Smart Energy Networks

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Tokyo Gas Co., Ltd.
Supporting 60-80% CO\textsubscript{2} reduction by expanding the advanced use of natural gas.

- **The First Commitment Period**
- **Post-Kyoto Period**
- **Further efforts toward a low carbon society**

1. **Expanded use of natural gas**
2. **Advanced use of natural gas** (e.g., highly efficient appliances)
3. **Maximum introduction of renewables**
4. **Deployment of area-network energy use**
5. **Configuration of local hydrogen networks**

**Emission volume**
- Reducing CO\textsubscript{2} emissions from other types of fossil fuels such as oil
- Reducing CO\textsubscript{2} emissions from fossil-fired power stations, etc

**Creation of the Smart Energy Network**
Conceptual Scheme of the Smart Energy Network
Values of the Smart Energy Network
① Enhance energy efficiency, CO2 reduction
② Support the utility power grid for penetration of renewables
③ Enhance energy security in case of utility power outages, disasters

Future hydrogen society

Urban area energy interchange by Microgrid & DHC

Embedding unstable renewables

Demand-supply matching by CHP & battery
Support the Utility Power Grid for Renewables Penetration

- Point of common coupling
- Tie line flow
- Utility grid
- Intermittency of wind turbine
- Intermittency of solar photovoltaic
- Intermittency of electrical load
- Demand-supply matching by gas engine and battery
Test Facility at Tokyo Gas Yokohama Techno Station

- **3φ3W 200V**
- **100kVA transformer**

- **Solar photovoltaic 10kW**
- **Gas engine CHP 25kW×2**
- **Wind turbine 6kW×2**

- **Lead acid battery 50kW-30min**
- **Nickel hydrogen battery 50kW-2hrs**
- **Gas engine CHP 9.9kW**
- **Biogas engine generator 9.9kW**

- **Air-conditioning**
- **Shadable load**
- **Sensitive load**
- **Most sensitive load**
- **UPS**
- **INV**
- **100kVA transformer**

- **Hot water**

- **Most sensitive load**

- **1φ3W 200/100V**

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Test Results of Renewable Intermittency Compensation

Integrated Control of Gas Engines and a Battery

- Low frequency intermittency compensated by Gas Engines
- High frequency intermittency compensated by a Battery

<Results>

- Superior Tie Line Flow Control within ± 3% Matching Error in Every 5 Minutes
- 2kW Battery Power for Compensating 6kW Solar PV Volatility
Enhance Energy Security in Case of Utility Power Outages

Islanded operation of multiple DERs

- 3φ3W 200V
- 100kVA transformer

- Gas engine CHP 25kW×2
- Solar photovoltaic 10kW
- Triple effect absorption chiller
- Air-conditioning
- Biogas engine generator 9.9kW

- Wind turbine 6kW×2
- Nickel hydrogen battery 50kW-2hrs
- Lead acid battery 50kW-30min

- Gas engine CHP 9.9kW
- Most sensitive load
- Sensitive load

- Hot water
- Shadable load

- 1φ3W 200/100V
- 100kVA transformer

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Most sensitive load

Sensitive load

Islanded operation of multiple DERs
Islanded Operation of Multiple DERs & Demand-side Control

Total Available Load Improved by 40% with Control Integration of Islanded Gas Engines, Solar PV and Demand-side Controllers
Test Facility at Tokyo Gas Senju Techno Station

Flow Chart

PV panels
- Kyocera 30kW
- Showa-Shell 10kW
- Honda 10kW
- Sharp 40kW
- Sanyo 16kW

Gas CHP
- Yanmar 370kW
  - 700kW

Solar Collectors
- Size 246m²
  - Output 130kW

Heat Recovery
- Steam Absorption HP 422kW
- Absorption HP (Steam) 422kW
- Absorption HP (Gas) 949kW×2
- Heat Exchanger (Hot Water) 763kW
- Heat Exchanger (Steam) 582kW
- Heat Exchanger 349kW

Electric Refrigerators
- Turbo refrigerator 703kW
- Chiller 118kW

Gas Heaters & Refrigerators
- Gas Refrigerator 1125kW
- Hot Water Boiler 175kW
  - 349kW
- Steam Boiler 1250kW

Electricity
- Chilled Water
- Hot Water

Demonstration Residence
- Building A
- Building B

Nursing Home
- Hot water Boilers 233kW×2
Conclusions

- Natural gas must play a significant role in a low carbon society through advanced utilization technologies.

- Need to expand the scope of our R&D activities not only single device but also integrated energy systems to create smart energy network.

- Appropriate combination and harmonization with renewables and centralized power sources required.

- Strong need of a single voice (lobbying) toward each country’s policy makers.