Approaches by the city gas industry based on the direction of future energy policy

— Expanded natural gas use to 2030 —

October 27, 2011
The Japan Gas Association
1. Major agenda of Japan's energy policy after March 11

Addition of three new perspectives to the current "Three E's" (energy security, environmental friendliness, and economic efficiency)

- Energy security
- Environmental friendliness
- Economic efficiency

(1) Enhancement of energy security
(2) Reform of the energy system
(3) Establishment of an energy supply-demand structure contributing to Japan's sustainable development
## 2. Review of Japan's energy policy

Examinations on the advisable setup for the new energy system over the short, medium, and long terms, even at national venues such as the Energy and Environment Council

### Basic principles of new energy strategy

| Basic Principle 1: Realization of a new best-mix |
| Basic Principle 2: Realization of new energy systems |
| Basic Principle 3: National consensus-building |

### (1) Short term (next three years)

- All-out effort to stabilize the supply and demand for the immediate future
- National discussion on reduction of dependence on nuclear power

### (2) Medium term (up to 2020)

- Promotion of the spread of distributed energy systems targeted for 2020
- Construction of a new best-mix of energy sources including less dependence on nuclear power

### (3) Long term (from 2020 to 2030 or 2050)

- Realization of results of the new best-mix and energy systems
- Establishment and rooting of new power systems grounded in new technological systems

(Prepared on the basis of the interim report at the 2nd meeting of the Energy and Environment Council held on July 29)
3. Approaches for immediate agenda

Installation of diverse gas systems for contribution to power conservation, energy conservation, and measures to assure energy security in the event of disasters and power outages

1) Stabilization of power supply and demand

- Supplementation of grid power supply capacity with distributed energy systems
  - Increased input and operation of cogeneration systems and fuel cells
  - Reverse flow of surplus power
- Power peak shaving through gas air conditioners and heating equipment
  - Input and priority operation of gas air conditioners (absorption and GHP types)
  - Reduction of power demand for heating in winter through gas fan heaters and warm-water underfloor heaters
- Replacement of equipment with high power consumption in the kitchen and water-heating demand
  - Shift from electrical to gas kitchen appliances and water heaters

2) Reinforcement of security in the event of disasters and power outages

- Backup power sources using distributed energy systems
  - Expanded installation of cogeneration systems for both ordinary and emergency use in hospitals and other priority facilities
- Spread (or marketing) of gas equipment to cope with power outages
  - Development and sales of residential cogeneration systems to cope with power outages
- Study of initiatives to improve energy security on the district level
4. Approaches over the medium and long terms

Approaches to the new best-mix of energy sources while heightening energy security

1) Promotion of the shift to and advanced use of natural gas
   • Energy conservation and carbon reduction through fuel conversion and advanced use
   • Energy conservation and carbon reduction through energy management

2) Expanded diffusion of distributed energy systems
   • Accelerated introduction of renewable energy
   • Construction of smart energy networks and smart communities with natural gas cogeneration at the core

3) Strengthening of the foundation for expanded diffusion of natural gas
   • Assurance of a stable supply of low-cost natural gas resources
   • Construction of the domestic network for natural gas supply
4. Approaches over the medium and long terms
   - (1) Promotion of the shift to and advanced use of natural gas

Further shift to and advanced use of natural gas for promotion of energy conservation, carbon reduction, and energy diversification, for realization of a new best-mix of energy sources

* Average rate of natural gas use in the energy mix of OECD countries: 23.8% (2009, IEA)

<table>
<thead>
<tr>
<th></th>
<th>Strengths</th>
<th>Weaknesses</th>
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</thead>
<tbody>
<tr>
<td>Oil</td>
<td>Convenience, Economic merit, Supply infrastructure</td>
<td>Supply stability (high dependence on Middle-Eastern oil), Price fluctuation</td>
</tr>
<tr>
<td>Coal</td>
<td>Cost, Supply stability</td>
<td>High CO2 emission levels</td>
</tr>
<tr>
<td>Nuclear power</td>
<td>Zero CO2 emissions, Economic merit</td>
<td>Safety</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>Environmental merit, Domestic availability</td>
<td>Cost, Stable use</td>
</tr>
<tr>
<td>Natural gas</td>
<td>Low CO2 emission levels, Supply stability, Convenience</td>
<td>Price fluctuation, Supply infrastructure</td>
</tr>
</tbody>
</table>

Status of primary energy use in Japan (2009) and characteristics of each type of energy

4. Approaches over the medium and long terms

- (1) Promotion of the shift to and advanced use of natural gas - 2

Advanced use of natural gas in all sectors is vital for realization of a best-mix on a par with those in other developed countries.

1) Conversion to natural gas for heat (thermal energy) demand in the industrial sector
(Current share of the industrial demand for heat occupied by natural gas: 10.7%)

- More sophisticated (energy-saving) engineering
- Extensive use of the Center for Promotion of Conversion to Natural Gas Fuel

2) Energy conservation and carbon reduction through gas systems with higher levels of performance and functionality in the commercial and residential sectors

- Fusion with renewable/unused energy
- Expanded introduction of energy management (installation and use of HEMS and BEMS)

3) Energy diversification in the transportation sector

- Expanded diffusion of natural gas vehicles (NGVs)
- Diffusion of new large trucks fueled with compressed natural gas (CNG)

- Examination of hydrogen supply networks for further carbon reduction

Conditioning of the infrastructure for hydrogen supply (hydrogen stations) for the spread of fuel cell vehicles (FCVs)
4. Approaches over the medium and long terms

- (2) expanded diffusion of distributed energy systems - 1

Response to the decline in power supply due to nuclear power reduction by assurance of sources applying renewable energy and cogeneration, and reduction of demand through energy and power conservation

**Power supply mix in 2030**

(based on data from the Agency for Natural Resources and Energy, June 2010)

- **Breakdown of generated output**

  - **Nuclear power**: 5,366
  - **Renewable energy**: 2,140
  - **Coal**: 1,131
  - **LNG**: 1,357

- **2030 estimate**

- **Potential to meet 10 - 20% of the total domestic power demand with natural gas cogeneration**
- **Possibility of introduction of 30 million kW in natural gas cogeneration capacity through use of surplus power**

⇒ *Installation of gas-fueled air conditioning systems also effective for shaving power demand peaks*
4. Approaches over the medium and long terms
- (2) expanded diffusion of distributed energy systems - 2

Contribution not only to energy security, conservation, and renewable energy but also to achievement of a new energy supply-demand structure integrated with the customer side

Significance of natural gas cogeneration

1) Improvement in social value

- Improvement in energy security by installation of backup power sources
- Promotion of energy conservation and carbon reduction through use of waste heat (high total efficiency)
- Accelerated installation based on fusion with renewable energy (output stabilization)

2) Reduction of social cost

- Shortening of construction lead time (siting flexibility)
- Siting of new demand centers (reduction of transmission loss)
- Encouragement of awareness of optimal energy use on the customer side
4. Approaches over the medium and long terms

(2) expanded diffusion of distributed energy systems - 3
Leveling of fluctuation in renewable energy output by control of cogeneration output

4. Approaches over the medium and long terms
- (2) expanded diffusion of distributed energy systems - 4
Development of technology for accommodation of a wide range of sectors, from residential to districts and large factories

**Increase in energy security**

- Self-sufficient operation system for residential cogeneration (2012-)
- Self-sufficient operation system for condominium cogeneration
- Self-sufficient operation system on the district level
- Creation of smart communities

**Further increase in efficiency and performance**

- Residential SOFC (2012-)
- Hydrogen stations (2015-)
- Pure hydrogen PEFC
- Inter-building thermal energy Network (2015-)
- Smart cogeneration (2015-)
- Gas engine cogeneration with full steam recovery (2015-)
- Construction of systems for grid power stabilization (2013-)

**Support for input of renewable energy**

- Commercial SOFC (2015-)
- Industrial SOFC (2020-)

- Biogas cogeneration
### 4. Approaches over the medium and long terms

#### - (2) expanded diffusion of distributed energy systems - 5

Higher efficiency and lower costs through technology development

<table>
<thead>
<tr>
<th></th>
<th>Increase in generation efficiency/equipment input</th>
<th>Cost reduction targets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cogeneration (gas engine)</strong></td>
<td></td>
<td></td>
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<tr>
<td>Small</td>
<td>Current 34% → <strong>At least 42%</strong> → <strong>At least 45%</strong></td>
<td>2020 - <strong>25% ~ - 30%</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.02M – 1.5M kW/year; at time of production)</td>
</tr>
<tr>
<td>Medium</td>
<td>Current 40% → <strong>At least 45%</strong> → <strong>At least 50%</strong></td>
<td>2020 - <strong>20%</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.0M kW/year; at time of production)</td>
</tr>
<tr>
<td>Large</td>
<td>Current 48% → <strong>At least 50%</strong></td>
<td>2020 - <strong>20%</strong></td>
</tr>
</tbody>
</table>

| **Cogeneration (gas turbine)** | | |
| Current 33% → **At least 36%** → **At least 38%** | 2020 - **20%** |

| **Fuel cells (PEFC)** | | 
| Current 35-40% → Pure hydrogen PEFC **At least 55%** | 2020 - **1-kW class: manufacturer ex-factory shipment price ¥400,000 - 500,000/system** |

| **Fuel cells (SOFC)** | | 
| 2012- **Residential (Efficiency of at least 45%)** | 2030 - **100s of kW class; manufacturer ex-factory shipment price No more than ¥150,000/kW** |
| 2020- **100-kW class (Efficiency of at least 55%)** | | (at time of production of 200,000 systems/year/firm) |
4. Approaches over the medium and long terms
- (2) expanded diffusion of distributed energy systems - 6

Construction of a smart energy network with natural gas and distributed energy systems at the core

- Contribution to the expanded diffusion of renewable and unused energies
  - Wind power generation
  - PV systems (electricity and heat)
  - Grid power network
  - Natural gas pipelines
  - Expanded diffusion of distributed systems
  - Gas cogeneration
  - Gas air conditioning

- Improvement of energy security
  - Supply of power and heat to priority facilities and peripheral areas in times of disaster etc.

- Fuel diversification in the transportation sector
  - Biomass power generation
  - Natural gas stations
  - Hydrogen stations
  - Natural gas vehicles
  - Fuel cell vehicles

- Energy-saving, low-carbon energy management
  - Alleviation of burden on grid power + energy conservation and carbon reduction

- Area-wise heat interchange through the heat supply network
4. Approaches over the medium and long terms
   - (3) assurance of a stable supply of low-cost natural gas resources - 1

Toward the realization of reasonable prices in the Asian market

Crude oil and LNG fuel price trends

Source: trade statistics from the Ministry of Finance and publicly available data from the EIA, IMF, and data the Kakimi crude oil price website
4. Approaches over the medium and long terms
- (3) assurance of a stable supply of low-cost natural gas resources - 2

Initiatives to assure a stable supply of LNG, for which the demand is projected to increase

1) **Acquisition of new supply sources**
   - More acquisition of upstream rights and interests
   - Participation in projects applying new technology such as liquefaction at sea (FPSO)
   - Deployment of futuristic methane hydrate and coal gasification technology
   - Support by resource-oriented diplomacy and financing

2) **Application of diverse procurement means and procurement of diverse LNG types**
   - Approaches to strengthening bargaining power by joint procurement etc.
   - Procurement from inside and outside the Asia-Pacific region, including unconventional gas
   - Ongoing dialogue between producer and consumer countries
4. Approaches over the medium and long terms

- (4) Reinforcement of the domestic natural gas supply network - 1

Application of diverse means for reinforcement of the infra-network for supply of natural gas throughout Japan

Source: “Toward Conditioning of the Gas Infrastructure”, report by the working group on gas infrastructure conditioning

* Floating Storage and Regasification Unit

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4. Approaches over the medium and long terms
- (4) Reinforcement of the domestic natural gas supply network - 2

Launch of studies for construction of the natural gas infra-network

- Expansion of the natural gas supply network for the further diffusion of natural gas and improved security

- Study to determine measures for improved security along with revision of business continuity programs (BCP) for energy supply in emergencies

- Study of the future vision for the natural gas infrastructure encompassing pipelines for import and underground storage
5. Expansion of natural gas use to 2030
Approaches to realization together with the national authorities and other parties, to accelerate the natural gas shift

<table>
<thead>
<tr>
<th>1. Cogeneration</th>
<th>Anticipated effects (as compared to the present)</th>
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<tbody>
<tr>
<td>4.6 million kW</td>
<td>[Reduction of CO2 emissions] About 62 million tons-CO2/year</td>
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<td></td>
<td>[Power supply and demand stabilization]</td>
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<td></td>
<td>Cogeneration and fuel cells 25 – 30 million kW</td>
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<tr>
<td></td>
<td>(* representing about 15% of the total yearly domestic demand for power, in terms of electrical energy)</td>
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<tr>
<td></td>
<td>Cut in the power peak by gas air conditioning 13 million kW</td>
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<tr>
<td>2. Gas air conditioning</td>
<td></td>
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<tr>
<td>13 million RT</td>
<td>[Expansion of the domestic demand (as of 2030)]</td>
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<tr>
<td></td>
<td>Amount of investment in the gas systems at left: 1.2 - 1.5 trillion yen/year</td>
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<tr>
<td>3. Natural gas share of the industrial demand for heat</td>
<td></td>
</tr>
<tr>
<td>10.7%</td>
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<tr>
<td>25.0%</td>
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<tr>
<td>4. Residential fuel cells</td>
<td></td>
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<tr>
<td>20,000 unit order</td>
<td></td>
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<tr>
<td>5 million unit order (including LGP types)</td>
<td></td>
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<tr>
<td>5. Natural gas vehicles (NGVs)</td>
<td></td>
</tr>
<tr>
<td>40,000 unit order</td>
<td></td>
</tr>
<tr>
<td>500,000 unit order</td>
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</table>
6. Policy package for realization of expanded diffusion through the natural gas shift

While the city gas industry will make further efforts to accelerate the shift to natural gas, arrangements must be made to support the promotion of diffusion to accomplish this shift.

1. Recovery from the Great East Japan Earthquake and stabilization of power supply and demand
   (1) Support for approaches by gas companies nationwide to prepare for possible large-scale disasters
   (2) Support for initiatives making extensive use of natural gas for conservation of power and energy

2. Promotion of the diffusion of distributed energy systems
   (1) Promotion of the installation of distributed systems in priority facilities to improve security
   (2) Supplementation of grid power, support for power source diversification, and fuller provisions for systemic reform
   (3) Incorporation of distributed energy systems in the vision for smart communities of the future
   → Establishment of legal positioning related to input of distributed energy systems

3. Toward expanded natural gas for the best-mix of energy sources
   (1) Bolstering of approaches to assurance of resources through public-private collaboration for both long-term supply stability and lower costs
   (2) Support for conditioning of the natural gas infra-network to assist the natural gas shift and enhance energy security
   (3) Promotion of the natural gas shift in the demand for heat in the industrial sector, fuel in the transportation sector, and air conditioning