Contribution of Natural Gas and Distributed Energy Systems to the Achievement of a Low-Carbon Society by 2030

November 30, 2007

Japan Gas Association

The Role of Natural Gas in Creating a Low-Carbon Society and Sustainable Communities

Demand-side best mix promotes reduction of CO_2 emissions and enhances energy security

1. More widespread use of low-carbon energy (natural gas)

- Promote widespread use by assuring safety, security and reliability from upstream processes through to usage sites

2. Develop and promote use of high-efficiency appliances and systems

- Eco-Jozu, Eco-Will, fuel cells, natural gas cogeneration, etc.

3. Promote optimal energy use

- Achieve high efficiency by introducing optimum equipment/systems in response to demand structure

4. Local production and consumption systems utilizing renewable energy sources

- Solar energy water heaters, fuel cells + photovoltaic power generation, biomass power generation, etc.

5. Area/network-based energy use in cities and communities

- Build optimum energy systems making use of particular characteristics of each region or community
- Balance and optimally combine with large-scale centralized power generation
- Build low-carbon energy networks and enhance security

6. Develop “local hydrogen network” society

- Aim for further reduction of CO_2 emissions

(For Reference) Positioning of Natural Gas/Distributed Energy Systems within Environmental/Energy Policies

Positioning within Environmental/Energy Policies

Energy Basic Plan (Approved by Cabinet March 2007)

Natural gas and distributed energy systems continue to be positioned as key forms of energy from the perspectives of both stable supply and environmental conservation

Excerpt from Energy Basic Plan: Development and Introduction of Gas Energy

◇ Natural gas is a key form of energy from the perspectives of both stable supply and environmental conservation. Introduction and use of natural gas will be encouraged while maintaining a balance with other energy sources.

◇Fuel switching will be encouraged for power stations, factories, buildings and other commercial facilities. In the city gas sector, the introduction of distributed energy sources such as efficient cogeneration, fuel cells, etc. shall be encouraged.

◇The promotion of initiatives aimed at building distributed energy systems is a key issue in considering an ideal future vision for energy … and it is important to plan for development and widespread use of such systems.

G8 Summit Trends (IEA G8 Program)

◇ Heiligendamm Summit (2007)

Encouragement of cogeneration was included among measures to deal with climate change and assure energy security in the summit declaration entitled “Growth and Responsibility in the World Economy.”

◇Toyako Summit (2008)

An IEA working group will report its findings on issues including introduction of cogeneration.

1. More widespread use of low-carbon energy (natural gas) (1)

Switching to natural gas in industrial sector

・Switching to natural gas and introducing high-efficiency technologies in the industrial sector is expected to result in:

Effect of switching to gas

Switching from other fuels such as coal to natural gas

⇩

Reduction in CO_2 emissions: approx. 25%

Note: Effect of shift resulting from subsidies to promote switching to natural gas in high-energy-use facilities (FY2002–2006)

-2.5 million t-CO2 p.a.

(Reduction of approx. 2,400 t-CO2 per facility on average)

Also:

Effect of boosting efficiency

Introducing high-efficiency equipment when fuel is switched

⇩

Even greater reduction of CO_2 emissions

Example: Switching of forging furnace to natural gas

Co2 emission

Heavy fuel oil + conventional burner 100

Natural gas + conventional burner 75

Regenerative burners 45

1. More Widespread Use of Low-Carbon Energy (Natural Gas) (2)

Use for Transportation Energy

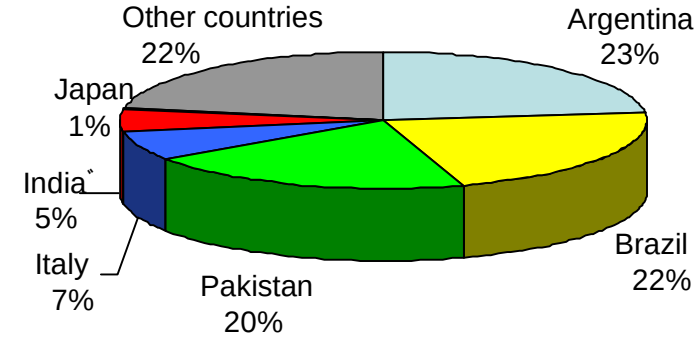
▪ The IGU and other bodies have announced initiatives aimed at achieving the use of 65 million natural gas vehicles (NGV) worldwide by 2020.

▪ Supplying hydrogen reformed from natural gas to fuel cell vehicles is a possibility for the future.

World NGV usage

▪ At the end of last fiscal year there were 30,000 NGVs on the roads in Japan and more than 6 million worldwide, chiefly in natural gas producing countries.

▪ In October 2007 the IGU and other bodies announced introduction of support measures for governments aimed at achieving worldwide use of 65 million NGVs by 2020.



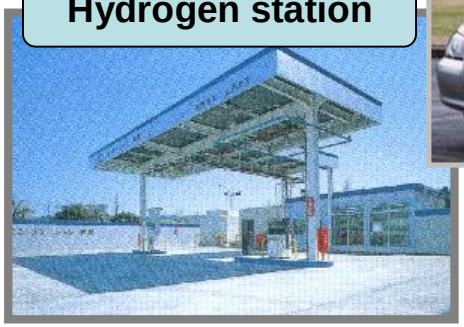
Source: ENGVA statistics (The GVR, March 2007)

Vehicle fuels of the future

▪ The supply of hydrogen reformed from natural gas for fuel cell vehicles and the supply of electricity from distributed power sources for plug-in hybrids are possibilities for the future.

Fuel cell vehicle

Hydrogen station

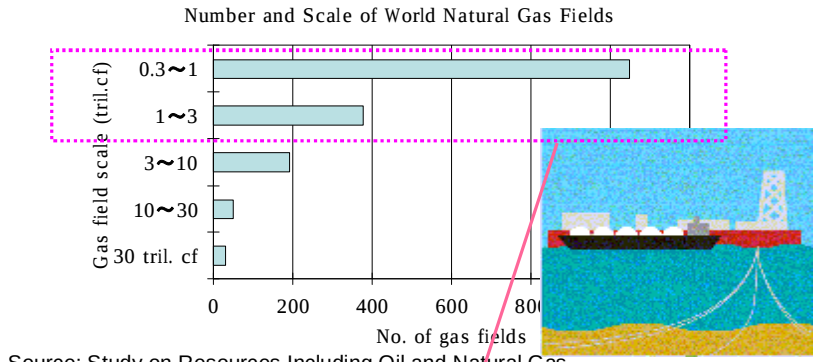


Source: Tokyo Gas

(For Reference) Initiatives Aimed at More Widespread Use of Low-Carbon Energy (Natural Gas)

Promote supply infrastructure to create base for more widespread use of low-carbon fossil fuels and diversification of raw materials procurement ⇒ <u>assure safety, security and reliability from upstream processes to usage sites</u>

Independent natural gas field development efforts

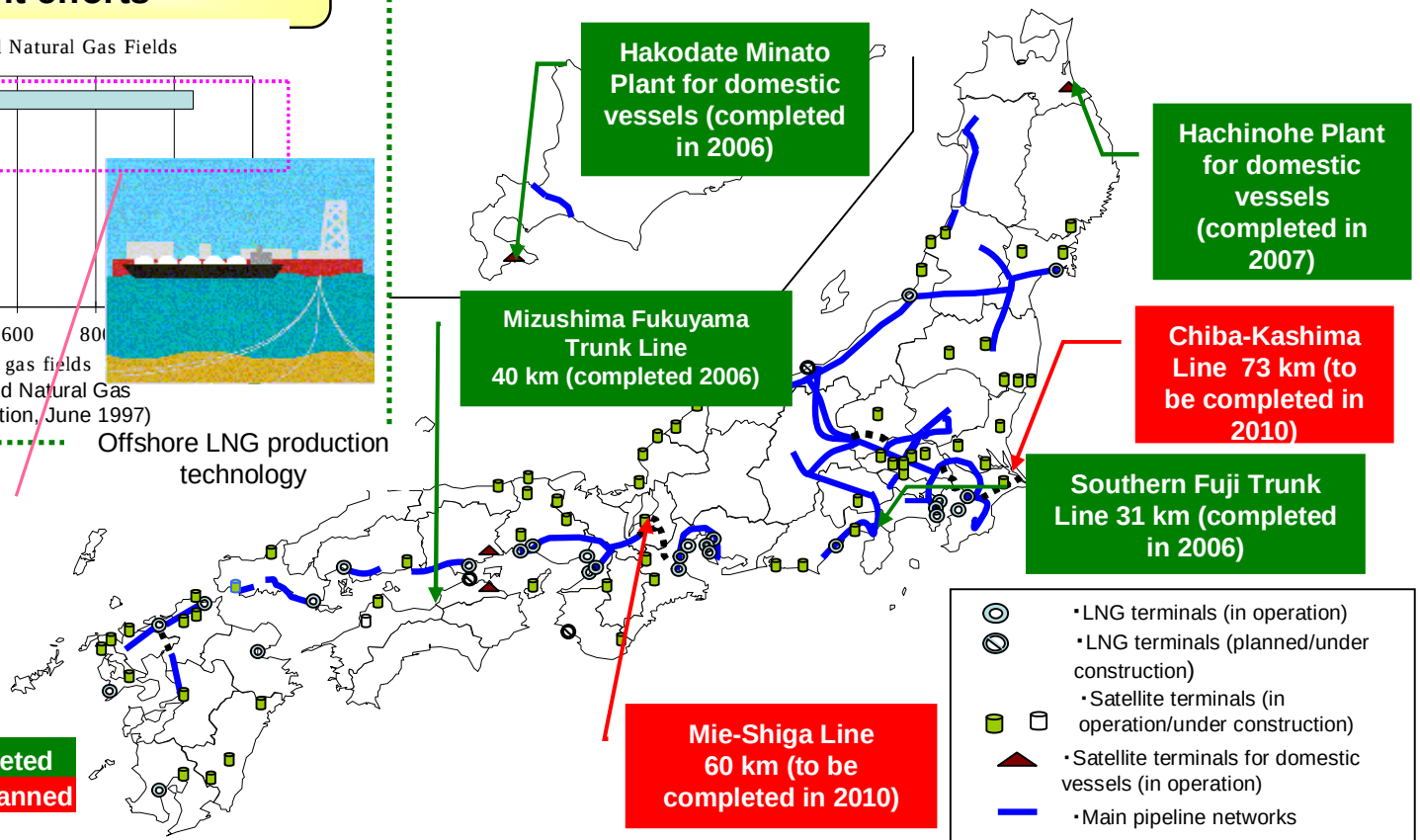


Source: Study on Resources Including Oil and Natural Gas (Japan Petroleum Development Association, June 1997)

Offshore LNG production technology

Gas fields where use of offshore LNG production technology is expected to yield results

Infrastructure building



Sources: Agency for Natural Resources and Energy, gas utilities' supply plans

2. Development and Use of High-Efficiency Equipment & Systems (1)

High-Efficiency Water Heaters

Promote widespread use of latent heat recovery water heaters and gas engine water heaters, which conserve energy and reduce CO_2 emissions. Greater use of such equipment is part of the Kyoto Protocol Target Achievement Plan.

Latent heat recovery water heaters

Easy to install in all dwellings, including existing homes

エコジョーズ

Energy saving rate: ***13%***

CO_2 reduction rate: ***13%***

Gas engine water heaters for household use

Home power generation + water heating using exhaust heat

エコウィル ECO WILL

Energy saving rate: ***22%***

CO_2 reduction rate: ***32%***

Note: Energy saving rate and CO_2 reduction rate are comparisons with conventional products (Sources: Tokyo Gas, Osaka Gas)

The High-Efficiency Gas Water Heater De Facto Standard Study Group was established in November 2007 with the aim of making high-efficiency water heaters the de facto standard by 2015.

2. Development and Use of High-Efficiency Equipment & Systems (2)

Residential Fuel Cells

Aim for further reduction of CO_2 emissions over the medium to long term by promoting the development and introduction of household-use fuel cells, the next step in home power generation.

Residential fuel cell (PEFC*) initiatives

Generation efficiency rate: 37%
Energy saving rate: 32%
CO_2 reduction rate: 45%

*Polymer Electrolyte Fuel Cell (LHV standard)

Initiatives to improve power generation efficiency (SOFC*)

Residential use (actual): ***45%***
Industrial use (target): ***67%***
(combined with GT)

*Solid Oxide Fuel Cell (LHV standard)

■Large-scale trial project for fixed fuel cells (2005-2008)

・FY2005: 480 units FY2006: 777 units FY2007: 930 units

Results of large-scale trial project: LHV standard

Generation efficiency rate: 37% Energy saving rate: 27% CO_2 reduction rate: 41%

(Source: New Energy Foundation)

■SOFC Trial/Research Project (from 2007)

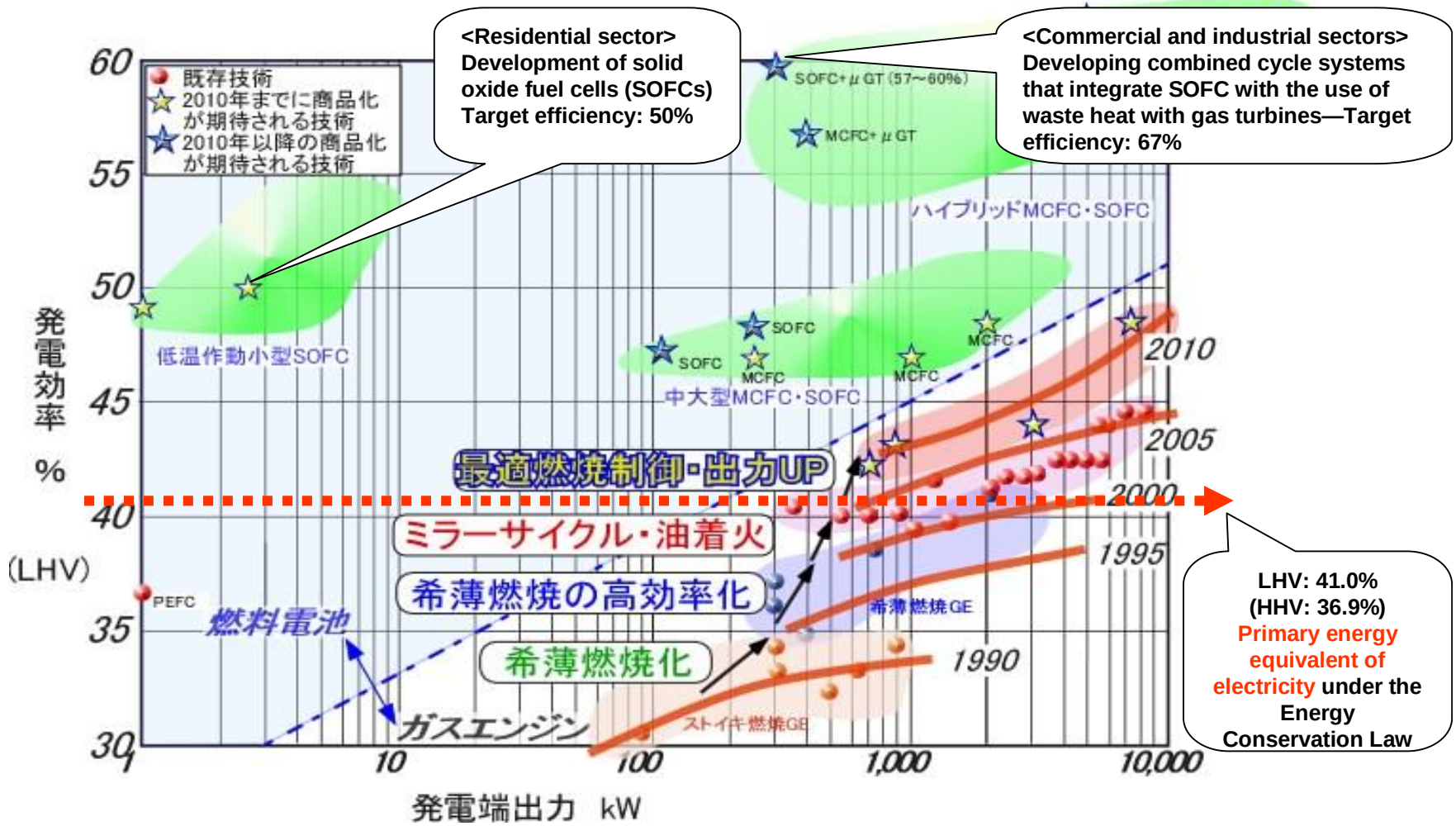
・Trial/research project launched following on from PEFC project, aimed at rapid commercialization

Speed up development for rapid full-scale introduction

2. Development and Use of High-Efficiency Equipment & Systems (3)

Gas cogeneration

- Introducing cogeneration systems that exceed the average power generation efficiency of grid power (receiving end; LHV: 41%)
- Developing and introducing small to large super-high-efficiency fuel cells (LHV: 50 – 67%)



3. Promoting the Optimal Use of Energy

- Gas systems can **flexibly meet customer demand** for hot water, which varies by customer and fluctuates over time depending on such factors as family composition and lifestyle. This flexibility makes it possible to steadily reduce CO_2 emissions and energy consumption.

Delivers stable energy savings regardless of the level of hot water load

Delivers large energy savings for households that use relatively large amounts of hot water

Large

Fluctuation in hot water use

Small

Use of Eco-Jozu will reduce energy consumption

Energy saving rate: 13%

CO_2 reduction rate: 13%

Use of fuel cells or Eco-Will system will reduce energy consumption

Fuel Cells

Energy saving rate: 32%

CO_2 reduction rate: 45%

Energy saving rate: 22%

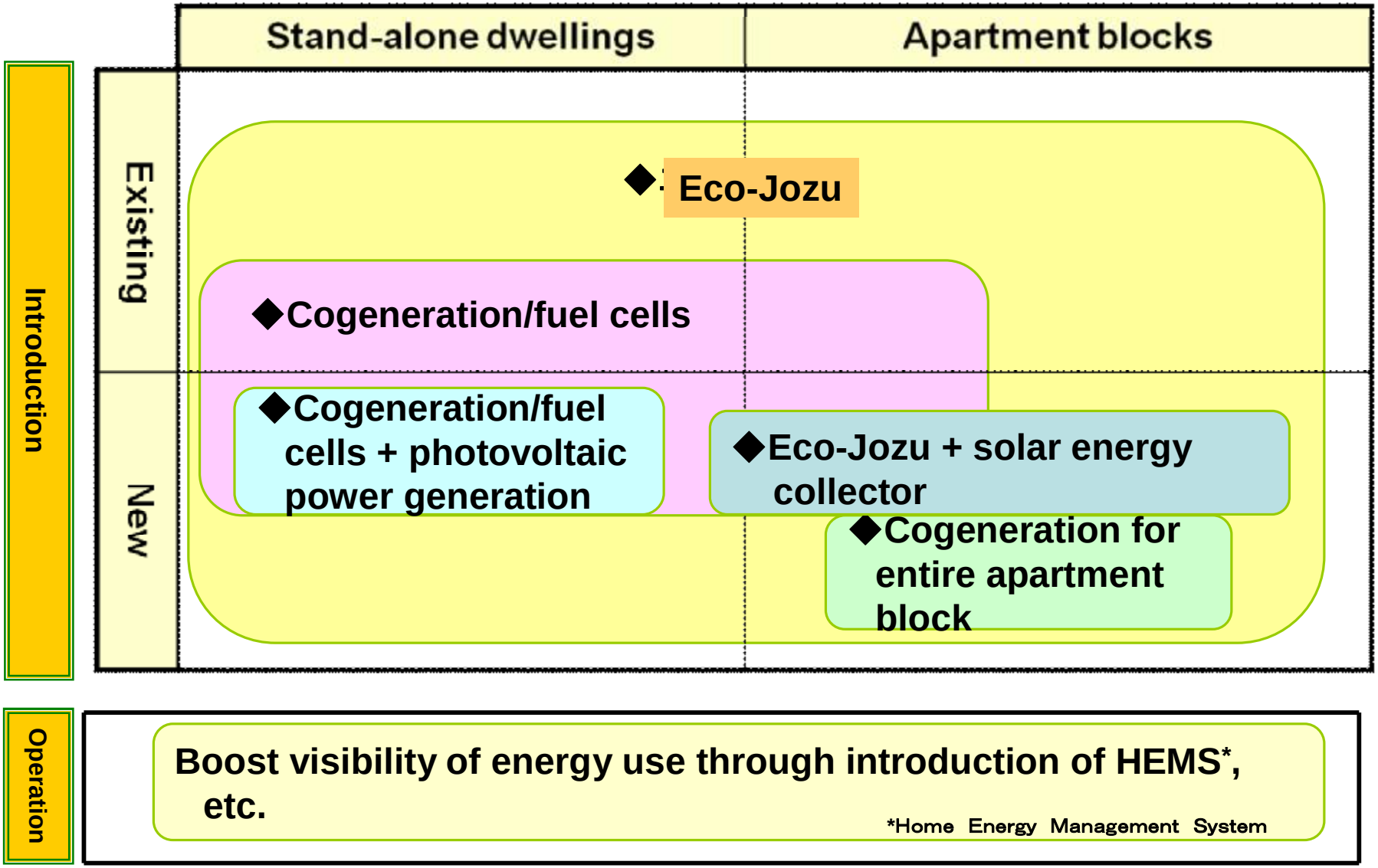
CO_2 reduction rate: 32%

Small

Hot water use

Large

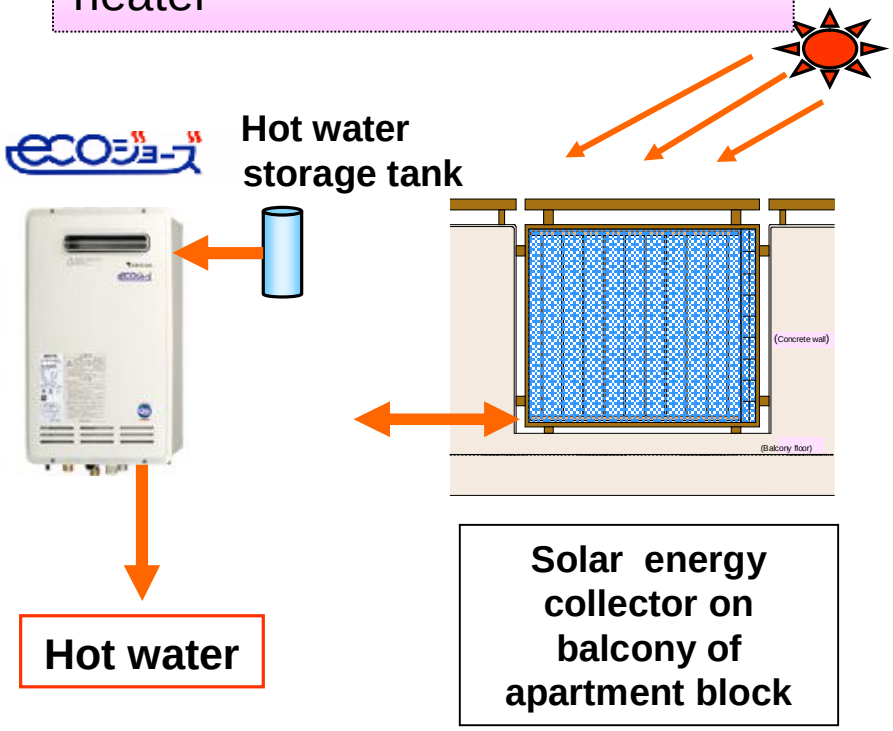
(For Reference) Optimal Residential Energy-Saving Measures ①



(For Reference) Optimal Residential Energy-Saving Measures ②

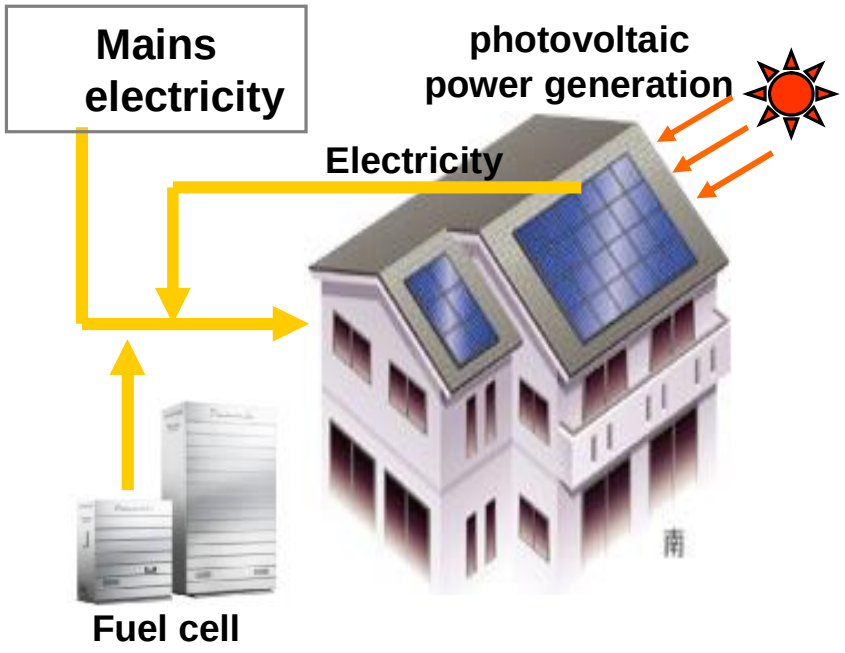
Example 1: Eco-Jozu + solar water heater (installed on balcony)

Eco-Jozu backs up unstable hot water output from solar water heater



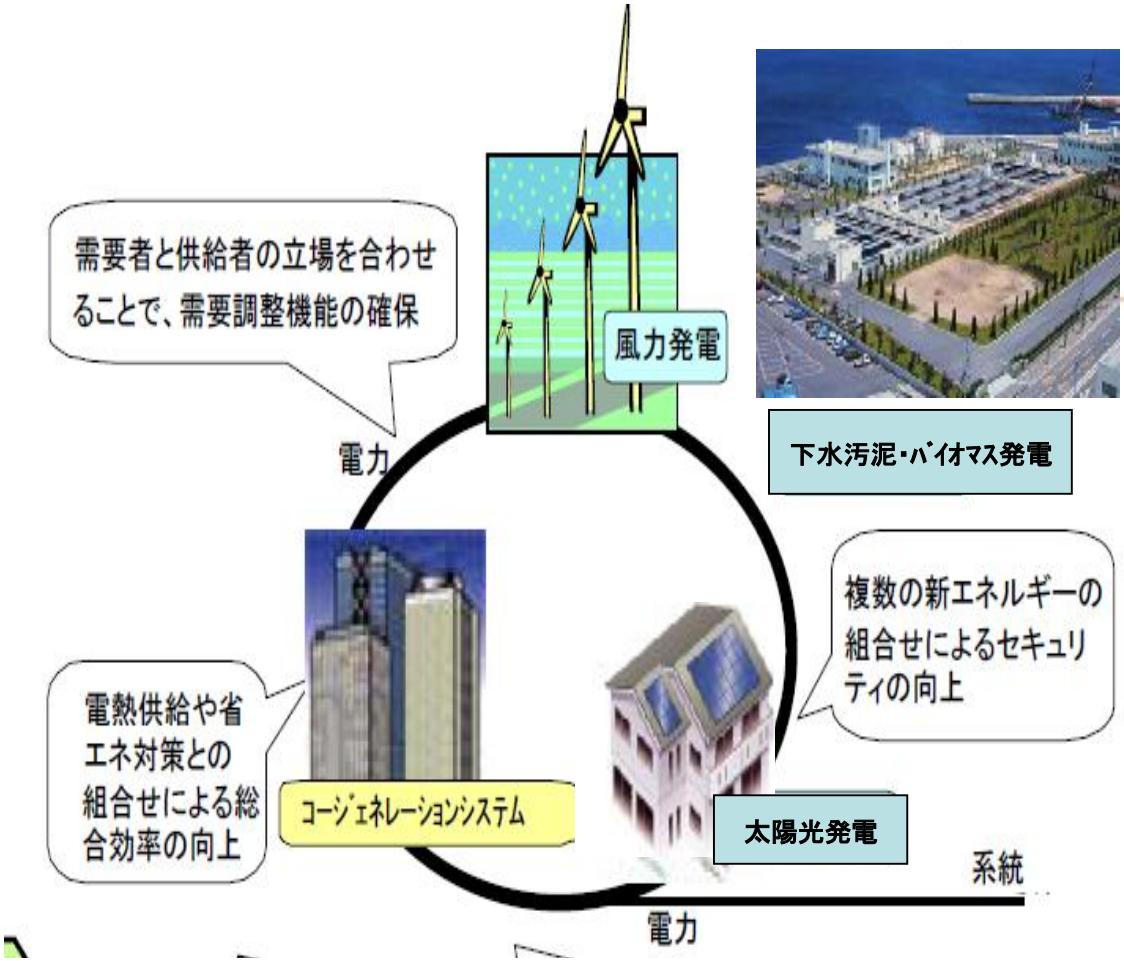
Example 2: Fuel cell + photovoltaic power generation

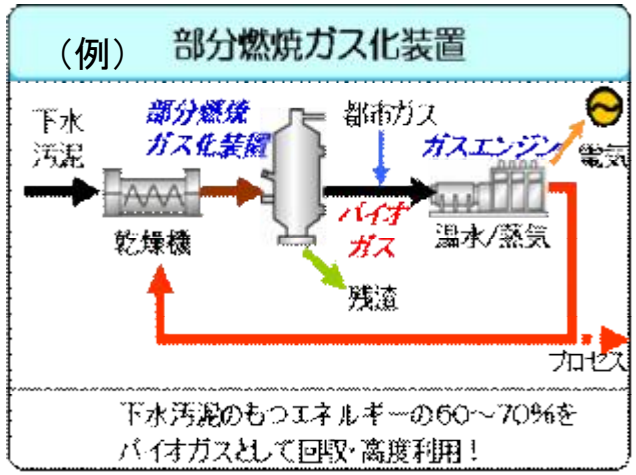
Best mix of fuel cell and photovoltaic power generation, which has unstable output



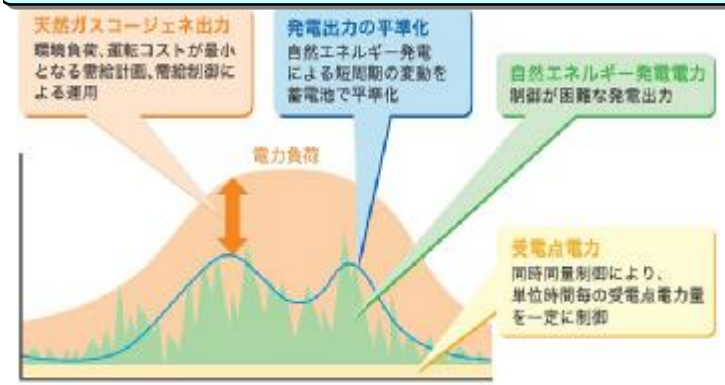
4. Local production and consumption systems utilizing renewable energy sources

- By using natural-gas cogeneration systems to compensate for fluctuations in energy output from renewable energy sources, it is possible to promote the widespread use of local energy production and consumption systems that utilize renewable energy sources. (R&D and business models are very important.)





Fluctuations in the output of wind power generation systems can be compensated for by gas cogeneration systems



5. Area/network-based energy use in urban areas (1)

- **Building an optimal energy system for each local community** by combining different user demand patterns, and by promoting area- and network-based electric power and heat that are used by buildings/city blocks (or groups of industrial plants) within a given district.

Current issues

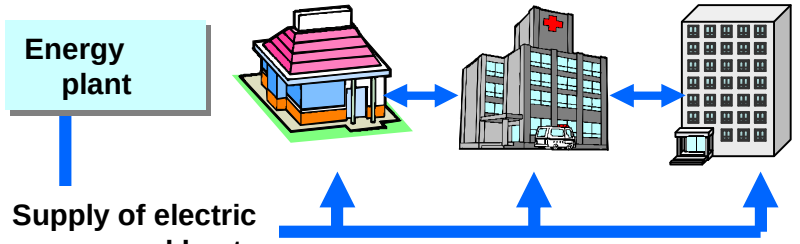
Low energy efficiency of buildings

＜Factors＞
- **Drop in efficiency due to operation at partial load**
- **Low efficiency of equipment installed**

Equipment installed separately in each building

Solutions

Promote area- and network-based energy use by combining users' demand. This will produce further gains in energy efficiency by:
- **Avoiding partial-load operation**
- **Making it possible to introduce large-scale high-efficiency systems (distributed energy systems, etc.)**



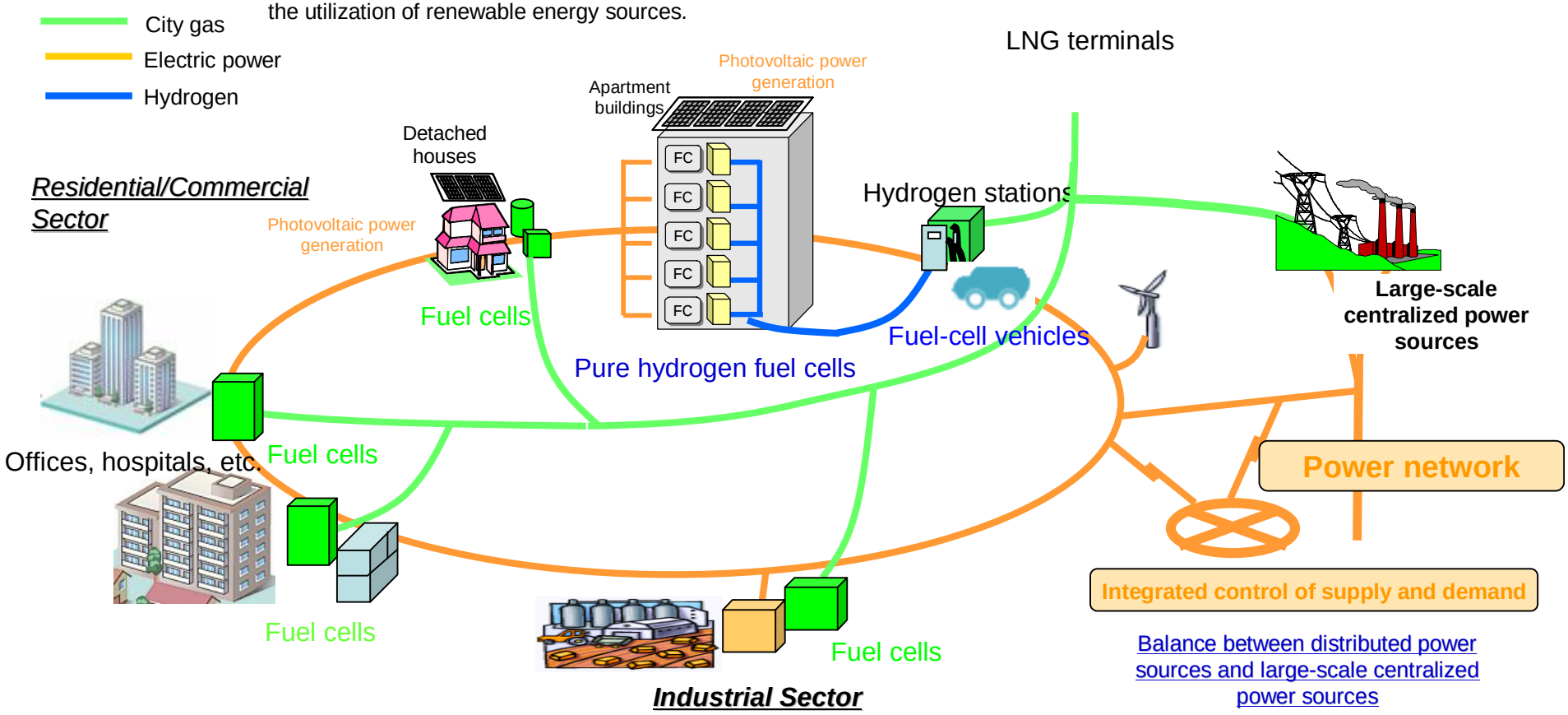
Important: the positioning of the energy conservation measures including area/network-based energy use in city planning

- **To give the incentive for the corporation with other utilities**
- **To establish the evaluation system of the area-based energy efficiency in Energy Conservation Law**

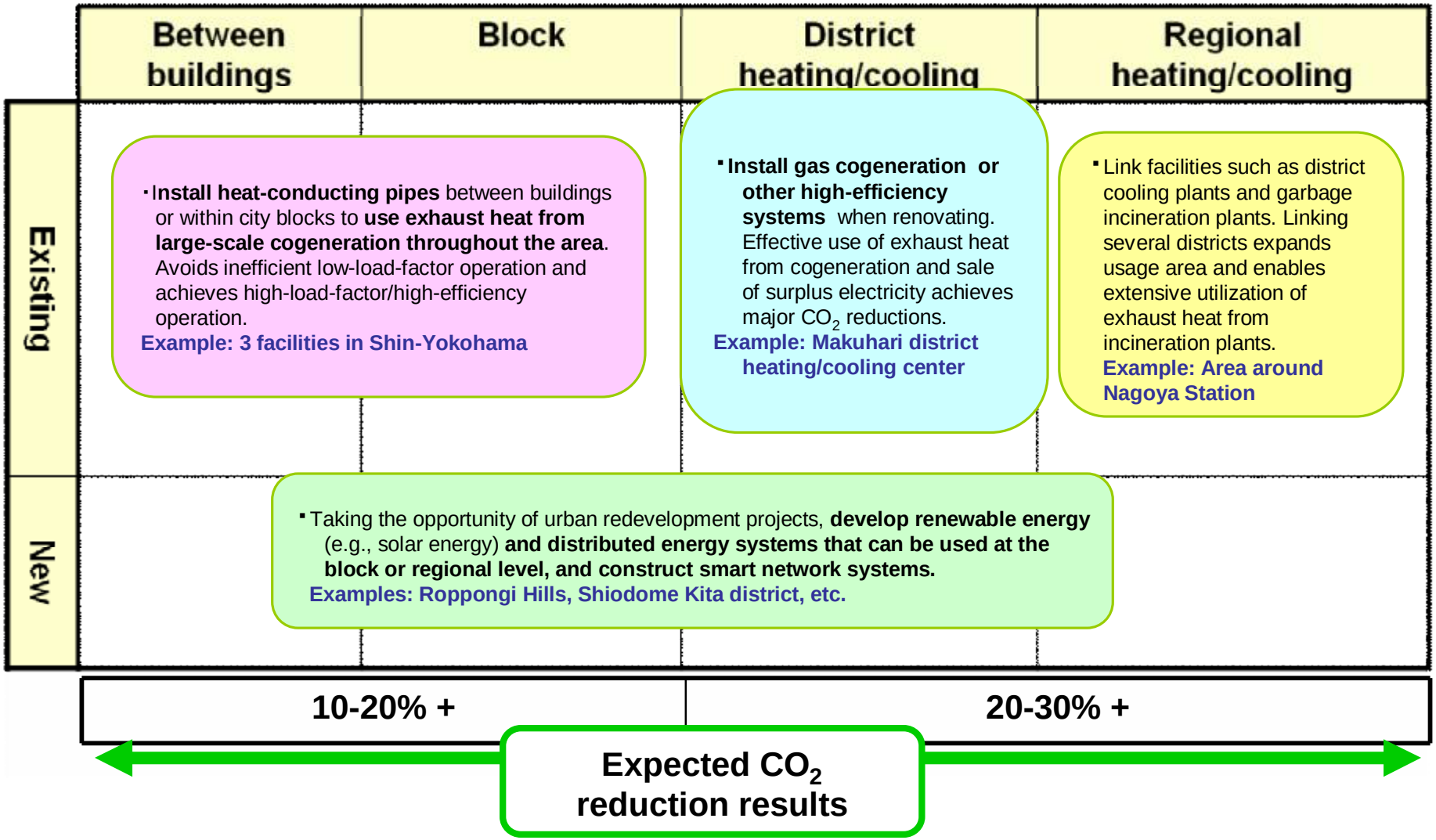
5. Area/network-based energy use in urban areas (2)

- **Building smart networks* by balancing and optimally combining advanced distributed energy systems with large- scale centralized power sources to promote energy security and reduce CO_2 emissions.**

* Networks that use information technology to integrate large-scale centralized power sources and distributed energy systems. These networks ensure the stability of the energy supply and help to reduce CO_2 emissions by enabling efficient energy use and the utilization of renewable energy sources.



(For Reference)
Area/Network-Based Energy Supply Configuration



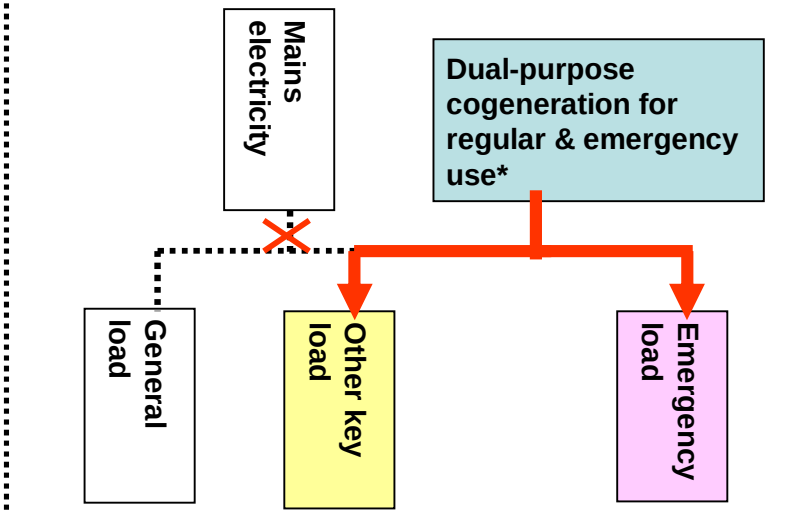
5. Area/network-based energy use in urban areas (3)

Even when mains electricity is cut, use distributed electricity systems to:

- **Secure power supply for emergency load and other key load through dual-purpose cogeneration facilities for regular and emergency use**
- **Improve regional-level reliability through quality-specific supply from micro-grids**

Example 1: Dual-purpose cogeneration for regular and emergency use

Cogeneration facilities enable supply for emergency load and other key load



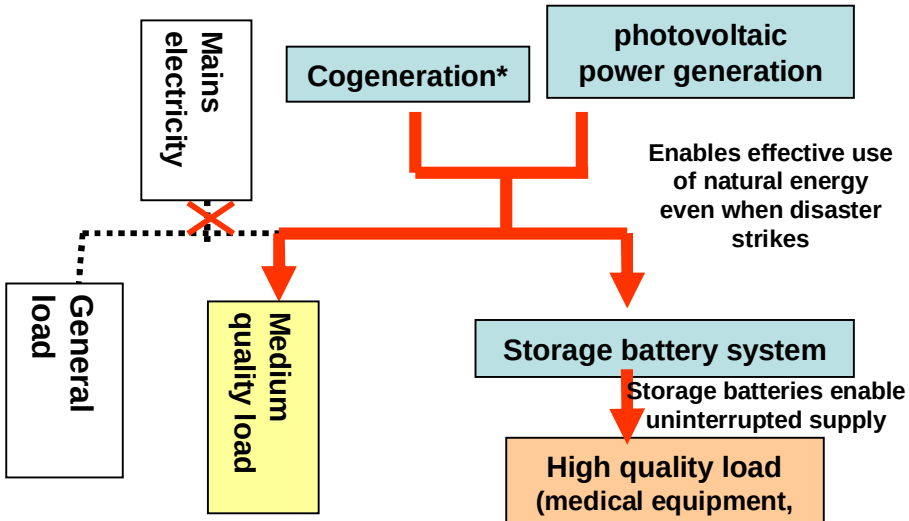
Reference

Commercial-use dual-purpose plants for regular and emergency use* are used in 26.3% of all cases of commercial use by organizations where emergency response is required, such as public agencies. (Facility capacity basis/based on FY2005 results/JGA data)

* Equipped with blackout start function and need for regular and emergency use is recognized

Example 2: Micro-grids

Micro-grids combining cogeneration, photovoltaic power generation, storage batteries, etc. can supply electricity according to need



Can be supplied from independent operation of cogeneration facilities

*Equipped with blackout start function

Total CO_2/Primary Energy Reduction

By 2030 the city gas industry can make reductions of approx. 48 million t-CO_2 p.a. and approx. 12 million kl p.a.

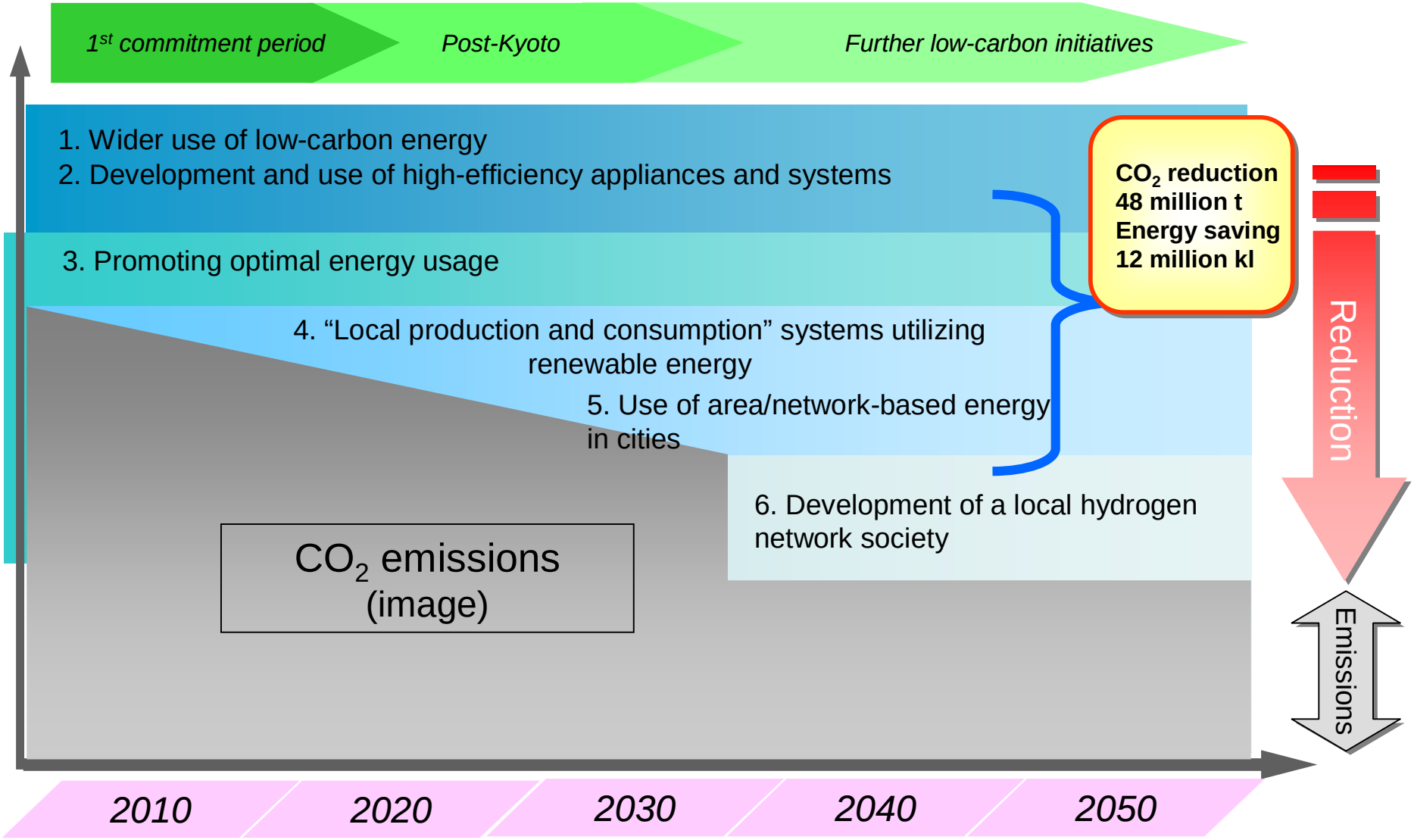
Scenario	CO_2 reduction (million t-CO_2 p.a.)	Primary energy reduction (million kl p.a.)
Residential use: switch to high-efficiency water heaters, etc.	12	5
Commercial use: distributed energy, area-based use, etc.	9	2.4
Industrial use: switching fuel to natural gas, advanced use	27	5
Total	**Approx. 48**	**Approx. 12**

(For Reference) During the period 1990 to 2005, Japan's CO_2 emissions increased by 144 million t-CO_2

Source: Documents prepared for the 21st Joint Meeting of the Central Environmental Council and the Industrial Structure Council

Of these figures, reductions of approx. 28.5 million t-CO_2 p.a. and approx. 8 million kl p.a. result from progress with distributed energy systems

City Gas Energy Makes a Major Contribution to Energy Conservation and CO_2 Reduction



Gas Vision 2030:
Reduce CO_2 Emissions by 48 Million t/y by 2030

1. Wider and more intensive use of natural gas

2. Optimal use of energy

3. Advances in distributed energy systems (creation of smart networks)

(1) Enhanced efficiency of natural gas cogeneration systems

(2) Local production and consumption systems utilizing renewable energy sources

(3) District-based and network-based energy use in urban areas

Balancing and optimally combining distributed energy systems with large-scale centralized power sources
Creating a low-carbon energy network and improving in energy security

● Ensuring safety and security and gaining public trust in all stages of energy flow from upstream suppliers to users