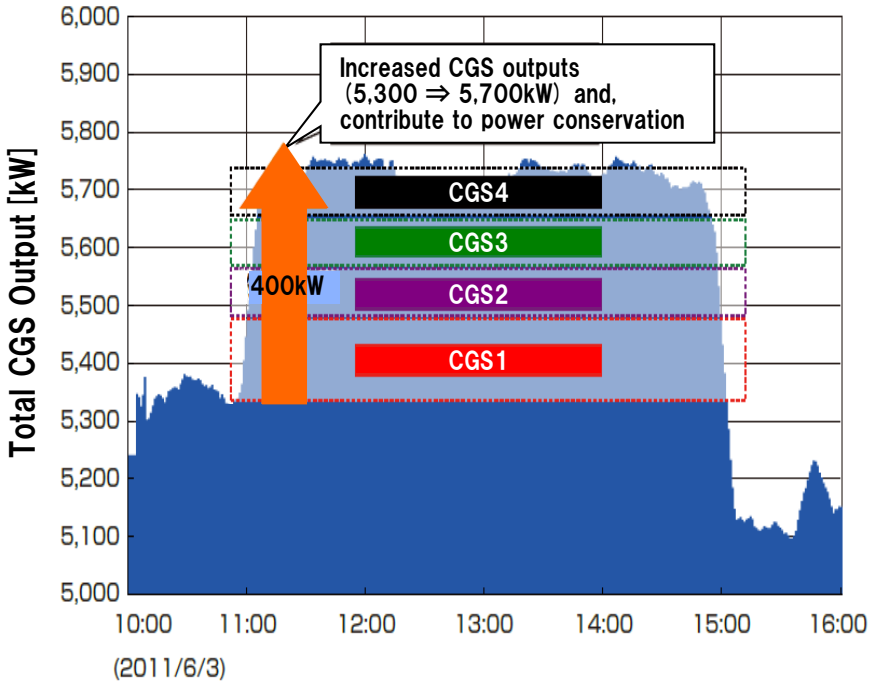
Power supply:

The amount of power received from grid is reduced by restart CGS or increase CGS outputs.



※) Source: Committee by METI





"Electrical power shortage has been occurring"

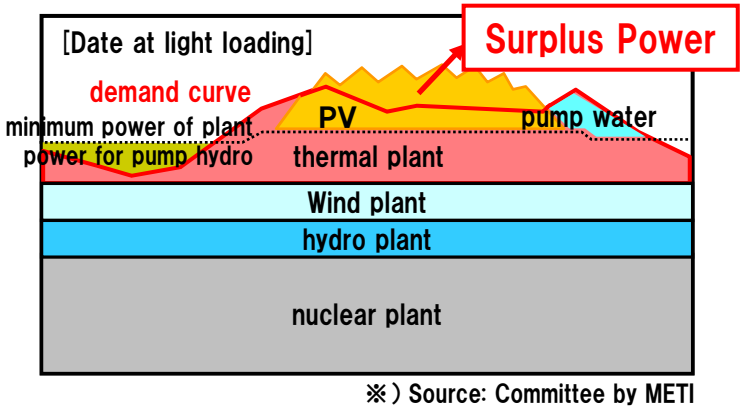
Developed the imaginary scenario, and control four CGS outputs to increase power. In result, CGS outputs increased to satisfy electric demand instead of receiving electricity from the grid, and contribute to power conservation.

Test C [Reduce Surplus Power] Result

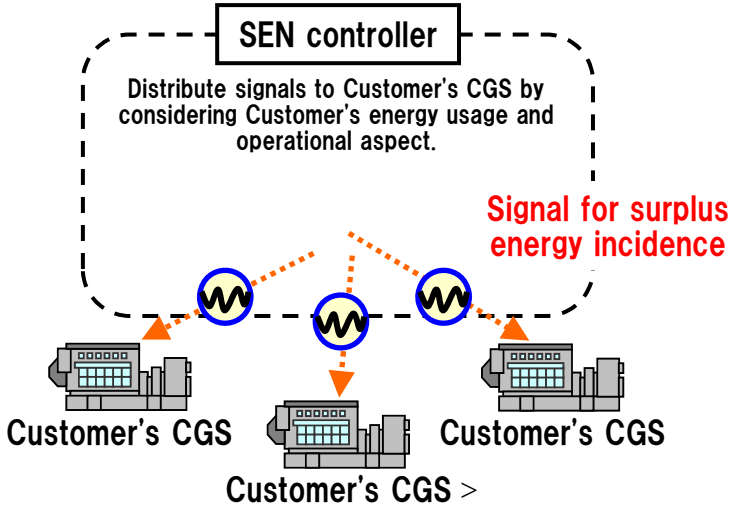
Provision of supply-and-demand adjustment capability by supplementing system power supply based on the integrated control of multiple CGS.

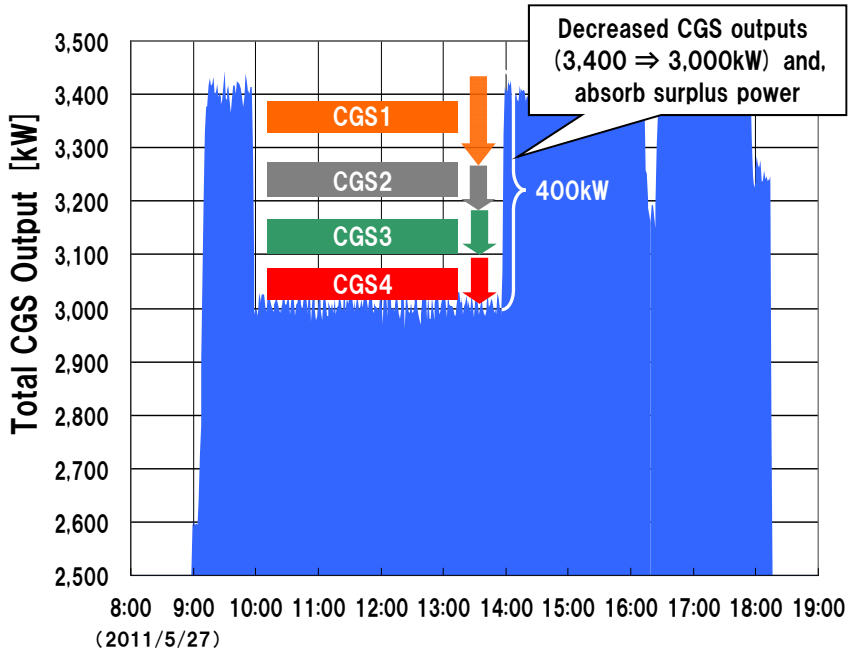
Provision for reducing surplus power:

When surplus power occur at the time of mass-PV installed, the amount of power received from grid is increased by stopping or reducing CGS outputs.



※) Source: Committee by METI





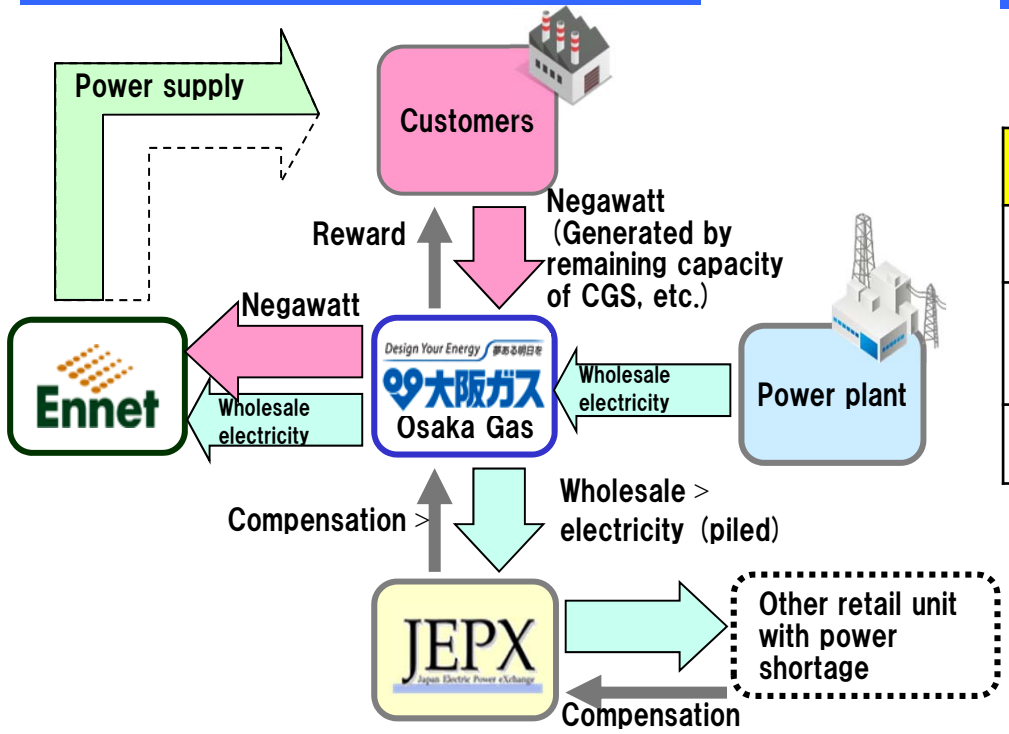
"Surplus power has been occurring"

Developed the imaginary scenario, and control four CGS outputs to decrease power. In result, CGS outputs decreased to absorb surplus power.

Demand response by CHP: achievement

Achievement of energy efficiency improvement at tight supply and demand for two years of demonstration from 2012
Awarded the Energy Conservation Grand Prize in the fiscal year 2012

Example: JEPX application model



Total energy efficiency improvement is achieved by operating at tight supply and demand.

Achievement in the fiscal year 2012

Demand response had been collected at peak time 10:00-17:00 on weekdays.

Achievement in 2012	
Days of DR collection	54 days
Total number of transaction	154
Result of DR	159 MWh

平成24年度 省エネ大賞 (製品・ビジネスモデル部門)

Awarded the Energy Conservation Grand Prize for business model.

Smart Energy Network in Iwasaki Area >

The area is redeveloping as a shopping mall and a commercial zone (to be opened within 2013). In this area, Smart Energy Network have been incorporated into the energy system.

Heat grid

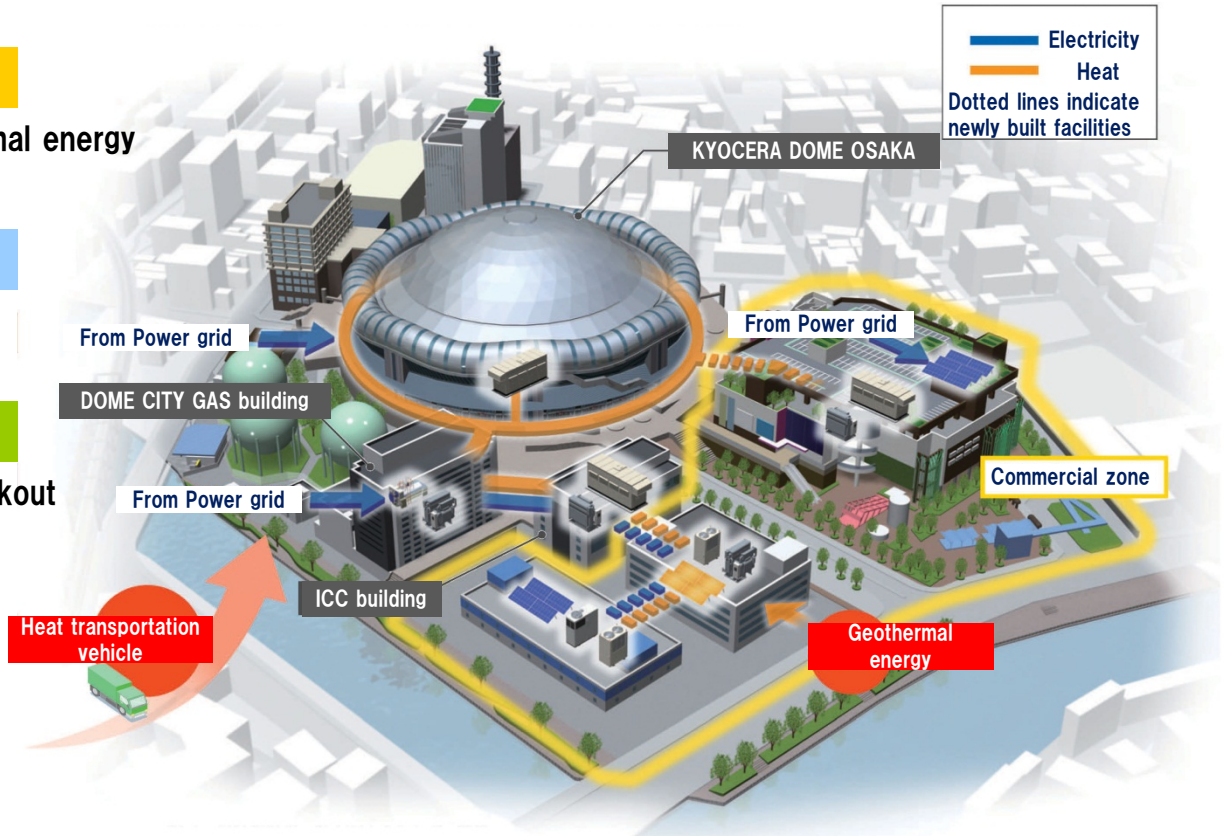
●CHP ●Solar heat collector ●Geothermal energy
●Waste heat from incineration plants

Power grid

●CHP ●PV ●Storage battery
●Demand response

Energy security

●CHP for power supply at the tune if blackout
●GHP EXCEL+
●Certified gas pipelines for emergency

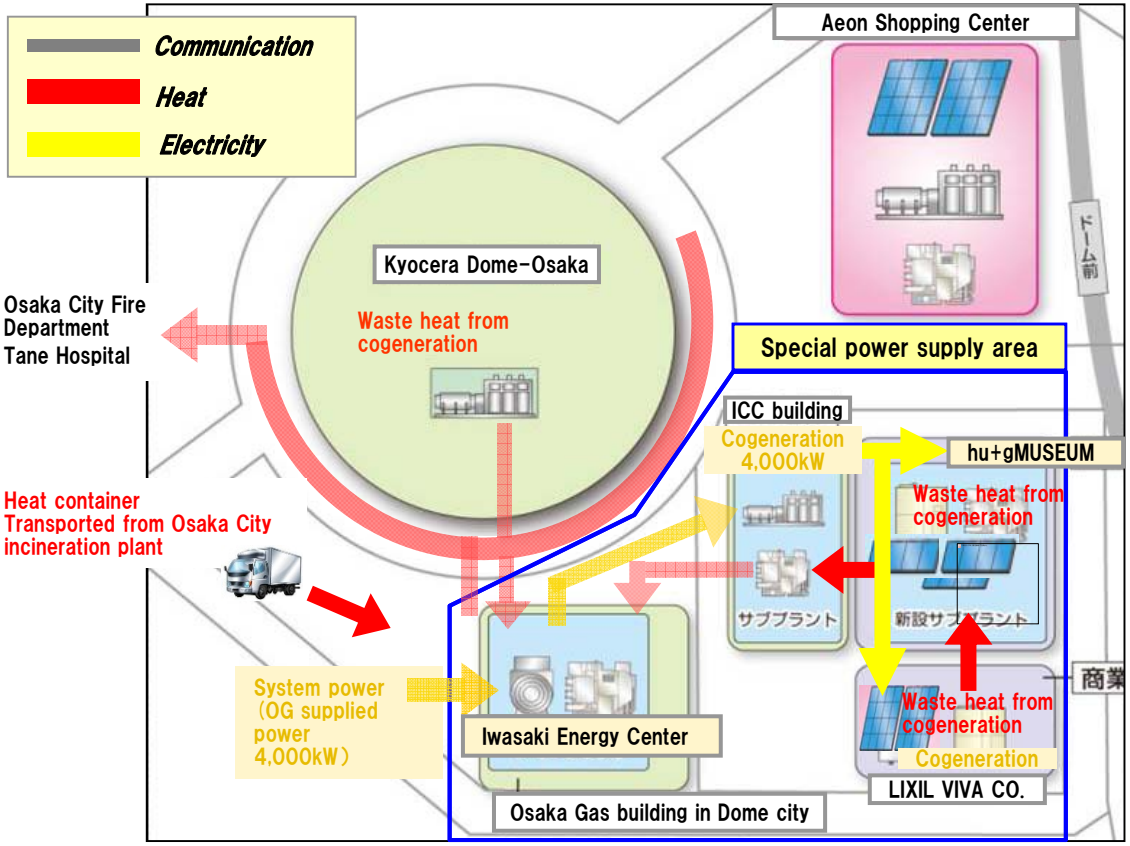


- GHP EXCEL+: a gas heat pump type air conditioner. Air conditioning and power generation with gas are available at the time of power outage.
- Certified gas pipe lines for emergency: gas pipelines certified by the Japan Engine Generator Association. Continuously supplying the power at emergency or at the time of disaster without damages.

Specially designed power supply business

- In this this specially designed power supply business, 30-minute power balancing control is necessary to use electric power supplied by wheeling.
- Demand Response is implemented for customer's cogenerations and batteries depending on the supply/demand balance in the area.

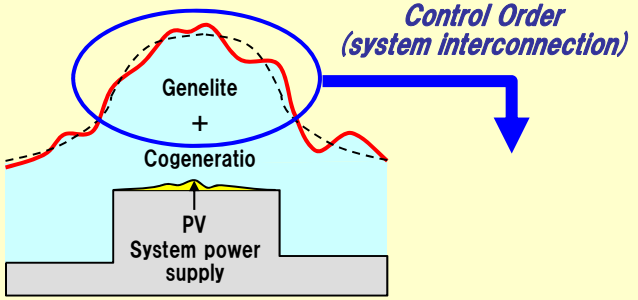
Specially designed power supply business in South-Iwasaki area (launched in July 2013)



DR by system interconnection

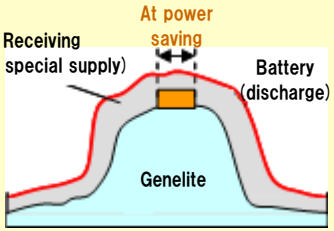
Iwasaki Energy Center: supply/demand control system

- Real-time monitoring of demand, wheeling capacity and generation capacity within the region in the whole South-Iwasaki area.
- Sending a control order to the hu+gMUSEUM BEMS and cogenerations to achieve 30-minutes power balancing control.



- Implementing Demand Response for Genelite and storage batteries according to the order from the control system of special power supply

hu+gMUSEUM BEMS



Further use of municipal waste heat from incineration facilities

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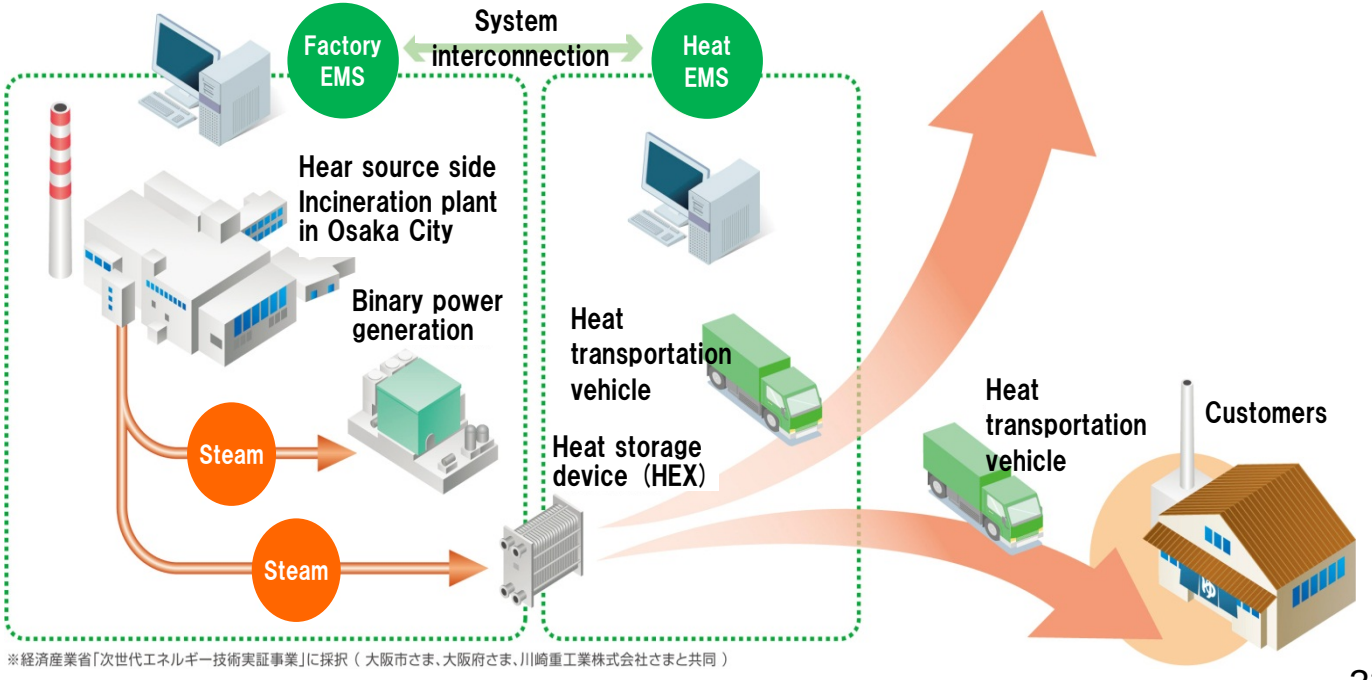
- Demonstration project: Effective and optimum use of waste heat from incineration plants ＊This project will be completed this fiscal year.
  - Factory EMS (by Kawasaki Heavy Industries, Ltd.) : Optimum use of waste heat from incineration plants, low thermal power generation (binary power generation), and heat transportation.
  - Heat EMS (by Osaka Gas) : Optimum operation of heat transportation vehicles to distant users.

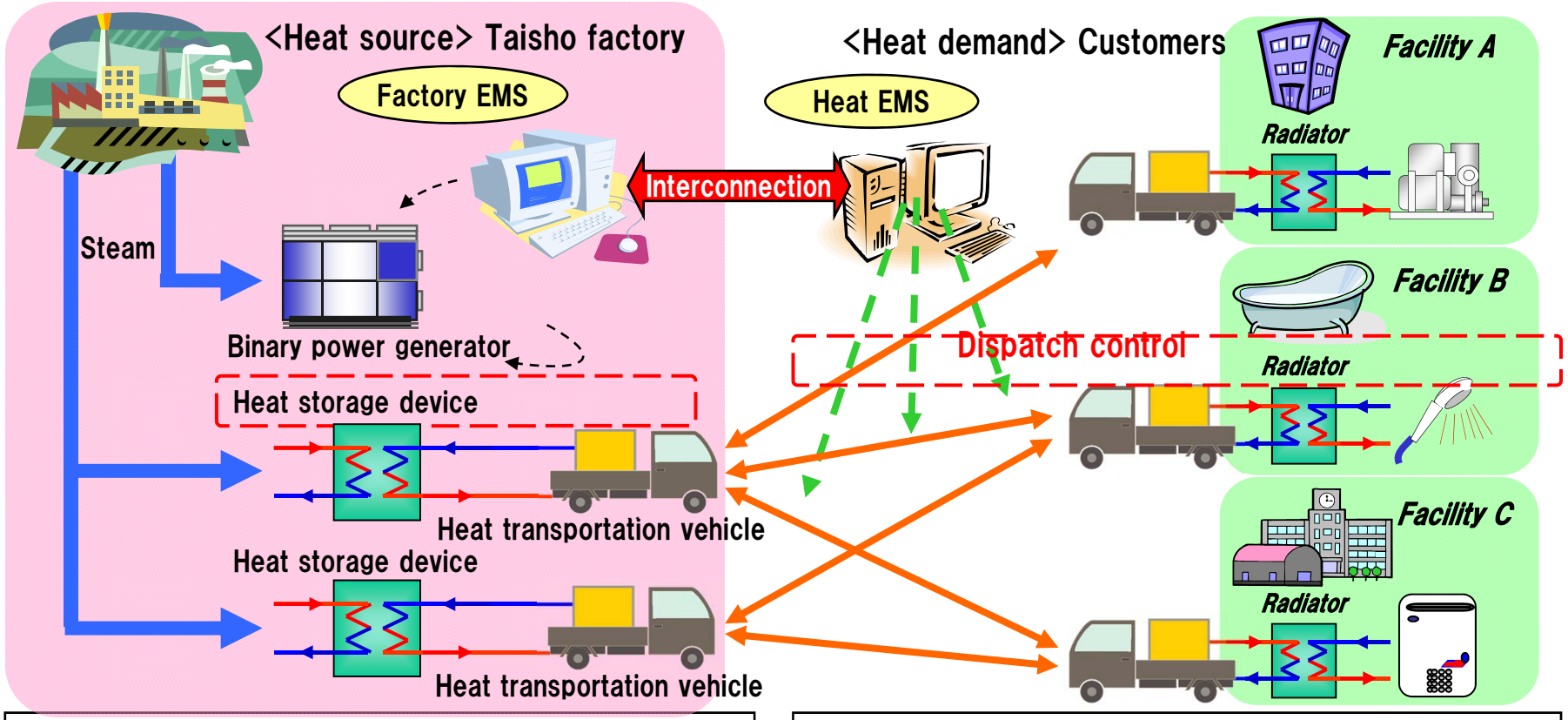
Waste incineration plant in Taisho, Environmental agency of Osaka City



※経済産業省「次世代エネルギー技術実証事業」に採択（大阪市さま、大阪府さま、川崎重工業株式会社さまと共同）

Overview of the project >

Utilization of CO2 free waste heat from waste incineration
(1) Inputting the heat to binary power generation
(2) Transporting the heat by heat transportation vehicles (optimizing the transportation between multiple devices by EMS)



(1) Utilization and optimization of low-temperature waste heat at a plant
<By Kawasaki Heavy Industries, Ltd.>

(2) Heat transportation and optimization of supply/demand in a community
<By Osaka Gas>

Concluding remarks >

Osaka Gas has been carrying out various integration projects which can contribute to energy saving and CO_2 reduction with the knowledge cultivated by installing CHP units to the customers.

The result of these projects also shows the possibility to solve to the problems such as the shortage of balancing power and supply capacity, which the Japanese electric power system is faced.

These activities will be accelerated not only now, but also after the electric market reform in Japan.

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THANK YOU
FOR YOUR KIND ATTENTION >