The 4th Strategic Energy Plan of Japan
Summary

April 2014
As for Japan, which depends on most of fossil fuel from abroad, energy security is always a significant issue.

This plan gives a direction of Japan’s energy policies for medium/long-term (about next 20 years). It declares a period from now to 2018-2020 should be a special stage to reform a variety of energy systems.

GOJ will share distress of the affected people caused by the accident at TEPCO’s Fukushima Daiichi Nuclear Power Plant, and achieve the restoration and reconstruction of Fukushima. Japan’s energy strategies, which were drafted before the Great East Japan Earthquake, should be reviewed from scratch, and GOJ should make efforts to decrease dependency on nuclear power as much as possible. It is a starting point to reestablish Japan’s energy policies.
# I. Problems on Japan’s Energy Supply/Demand Structure

## 1. Basic Problems

- Japan’s energy supply would be easily affected by external factors due to its high dependency on oversea fossil fuel.
- Population decline and innovation in energy conservation technology have caused structural changes in Japan’s medium/long-term energy demand.
- Increased energy demand in emerging countries has led rapid increase in natural resources’ prices and global greenhouse gas emission.

## 2. Problems exposed just before and after 3.11

- Concerns regarding safety of nuclear power plants and weak public confidence toward GOJ and utilities.
- Due to an increase of fossil fuel imports, Japan faces further dependency on the Middle-East, a rise in electricity prices, a rapid increase of greenhouse gas emissions, and an outflow of national wealth.
- Exposed structural defects, such as difference in electricity frequency between East and West in Japan, a lack of emergency system to deliver oil products.
- New trend for energy saving by household and industries.
- New trend in global energy supply structure such as energy independency of North America due to shale gas, emerging regional differences in energy prices.
1. Principles of Energy Policy and Viewpoints for Reformation

(1) Confirmation of basic viewpoint of energy policies (3E + S)

Stable Supply (Energy Security)

Cost Reduction (Economic Efficiency)

Environment

Safety

Global Viewpoint
- Developing energy policies with international movement appropriately
- Internationalizing energy industries by facilitating business overseas.

Economic Growth
- Contribution to reinforce Japan’s locational competitiveness.
- Activating Japan’s energy market through energy system reform.

(2) Building multilayered and diversified flexible energy demand-supply structure

- Establishing resilient, realistic and multi-layered energy supply structure, where each energy source can exert its advantage and complement others’ drawbacks.
- Creating a flexible and efficient supply/demand structure where various players can participate and various alternatives are prepared by system reforms.
- Improving self-sufficiency ratio by developing and introducing domestic resources to minimize influence from overseas’ situation.
2. Evaluation of each energy source

(1) Renewables (solar, wind, geothermal, hydroelectricity, biomass)
- Promising, multi-characteristic, important, low carbon and domestic energy sources.
- Accelerating their introduction as far as possible for three years, and then keep expanding renewables.

(2) Nuclear Power
- Important base-load power source as a low carbon and quasi-domestic energy source, contributing to stability of energy supply-demand structure, on the major premise of ensuring of its safety, because of the perspectives; 1) superiority in stability of energy supply and efficiency, 2) low and stable operational cost and 3) free from GHG emissions during operation.
- Dependency on nuclear power generation will be lowered to the extent possible by energy saving and introducing renewable energy as well as improving the efficiency of thermal power generation, etc.
- Under this policy, we will carefully examine a volume of electricity to be secured by nuclear power generation, taking Japan’s energy constraints into consideration from the viewpoint of stable energy supply, cost reduction, global warming and maintaining nuclear technologies and human resources.
Ⅱ. Principles of Energy Policy and Viewpoints for Reform

(3) Coal

- Reevaluating as an important base-load power source in terms of stability and cost effectiveness, which will be utilized while reducing environmental load (utilization of efficient thermal power generation technology, etc.).

(4) Natural Gas

- Important energy source as a main intermediate power source, expanding its roles in a variety of fields.

(5) Oil

- Important energy source as both an energy resource and a raw material, especially for the transportation and civilian sectors, as well as a peaking power source.

(6) LP Gas

- A clean and distributed energy source that can not only be utilized in everyday life but also in emergency situations.

Energy Mix

- Energy mix will be shown soon after this plan, taking into consideration factors including restart of nuclear power plants and expansion of renewable energies, and so on.
1. Promoting comprehensive policies for securing of resources

- Promoting multilayered “resource diplomacy” with natural resource exporting countries.
- Facilitating diversification of supply sources and upstream development through risk money supply.
- Promoting new styles of joint procurement such as comprehensive business partnership.
- Establishing a stable and flexible LNG supply-demand structure with a long-term strategy that Japan would be a hub of a coming Asia LNG market.
- Developing domestic seabed mineral resources such as methane hydrate and rare metals.
- Promotion of recycling system for rare metals and reinforcement of reserve system.

2. Realization of an advanced energy-saving society

(1) Enhancing energy efficiency in each sector

- Formulating energy efficiency indexes in order to facilitate energy-saving on each sector.

  <residential & commercial sector>
  - Introduction of complementary energy efficiency standards for buildings/houses.

  <transport sector>
  - Promoting ITS which enables automatic driving system to improve fuel efficiency.

  <industry sector>
  - Encouraging investment to replace more efficient facilities.

(2) Realization of smart energy consumption through various options to end users

- Establishing a method of “Demand Response” through smart meters in all homes and all businesses.
3. Accelerating Introduction of Renewable Energy: Toward Grid Parity in the Mid/Long Term

- Accelerating introduction as far as possible for three years from 2013, followed by continuous active promotion.
- Establishing “Ministerial Meeting on Renewables” for policy coordination.
- Pursuing a higher level of introducing renewables than the levels* which were indicated based on the former Strategic Energy Plans, and GOJ takes them into account in a next energy mix.
- Operating FIT stably and appropriately, promoting regulatory reforms, R&D etc.

* “the Foresights of Long-Term Energy Supply and Demand (Recalculated)” (Aug. 2008, METI)
  - The ratio of renewables in total watt-hour in 2020: 13.5% (141.4 billion kWh)
  - “The Shape of Energy Supply and Demand in 2030” (Jun. 2010, the document for Advisory Committee on Energy and Natural Resources)
  - The ratio of renewables in total watt-hour in 2030: approximately 20% (214 billion kWh)

(1) **Strengthening the measures for expansion of wind and geothermal power**

**Onshore Wind Power**
- Shortening periods for environmental assessment, establishing regional/inter-regional grid for renewables, installing large storage cells, rationalizing regulations, and so on.

**Offshore Wind Power**
- Promoting pilot projects for floating wind turbines technology in Fukushima and Nagasaki prefecture, and making the technology commercialized by 2018.

**Geothermal**
- Reducing investment risk, shortening a period for environmental assessment, and promoting understanding of local people.
(2) Promoting distributed energy systems with renewables

WOODY BIOMASS
- Promoting the power generation and thermal usage of woody biomass, through forest/timber policies and the “Act for Promotion of Power Generation of Renewable Energy Electricity to take Harmony with Sound Development of Agriculture and Forest”.

MEDIUM/SMALL SIZE HYDRO POWER
- Simplification of procedure on water rights by the amendment of the “River Act”.

SOLAR POWER
- Continuing supports for introduction for self-consumption in regions.

THERMAL ENERGY FROM RENEWABLES
- Promoting introduction of thermal-supply facilities and pilot projects for multi-heat use.

(3) FIT

- Examination of the system from various views; facilitating the maximum use of renewables as well as reducing cost burden, referring situations of other countries which have faced challenges of cost burden and strengthening grid systems.

(4) Fukushima as a new hub of renewable energies’ industries

- Constructing an AIST’s new research center for renewables.
4. Re-establishment of nuclear policy

(1) Efforts towards restoration and reconstruction of Fukushima
- Efforts towards restoration and reconstruction of Fukushima is a starting point to rebuild Japanese energy policies.
- GOJ’s playing more proactive roles in the decommissioning of Fukushima Daiichi NPPs and the countermeasures for the contaminated water issue (CWI).
- GOJ’s playing more proactive roles in proceeding compensation, decontamination and operations of intermediate storage facilities.
- Conducting necessary studies for the establishment of R&D center for decommissioning and of industrial cluster for the fabrication/maintenance around the Fukushima Daiichi site.

(2) Untiring pursuit of safety and establishment of stable environment for nuclear operations
- Shedding the “safety myth” and pursuing the world’s highest level of safety for operations.
- In case that the Nuclear Regulation Authority confirms the conformity of nuclear power plants with the regulatory requirements which are of the most stringent level in the world, GOJ will follow the NRA’s judgment and proceed with the restart. In this case, the GOJ will make best efforts with operators to obtain understanding of relevant parties including host municipalities.
- Establishing an appropriate risk management system and implementing objective/quantitative risk assessments by nuclear power operators.
- Examining an appropriate business environment, where nuclear power operators can realize smooth decommissioning, prompt safety measures, stable supply of electricity, etc. under the liberalized electricity markets.
- Discussing a revision of the domestic nuclear damage compensation system comprehensively.
- Accelerating the necessary work towards a conclusion of CSC.
- Supporting municipalities hosting nuclear facility sites to enhance their evacuation plans, and reinforcement of measures for the nuclear emergency response.
(3) Steady approach to solve issues of nuclear power

(a) Drastic reinforcement of measures for achieving solutions and promotion concerning spent fuel management

- GOJ’s playing more active roles in finding proper solutions of geological disposal of high-level radioactive waste (HLW), securing reversibility and retrievability in HLW management for future generation.
- GOJ’s promoting study and research on alternative disposal options including direct disposal method.
- GOJ’s taking more initiative in explaining selection of candidate disposal sites from a scientific viewpoint and constructs a mechanism to build consensus in regions.
- Facilitating construction and utilization of new intermediate storage facilities and dry storage facilities.
- R&D for reduction and mitigation of volume and harmfulness of radioactive waste.
(b) Promotion of nuclear fuel cycle policy

- Strongly keeping a stable nuclear fuel cycle policy with the understanding and cooperation of located municipalities and international community, and holding flexibility to promote nuclear fuel cycle policy for mid- to long-term.
- Continuing committing to the principle of not possessing reserves of plutonium, of which use is undetermined on the premise of peaceful use, and conducting an appropriate management and utilization of plutonium considering an appropriate plutonium balance.
- Promoting R&D of fast reactors, etc., through international cooperation with US and France etc.
- Reforming any aspects of Monju research thoroughly and placing Monju as an international research center for technological development, such as reducing the amount and toxic level of radioactive waste and technologies related to nuclear nonproliferation.

(4) Establishment of trust relationship with people, municipalities hosting nuclear facility sites and international community

- Carrying out attentive public hearings and public relations based on facts and scientific evidence.
- Promoting measures supporting municipalities hosting NPPs in accordance with each regional situation.
- Providing nuclear technology with enhanced safety based on lessons from the accident, and strengthening support for human resource and institutional development for countries newly introducing NPPs.
III. Policies on energy supply/demand structures that should be applied secularly, comprehensively according to the plan

5. Environmental arrangement for the efficient/stable use of fuel fossils

(1) Promoting the effective use of high efficiency coal/LNG-fired power generation
- Shortening a period for environmental assessment.
- Developing next-generation high efficiency coal-fired power generation technologies (e.g., IGCC) and carbon capture and storage (CCS) technology.
- Promoting exports of Japan’s advanced coal/LNG-fired power generation.

(2) Restructuring of the Market and Business Foundations for Petroleum and LP Gas Industries
- Supporting business restructuring for oil refining industry, SS and LP gas operators.

6. Promotion of reforms in supply structure to remove market barriers

(1) Electricity System Reform
- Expanding cross-regional coordination of transmission operators, introduce full retail competition and legally unbundle transmission and distribution sectors.
- Introducing a mechanism for Transmission System Operators to purchase load following power, an obligation to retailers for securing power supply and so on, to secure stable supply to end users under full competition.

(2) Promoting Reforms in Gas Systems and Heat Supply Systems
- Introducing a full competition in gas supply market, and reviewing a system to use gas supply infrastructure for new comers.
- Overhauling a heat supply business to further promote effective use of heat.
7. Enhancing resilience of domestic energy supply network

- Reinforcing oil and LP gas storage systems and promoting cooperation with oil-producing countries and neighboring countries.
- Enhancing disaster response capability of refineries, service stations, as well as ensuring stable supply of petroleum products in everyday life.
- Establishing an emergency response system to coordinate among public agencies.
- Encouraging critical consumers (hospitals, etc.) to store petroleum products for emergency.
- Enhancing resilience of the electricity/gas supply system.

8. Future of a secondary energy supply structure

(1) Promoting co-generation and introduction of storage batteries
- Examination of a new dealing to introduce electricity from co-generation to the market.

(2) Facilitating new technologies, which can use new energy sources, to introduce competition among energy sources in such new energy vehicles
- Aiming that a sale of new next-generation automobiles will reach at 50% through 70% in total new vehicles sale by 2030.

(3) Realization of the “Hydrogen Society”
- Promoting residential fuel cells “Ene-farm” to 5.3 million in 2030.
- Building 100 hydrogen refueling stations in 2015.
- Commercialization of advanced technologies such as Hydrogen Power Generation.
- Continuing R&D efforts for the technologies such as hydrogen production, transport, and storage.
- Making a roadmap to realize the “Hydrogen Society” in Spring 2014.
9. Energy leading Growth Strategy : creation of new energy enterprises etc,

(1) Big turnaround of industrial structure in energy sector
- Facilitating new entries by new servicers to energy markets through electricity/gas system reforms.

(2) Fostering new energy enterprises
- Mitigating regulations for creation of comprehensive energy enterprises.
- Promoting smart communities which would give a new energy supply service with other regional public services.

(3) Creation of new energy markets and development of international energy markets
- Facilitating of Japan’s advanced technologies such as storage batteries and fuel cells.
- Promoting exports of energy related infrastructures such as efficient thermal power plants, nuclear power plants and technologies for renewables and energy conservation.

10. Strengthening comprehensive international energy cooperation
- Contributing to multilateral energy cooperation frameworks such as the IEA and IAEA.
- Utilizing EAS as a framework to secure energy security with ERIA.
- Enhancing bilateral energy cooperation, especially Japan-US energy cooperation should be more comprehensive.
IV. Promoting strategic R&D

- Formulating a roadmap for technological development by next summer.
- Accelerating innovative technological development such as
  - lower-cost storage batteries and fuel cells
  - higher efficiency coal/LNG-fired power generation
  - technologies to reduce nuclear fuel waste and so

V. Communication with all levels of society on energy issues

- Sharing energy issues with all levels of Japan’s society more.
- Expansion of inter-active communication with various people.
Constitution of Electric Power Supply Corresponding to Demand

Base-load Power Source: Low production cost that can be operated stably day and night regardless of the time
Intermediate Power Source: Production cost is next lowest to base-load source. Generation can be adjusted in accordance with electricity demand
Peaking Power Source: Easy to control generation in accordance with electricity demand while production cost is high
JAPAN’S ENERGY SITUATION

April, 2014

Agency for Natural Resources and Energy
Ministry of Economy, Trade and Industry (METI) Japan
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LNG increase compensates for the decline of nuclear power.
Japan’s Energy Supply Structure

Japan’s Primary Energy Source

- **Renewables etc.**: 45%
- **Hydro**: 3%
- **Oil**: 23%
- **Natural gas**: 23%
- **Coal**: 75%
- **Nuclear power**: 4%

* "Renewables etc." consists of solar power (0.1%), wind power (0.2%), geothermal heat (0.1%), and biomass (3.3%).

Source: Prepared based on "Comprehensive Energy Statistics (Preliminary Report for 2012)" issued by the Agency for Natural Resources and Energy."
Trends in Final Energy Consumption in Japan

Japan lacks natural resources which are indispensable to economic and social activities. In order to meet changing economic and energy situations at home and abroad, Japan has reviewed its energy policy in order to ensure energy security, economic efficiency, and environmental preservation.

**Japan’s Energy Policy History**

- **1970s**
  - (1) Responding to the oil crises (1970s-80s)
    - 1973: First oil shock

- **1980s**
  - (2) Promoting regulatory reform (since 1990s)
    - 1979: Second oil shock

- **1990s**
  - (3) Coping with global warming issues (since 1990s)
    - 1997: Kyoto Protocol adopted

- **2000s**
  - (4) Enhancing resource security (2000s)
    - 2005: Kyoto Protocol came into effect
  - (5) Current Basic Energy Plan
    - 2002: Basic Act on Energy Policy enacted
1. Energy Policy
To Overcome energy challenges while reducing costs in the procurement, distribution, and consumption sectors.

1. Production (Procurement) Sector
   <Diversify electricity sources>
   (1) Maximize introduction of renewable energy
       ① Deregulation
           (E.g. Accelerate procedures for environmental assessments)
       ② Promote wind and geothermal power, through enhancing grid, etc.
   (2) Restart nuclear power plants once safety is assured.
   (3) Introduce high-efficiency thermal power plants (coal and LNG) while considering the environmental impact

   <Diversify fuel sources>
   (1) Procure low-cost LNG.
   (2) Promote development of domestic energy sources including methane hydrate.

2. Distribution Sector
   (1) Electricity market reform
       ① Full liberalization of generation and retail.
       ② Unbundling
       ③ Nationwide transmission operation
   (2) Strict assessment of power rate (Cut down fuel cost)

3. Consumption Sector
   (1) Enhance competitiveness and promote energy efficiency by installing cutting edge and efficient facilities in industries.
   (2) Enhanced energy conservation by adding house/buildings in the Top Runner Program.
   (3) Promote efficient energy management systems such as demand response.
2. LNG
The nuclear power ratio in domestic power generation has decreased after the Great East Japan Earthquake due to the long-term shutdown of nuclear power plants. On the other hand, the thermal power ratio has increased to 90%. Currently, LNG thermal power alone accounts for nearly 50% of domestic power generation.
Japanese LNG Imports Increased by 30%

After the Great East Japan Earthquake, Japan’s LNG demand increased by 30% due to the shutdown of nuclear power plants. (2010fy 70M tons → 2012fy 90M tons)

Japan’s Energy Demand Outlook

- 2010fy: 71 MTA
- 2011fy: 84 MTA (17.2% increase)
- 2012fy: 88 MTA (5.2% increase)
- 2013fy: 89 MTA (1.2% increase)

FY2010 to FY2012 Increase by 20 M tons

※Assuming that 9 nuclear power plants will resume generation by 2013

Source: The Institute of Energy Economics, Japan
Different Pricing for Each Market

Due to the segmentation, each regional market has its own pricing formula and therefore its own price range.
- Asia Market: $16-18, Europe Market: $10-12, US Market: $3-5 (per MMBTU)
In 2011, due to the increase in fuel import costs, Japan recorded a trade deficit for the first time in 31 years. The trade deficit for 2013 is **11.5 trillion yen**. Lowering fuel import costs is an urgent task for the Japanese government.

### Fuel Import Cost Heavily Impacts Japanese Economy

<table>
<thead>
<tr>
<th>Changes in trade balance and current account balance (trillion yen)</th>
</tr>
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<tbody>
<tr>
<td><img src="chart.png" alt="Chart showing changes in trade balance and current account balance" /></td>
</tr>
</tbody>
</table>

#### Net Import Costs

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>2010</th>
<th>2013</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG</td>
<td>3.5</td>
<td>7.1</td>
<td>+3.6</td>
</tr>
<tr>
<td>Crude Oil</td>
<td>9.4</td>
<td>14.2</td>
<td>+4.8</td>
</tr>
<tr>
<td>Petroleum Products</td>
<td>2.4</td>
<td>3.7</td>
<td>+1.3</td>
</tr>
<tr>
<td>Coal</td>
<td>2.1</td>
<td>2.3</td>
<td>+0.2</td>
</tr>
</tbody>
</table>
Japan’s strategy to secure more competitive gas

Supply Side Strategy

1. Early realization of LNG imports from the US
2. Diversification of supply source
   - Canada (LNG Canada, Pacific Northwest LNG, Aurora LNG, Triton LNG)
   - Russia (Vladivostok LNG Project, Far East LNG Project),
   - Mozambique (Rovuma Offshore Gas Field Area 1 Project),
3. Acceleration of projects operated by Japanese firms
   - Ichthys LNG Project in Australia

Demand Side Strategy

1. Review applications to restart nuclear power plants
2. Stringent assessment on raising electricity tariff
   - Top-runner approach
3. Re-evaluation of coal power plants
4. Accelerate domestic resource development
   - Methane Hydrate
5. Relaxation of Destination Clauses
**Abundant LNG supply from the US**

- Four Approved projects = **65 MTA**
  - => Scheduled to be exported to Japan and other Asian markets starting 2015
  - => Asia’s current LNG demand is over 160 MTA
- Japan’s LNG claims from 4 projects totals 17 MTA
  (Equivalent to 20% of Japan’s annual LNG imports).

### Approved Projects

<table>
<thead>
<tr>
<th></th>
<th>Project</th>
<th>Export Approval Status</th>
<th>Production Capacity (Japan’s claim)</th>
<th>Start of Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sabin Pass</td>
<td>Approved (2011.5.20)</td>
<td>17 MTA</td>
<td>2015</td>
</tr>
<tr>
<td>2</td>
<td>Freeport</td>
<td>Approved (2013.5.17)</td>
<td>10.8 MTA (4.4MTA)</td>
<td>2018</td>
</tr>
<tr>
<td>3</td>
<td>Lake Charles</td>
<td>Approved (2013.8.7)</td>
<td>15.4 MTA</td>
<td>2018</td>
</tr>
<tr>
<td>4</td>
<td>Cove Point</td>
<td>Approved (2013.9.11)</td>
<td>5.75 MTA (2.3MTA)</td>
<td>2017</td>
</tr>
<tr>
<td>5</td>
<td>Freeport (Expansion)</td>
<td>Approved (2013.11.15)</td>
<td>3.1 MTA (2.2MTA)</td>
<td>2019</td>
</tr>
<tr>
<td>6</td>
<td>Cameron</td>
<td>Approved (2014.2.11)</td>
<td>13.1 MTA (8.0MTA)</td>
<td>2017</td>
</tr>
</tbody>
</table>

**Total of all applications**  
274 MTA

= Projects with participation by Japanese firms (Total 17MTA)
Japan’s LNG claims from 4 projects totals 17 MTA (Equivalent to 20% of Japan’s annual LNG imports). The exports are expected to start in 2017.

### Japan related Major LNG projects in North America

- **Freeport** (Freeport)
  - Capacity: 8.8 MTA
  - Start Operation: around 2018
  - Export license for Non-FTA: Approved (2013.5.17)
  - Sales: Osaka Gas and Chubu Electric Power: Total of 4.4 MTA

- **Freeport Expansion** (Freeport)
  - Capacity: 4.4 MTA
  - Start Operation: around 2019
  - Export license for Non-FTA: Approved (2013.11.15)
  - Sales: Toshiba 2.2 MTA

- **Cove Point** (Dominion)
  - Capacity: 5.75 MTA
  - Start Operation: around 2017
  - Export license for Non-FTA: Approved (2013.9.11)
  - Sales: Sumitomo, Tokyo Gas and Kansai Electric Power 2.3 MTA

- **Cameron** (Sempra Energy)
  - Capacity: 12 MTA
  - Start Operation: around 2017
  - Export license for Non-FTA: Approved (2014.2.11)
  - Sales: Mitsubishi Corporation, Mitsui Co. Ltd; Total of 8 MTA
Japanese firms such as Mitsubishi Corporation, JAPEX and INPEX are participating in upstream development and LNG projects in the Province of British Columbia.

Many LNG projects expected to export LNG to the Asian-Pacific market are under development.

Production from 4 projects involving Japanese firms total 40MTA with Japan’s claim totaling 8.6 MTA. The exports are expected to start around 2018.

**Aurora LNG Project**
- INPEX
- Production Scale: 10 MTA
- Production Start: 2020

**Pacific North West LNG Project**
- JAPEX
- Production Scale: 12 MTA
- Production Start: End of 2018

**LNG Canada Project**
- Mitsubishi Corporation
- Production Scale: 12 MTA
- Production Start: 2019

**Triton Gas Project**
- Idemitsu
- Production Scale: 2 MTA
- Production Start: 2017
※Liquefaction plant site TBD

※Liquefaction plant site TBD
Efforts to Diversify Supply Sources

- We will support upstream development and LNG projects by Japanese firms to realize new projects in countries such as Canada, Russia, Mozambique, etc. This will encourage competition among suppliers, leading to a more competitive and stable supply.
- We will also encourage utility companies to participate in upstream development.

**LNG Projects by Japanese Firms**

**Vladivostok LNG Project (Russia)**
- Under review by Gazprom and JFG (Itochu, Marubeni, JAPEX, INPEX)
- Production scheduled to start in 2018

**Far East LNG Project**
- Undergoing preliminary studies by Rosneft and Exxon
- Production scheduled to start in 2018

**Rovuma Offshore Gas Field Area1 Project (Mozambique)**
- Under review by Mitsui Co. Ltd. (Japan) and Anadarko Petroleum (USA)
- Production expected to start after 2018.

**Ichthys LNG Project (Australia)**
- Operated by INPEX. First large project to be operated by a Japanese firm.
- Production expected to start in the end of 2016
Japan’s METI has hosted LNG Producer-Consumer Conference, expecting that the conference is a platform for governments, business entities, and leading experts to exchange frank opinions on common issues concerning the LNG market.

On September 10, 2013, the 2\textsuperscript{nd} LNG Producer-Consumer Conference was held. More than 1000 people from 50 nations, including minister level officials and top business executives, attended the conference.

(The First Conference: 30 countries, about 600 participants)

METI plans to host the 3\textsuperscript{rd} conference on November 6. (The date is tentative and subject to change)
Relaxation of Destination Clauses

- Many LNG contracts include a destination clause which restricts buyers from reselling purchased cargo.
- However, globally, the destination clause for FOB (Free on Board) contracts are gradually being lifted.

**METI will support and encourage movements by Japanese buyers to relax the destination clause and abolish them from FOB contracts.**

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**Destination Clause in LNG Contracts**

- **Seller**
  - LNG Export Terminal
- **Buyer**
  - Port A
  - Third Party/Country
  - Port B

**Difference in LNG Contracts**

- **LNG Export Terminal**
  - Ex-Ship Contracts
  - FOB Contracts
- **LNG Import Terminal**
  - Seller
  - Buyer
The Impact of the Shale Revolution on the World

**North America**
- The growth of natural gas supply
- Exporting excess coal to Europe
- Became a net gas exporter

**Europe**
- The decline of demand for gas due to the increase of coal
- The expansion of gas import from the Middle East, the fall of import from Russia
- Introduction of various pricing methods

**China**
- The rise of natural gas import from Turkmenistan
- Obtaining an interest in the upstream of North America
- Taking advantage in negotiations with Russia regarding gas import
- The increase of oil production
- Decreasing dependence on the Middle East (2.7 mbd → 1.7 mbd)

**Russia**
- Pressure to lower natural gas prices for Europe and low supply.
- Development of Japanese/Chinese/Korean markets
- The possibility of the growth of export because of conventional/ non-conventional crude oil developments.

**Japan**
- Multilateralization of natural gas suppliers
- Introduction of pricing methods based on natural gas supply-demand
- Keeping resource options such as coal open

**Middle East (such as Qatar)**
- Further development of European and Asian markets
- The decrease of crude oil export to the U.S.A. (2.7 mbd → 1.7 mbd)
- Further expansion of export to Asia (mainly China and India) (For China: 2.6 mbd → 2.9 mbd)

**Africa**
- Declining export to the U.S.A. due to the shale oil revolution (1.1 mbd → 0.3 mbd)
- The possibility that crude oil produced in Algeria and Nigeria (light oil) flows into European and Indian markets
- The possibility of production growth and export because of developments in Argentina (shale oil), Venezuela (extra heavy oil), and other countries

**Mozambique**
- Increasing necessity of finding new supply destinations

**South America**
- The possibility of production growth and export because of developments in Argentina (shale oil), Venezuela (extra heavy oil), and other countries

Coal export to Europe

*Quoted from IEA “Medium-Term Market Report 2013”*
Asia, the Fastest Growing Region

Major LNG projects, LNG receiving terminals in the Asia-Pacific region

Natural gas demand (2010 → 2035)
- World: 3307 bcm → 4955 bcm, +49%
- Asia: 575 bcm → 1347 bcm, +134%
- OECD: 1597 bcm → 1937 bcm, +21%

Planned LNG Project
- Existing LNG Project
- Planned LNG Terminal
- Existing LNG Terminal

Senboku 1・2
Himeji LNG Terminal, etc

Chita LNG Office
Chita-Midorihama
Chita Joint Terminal, etc

Sodegaura
Negishi
Futtsu, etc

Sakhalin II
Vladivostok

Bataan
Pagbilao
Bontang

Arun
Jurong island
Sengkang
Greater Sunrise
Wheatstone
North West Shelf
Gorgon
Browse
Pluto

Donggi Senoro
Tangguh
PNG
Abadi
Darwin
Ichthys
Queensland Gurtis, GLNG, APLNG

Alaska
Hawaii

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Tangguh
PNG
Abadi
Darwin
Ichthys
Queensland Gurtis, GLNG, APLNG

Alaska
Hawaii
Rising supplies of unconventional gas & LNG help to diversify trade flows, putting pressure on conventional gas suppliers & oil-linked pricing mechanisms

Source: IEA, World Energy Outlook 2012
3. Methane Hydrate
Domestic resource development (Methane Hydrate)

1. Deep Methane Hydrate

1. **Offshore Production Test**
   - From March 12-18, 2013
   - World’s first experiment of methane hydrate gas production in a sea area using the depressurization method
   - Total output: 120,000 cubic meters
     Ave. daily output: 20,000 cubic meters

2. **Future plans**
   - Improve technologies for commercialization by 2018

3. **Cooperation with Other Countries**

---

2. Shallow Methane Hydrate

1. **Actions to assess reserve amounts**
   - Shallow methane hydrates mainly exist on the Sea of Japan side of Japan
   - Will conduct research starting in 2013 to 2016 in order to assess the resource reserve amount
   - Conducted geological research in 2013 and discovered 225 gas chimneys where Methane Hydrate may exist. Currently, analyzing data

2. **Future Plans**
   - Conduct detailed and wide-area geological research and also gather shallow methane hydrate samples in 2014
4. Nuclear
Nuclear Power Plants in Japan

- There are 48 nuclear power plant units in Japan.
- All units (in red) are in a state of temporary shutdown as of February 24, 2014.
- 17 units (in blue squares) are under review for restart by the Nuclear Regulation Authority in accordance with its new safety regulations.
Schedule of the Introduction of the New Nuclear Safety Regulation

Discussion with academics at the Commission of NRA

Review by experts
* Listening to other academics and electric utilities

Compile an outline of New Nuclear Safety Regulation (February 6)

Public Comment (until February 28)

Hearings from Experts, Electric utilities
(severe accident countermeasures only)

Draft texts of Nuclear Safety Regulation (April 10, 2013)

Public Comment (until May 10)

Publication • Enforcement (July, 2013)

Applications for restart were made in 17 reactors in 9 power-stations (as of Today)
Nuclear Fuel Cycle in Japan

(5.5~6.5tHM/y Plutonium usage by 16 to 18 MOX fuel load nuclear reactor
*Including 1.1tHM/y plutonium usage by Ohma Nuclear Power Plant)

MOX Fuel from foreign reprocessors
Plutonium quantity possessed by electric power supplier (storage in UK and France)
23.3tHM

JNFL: Japan Nuclear Fuel Limited
MOX: Uranium-plutonium mixed oxide

Next reprocessing plant
Fast Breeder Reactors (FBR)

Waste from operation and decommissioning

Study on implementation of sub-surface disposal for waste from decommissioning (2002FY~)

Spent Fuel

MOX Fuel from foreign reprocessors

JNFL

Spent Fuel

MOX Reprocessing Plant

JNFL

Spent Fuel

Rokkasho Reprocessing Plant

Storing: approx.2,900tU
Storage capacity: 3,000tU

Plutonium over 4tHM/y

(Start of construction: 2010
Plan of operation: 2016)

JNFL

Spent Fuel

Vitrified Waste

Off-site storage facility (Spent Fuel Interim Storage)

Storing: approx.14,000tU
Storage capacity: approx.20,000tU

Mutsu: 5000tU
(Start of construction: 2010
Plan of operation: 2013)

Spent Fuel

Low-Level Radioactive Waste Disposal Center

sub-surface disposal test cavern

Waste from operation

Vitrified Waste Storage Center

Waste (from Spent Fuel Reprocessing) returned from UK and France

Geological disposal repository

Waste from operation and decommissioning

Electric power supplier (Tokyo Electric Power co./Japan Atomic Power co.)

Waste from operation

Vitrified Waste

Storing: approx.14,000tU
Storage capacity: 3,000tU

Sub-surface disposal test cavern

Low-Level Radioactive Waste Disposal Center

Waste from operation

Vitrified Waste Storage Center

Waste (from Spent Fuel Reprocessing) returned from UK and France

Geological disposal repository

Next reprocessing plant
Fast Breeder Reactors (FBR)
The nuclear power ratio in domestic electricity production has dramatically decreased due to long-term shutdown of each Nuclear Power Plant (NPP) for periodic inspection after the quake disaster. (Oh-I No. 3 and 4 resumed in July, 2012.)

On the other hand, the thermal power generation ratio has increased up to 90%, especially LNG thermal which is about 50%.

And with the shutdown of NPP, replacement fuel costs from thermal generation are estimated to increase 3.1 trillion Yen from FY2010 to FY2012. In FY2013, it is estimated that fuel costs will increase 3.6 trillion Yen over FY2010.

---

**Trend of PWR Formation for Power Suppliers (general electricity utility and wholesale electricity utility) after Quake Disaster**

<table>
<thead>
<tr>
<th>Power Category</th>
<th>Fuel Cost (FY2012)</th>
<th>Cost Impact Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimation in FY2012</td>
<td>Estimation in FY2013 (※)</td>
</tr>
<tr>
<td>Nuclear</td>
<td>¥1/KWh</td>
<td>- 0.3 Trillion ¥</td>
</tr>
<tr>
<td>Coal</td>
<td>¥4/KWh</td>
<td>+ 0.1 Trillion ¥</td>
</tr>
<tr>
<td>LNG</td>
<td>¥11/KWh</td>
<td>+ 1.4 Trillion ¥</td>
</tr>
<tr>
<td>Oil</td>
<td>¥16/KWh</td>
<td>+ 1.9 Trillion ¥</td>
</tr>
<tr>
<td>Total</td>
<td>—</td>
<td>+ 3.1 Trillion ¥</td>
</tr>
</tbody>
</table>
## Movements of Electric Utilities toward Electricity Rate Increase

<table>
<thead>
<tr>
<th>Company</th>
<th>Regulation Division</th>
<th>Liberalization Division</th>
<th>Date of Application</th>
<th>Date of Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tokyo Electric Power Company</strong></td>
<td>10.28%</td>
<td>(16.39%)</td>
<td>May 11, 2012</td>
<td>September 1, 2012</td>
</tr>
<tr>
<td></td>
<td>8.46% (▲1.82%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Kansai Electric Power Company</strong></td>
<td>11.88%</td>
<td>(19.23%)</td>
<td>November 26, 2012</td>
<td>May 1, 2013</td>
</tr>
<tr>
<td></td>
<td>9.75% (▲2.13%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Kyushu Electric Power Company</strong></td>
<td>8.51%</td>
<td>(14.22%)</td>
<td>November 27, 2012</td>
<td>May 1, 2013</td>
</tr>
<tr>
<td></td>
<td>6.23% (▲2.28%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tohoku Electric Power Company</strong></td>
<td>11.41%</td>
<td>(17.74%)</td>
<td>February 14, 2013</td>
<td>September 1, 2013</td>
</tr>
<tr>
<td></td>
<td>8.94% (▲2.47%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shikoku Electric Power Company</strong></td>
<td>10.94%</td>
<td>(17.50%)</td>
<td>February 20, 2013</td>
<td>September 1, 2013</td>
</tr>
<tr>
<td></td>
<td>7.80% (▲3.14%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hokkaido Electric Power Company</strong></td>
<td>10.20%</td>
<td>(13.46%)</td>
<td>April 24, 2013</td>
<td>September 1, 2013</td>
</tr>
<tr>
<td></td>
<td>7.73% (▲2.47%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chubu Electric Power Company</strong></td>
<td>4.95%</td>
<td>(8.44%)</td>
<td>October 29, 2013</td>
<td>April 1, 2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* It indicates an increase rate at the liberalization division for cost calculation corresponding to the increase rate at the regulation division, and the electricity rate at the liberalization shall be determined through negotiations between the parties concerned in principle.
(1) Since the 1980s, international reorganization and consolidation of nuclear plant manufacturers in the world have advanced. 

(2) In recent years, integration of Japanese and U.S. nuclear plant manufacturers has advanced (Toshiba's acquisition of Westinghouse, establishment of a new Japanese and U.S. company by Hitachi and GE). The industrial cooperative relationship between Japan and the U.S. has become closer. In addition, Mitsubishi and AREVA established a joint venture for midsize reactors.
The total installed capacity of nuclear power generation in the world is expected to grow 1.25 - 2.0 times by 2030 by IAEA.

(Compiled from data of the total installed capacity of nuclear power generation in the world (GW) published by IAEA in September 2012)

It is expected the large expansion in the area of East Asia, East Europe, Middle-east/South Asia.
5. Electricity System Reform
Current electricity system

- Partial liberalization: retail competition for over 50kW customers
- Retail Players: 10 big EPCOs (vertically integrated, regional monopoly), PPS, etc.
- Reality is...
  - Share of non-EPCO power producers and suppliers: 3.6%
  - 0.6% of the total retail market sales is transacted at JEPX
  
  <Cf.>
  - Market volume: 1000TWh/280GW
  - Electricity price (2011): 16.8 yen (average), 21.3 yen (household), 14.6 yen (industry)

Frequency in West: **60Hz**

Frequency in East: **50Hz**

* DC – direct current, FC – frequency conversion
No competition in the electricity market before 1995: 10 vertically integrated GEUs (General Electricity Utilities) dominated and controlled the market.

METI embarked series of reforms...

<table>
<thead>
<tr>
<th>No.</th>
<th>Year enforced</th>
<th>Overview</th>
</tr>
</thead>
</table>
| 1   | 1995          | • Open the IPP (Independent Power Producer) market  
• Allow specified-scaled and vertically integrated power generators |
| 2   | 2000          | • Introduce partial retail competition  
• Accounting separation of transmission/distribution sector |
| 3   | 2005          | • Expand retail competition  
• Establish the wholesale power exchange (JEPX) and its supporting body for transmission in wider areas |
| 4   | 2008          | • Modify the rule of wheeling rates |
Problems Revealed by 3.11

- Negative aspects of regional monopoly system were revealed:
  1. Lack of system to transmit electricity beyond regions
  2. Little competition and strong price control
  3. Limit in handling the change in energy mix including the increase in renewables
Agency for Natural Resources and Energy organized the Expert Committee on Electricity System Reform in February 2012. The Committee compiled an interim report, “The Basic Policy on Electricity System Reform,” at the July 13 meeting.

In November, the Committee started discussion on detailed designs for reform. Based on the discussions over 12 meetings, the Committee compiled a final report on February 8, 2013.

The Members of the Expert Committee of Electricity System Reform

<Chairman>
Motoshige Ito  Professor at Graduate school of Economics, The University of Tokyo

<Deputy Chairman>
Junji Annen  Professor at Law School Academy, Chuo University

<Members>
Toshinori Ito  Representative Director and analyst at Ito Research and Advisory Co., Ltd.
Hiroko Ohta  Professor, National Graduate Institute for Policy Studies
Junichi Ogasawara  Chief Research fellow and Manager at The Institute of Energy Economics, Japan, Electric Power Group
Takao Kashiwagi  Specially appointed professor at Tokyo Institute of Technology
Hiroshi Takahashi  Chief researcher at Fujitsu Research Institute of Economics Co., Ltd.
Kikuko Tatsumi  Regular adviser, Public Corporation, Nippon Association of Consumer Specialists
Tatsuo Hatta  Special visiting professor, Gakushuin University
Toshihiro Matsumura  Professor at The Institute of Social Science, The University of Tokyo
Akihiko Yokoyama  Professor at Graduate School of Frontier Sciences, The University of Tokyo
Based on the Expert Committee Report, the Cabinet decided to approve the Policy on Electricity System Reform on April 2, 2013.

3 objectives:
(1) Securing a stable supply of electricity
(2) Suppressing electricity rates to the maximum extent possible
(3) Expanding choices for consumers and business opportunities

To achieve these objectives, a bold reform will be steadily carried out according to a realistic step by step schedule, focusing on the following 3 items:
Agenda 1: Cross-regional Coordination of Transmission Operators

- Establish the Organization for Cross-regional Coordination of Transmission Operators (OCCTO) by about 2015
- Main functions of OCCTO: Detailed plans are still being discussed
  1. Aggregate and analyze the EPCO’s supply-demand plans and grid plans, and order to change EPCO’s plans such as for tie lines
  2. Coordinate supply-demand balancing and frequency adjustments by T/D sectors in each area
  3. Order EPCOs to reinforce generations and power interchanges under a tight supply-demand situation
Function of OCCTO

1. To implement items such as formulating a supply-demand plan and an electrical grid plan, promoting the development of an infrastructure for transmissions such as frequency converters and interconnection lines between areas, and a nationwide system operations beyond control areas.

2. Under normal situations, to address coordination from the viewpoint of wide-area operation regarding the supply-demand balancing and frequency adjustment by transmission/distribution companies in each area.

3. Under a tight supply-demand situation due to trouble such as disaster, to balance supply and demand by means of ordering reinforcement of thermal power sources and power interchange.

4. To neutrally carry out the reception of interconnection to new power sources and provide grid information.
Agenda 2: Full Retail Competition

- Expand retail competition to the residential sector around 2016
- Maintain regulated tariffs to 10 big EPCOs until around 2018-2020

March 2000

<table>
<thead>
<tr>
<th>Contract (kW)</th>
<th>Voltage (V)</th>
<th>Liberalized segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,000kW</td>
<td>20,000V</td>
<td>[Extra-high-voltage power for industrial uses] Large-scale factories [Extra-high-voltage power for commercial uses] Department stores, office buildings <strong>Share of total power: 26%</strong></td>
</tr>
<tr>
<td>500kW</td>
<td>6,000V</td>
<td>[High-voltage A power] Small-scale factories <strong>Share of total power: 9%</strong></td>
</tr>
<tr>
<td>50kW</td>
<td>6,000V</td>
<td>[Low-voltage power] Small-scale factories, convenience stores <strong>Share of total power: 5%</strong></td>
</tr>
<tr>
<td></td>
<td>100~200V</td>
<td>[Electric light] Households <strong>Share of total power: 31%</strong></td>
</tr>
</tbody>
</table>

April 2004

<table>
<thead>
<tr>
<th>Contract (kW)</th>
<th>Voltage (V)</th>
<th>Liberalized segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,000kW</td>
<td>20,000V</td>
<td>[Extra-high-voltage power for industrial uses] Large-scale factories [Extra-high-voltage power for commercial uses] Department stores, office buildings <strong>Share of total power: 40%</strong></td>
</tr>
<tr>
<td>500kW</td>
<td>6,000V</td>
<td>[High-voltage A power] Small-scale factories <strong>Share of total power: 9%</strong></td>
</tr>
<tr>
<td>50kW</td>
<td>6,000V</td>
<td>[Low-voltage power] Small-scale factories, convenience stores <strong>Share of total power: 5%</strong></td>
</tr>
<tr>
<td></td>
<td>100~200V</td>
<td>[Electric light] Households <strong>Share of total power: 31%</strong></td>
</tr>
</tbody>
</table>

April 2005

<table>
<thead>
<tr>
<th>Contract (kW)</th>
<th>Voltage (V)</th>
<th>Liberalized segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,000kW</td>
<td>20,000V</td>
<td>[Extra-high-voltage power for industrial uses] Large-scale factories [Extra-high-voltage power for commercial uses] Department stores, office buildings <strong>Share of total power: 60%</strong></td>
</tr>
<tr>
<td>500kW</td>
<td>6,000V</td>
<td>[Low-voltage power] Small-scale factories, convenience stores <strong>Share of total power: 5%</strong></td>
</tr>
<tr>
<td>50kW</td>
<td>6,000V</td>
<td>[Electric light] Households <strong>Share of total power: 35%</strong></td>
</tr>
</tbody>
</table>

(Note) The scope of liberalization of Okinawa Electric Power Company was expanded in April 2004, from users of power over 20,000kW, 60,000V, to extra-high-voltage power users (over 2,000kW, in principle).
Activate generation competition

- Little use of the current wholesale market (JEPX)
  - Activate the wholesale market
    - Introduce various products such as intra-day and futures
    - Secure the balancing market at the same time etc.
  - Promote the “nega-watt” trading etc.

Share of trading in JEPX to retail market sales

Trading in JEPX
- 0.6% (5.68 TWh)
- 99.4% (920.69 TWh)

Breakdown of trading in JEPX
- 97% (5.5TWh)
- 3% (0.18 TWh)
- 4 hour-Ahead spot trading 5% (9.03 GWh)
- New Forward trading 6% (11.7 GWh)
- Others 3% (0.18 TWh)
- Forward trading 89% (162GWh)
Agenda 3: Unbundle the transmission/distribution sector

- Unbundle the transmission/distribution sectors by ITO-style (legal unbundling) at around 2018-2020

**Diagram:**

- **Generation** (Competitive)
- **Transmission/distribution (System operation)**
- **Transmission/distribution facilities**
- **Retail** (Competitive)
- **Holding company**

**Regulated**:
- Regional monopoly
- Network tariff
- Responsibility for maintaining frequency & providing LR service
- Code of conduct
A Generation companies
1) Construct and maintain transmission and distribution lines
2) Purchase fuel
3) Operate plants
4) Sell power to retailers (or retail section in the company)\(^1\)

B Transmission/Distribution companies
- 1) Regional monopoly, tariff regulation
- 2) Guaranteed return of investment on lines through the regulated electricity rate
- 3) Obligation to provide universal service, to maintain balance of demand-supply
- Code of conducts on some issues such as personnel, and accounting to secure neutrality

1) Construct and maintain transmission and distribution lines
2) Operate electric system (dispatch to each plant, stable power supply by operating the transmission/distribution lines)
3) Set up meters, metering
4) Provide “last resort service” and “universal service to isolated islands”

C Retailers
1) Purchase electricity to sell to consumers (purchase from power company or power sector in the company)\(^1\)
2) Develop and provide tariff menus
3) Business to consumers, provide services
4) Collect the tariff

1) The case that a company has both retail sector and power sector.
Roadmap for Electricity Market Reform in Japan

Bills

1st Reform: passed in Extraordinary Diet in 2013
1) Establishment of the Organization for Cross-regional Coordination of Transmission Operators (OCCTO)
2) Action programs for 2nd and 3rd reforms etc.

【1st Stage】
Around 2015

2nd Reform: Ordinary Diet in 2014
1) Full liberalization of entry to electricity retail business
2) Revision of applicable and regulations associated with the abolishment of GEU system

【2nd Stage】
Around 2016

3rd Reform: Ordinary Diet in 2015 (Plan)
1) Legal unbundling of transmission/distribution sector
2) Code of Conduct

【3rd Stage】
Around 2018 through 2020

Establishment of the Organization for Cross-regional Coordination of Transmission Operators (OCCTO)

Full retail competition

Period of transitional arrangement for retail tariff

Abolishment of retail tariff

Legal unbundling of transmission/distribution sector

※At around 2015: Transition to new regulatory organizations
Securing a Stable Supply of Electricity

Ⅰ．Transmission/Distribution companies

(1) Secure a high quality power supply such as stable frequency and voltage by continuously imposing the obligation to maintain a supply-demand balance of the whole electrical system.

(2) Have obligation to construct and maintain transmission/distribution network, guaranteed through regional monopoly and tariff regulations including fully distributed cost methods.

(3) Provide the last resort service of supply, and secure a stable supply in isolated islands at equivalent price that is comparable to that of the mainland.

Ⅱ．In Emergencies

(1) “The Organization for Cross-regional Coordination of Transmission Operators” (OCCTO) will balance supply and demand by means of ordering reinforcement of thermal power sources and power interchange.

(2) Government (METI) orders/requests power companies and other companies which have in-house power generation to supply power, as necessary.

Ⅲ．Securing Power Supply Capacity

(1) Place an obligation on electricity retailers to secure power supply capacity.

(2) Recruit power plants and construction workers who will be prepared by “the Organization for Cross-regional Coordination of Transmission Operators” (OCCTO) for future electricity shortfalls.
Status of the amending bill on Electricity Business Act

April 2, 2013  
Cabinet Decision

April 12, 2013  
The Bill based on the Cabinet Decision was submitted to the Diet

May 28, 2013  
Discussion on the Diet started

June 13, 2013  
Passed the lower house

June 26, 2013  
The regular Diet session ended
→ The current bill was abolished
→ Press conference of Minister Motegi
“ We will submit the bill again to the next extraordinary Diet session, and surely will try to pass it.”

August 2, 2013  
The Working Group for the detailed design started to discuss

October 15, 2013  
The Bill which had passed the lower house on the former Diet was re-submitted to the extraordinary Diet

November 13, 2013  
The Bill passed the upper house and was enacted
6. Renewable Energy
The contribution of renewable energy (excluding hydro power) to the total power generation in Japan has covered around 1%.

Since the launch of the Residential Surplus Electricity Purchasing Scheme for Photovoltaic Power in November 2009 and the Feed-in Tariff Scheme in July 2012, Japan's use of renewable energy, led by solar power, has steadily increased.

Renewable energy accounted for 1.6% in FY2012.
Shifts in Japan's Measures to Increase Renewable Energy Use

Japan’s measures to increase the use of renewable energy shifted from (1) financial support through subsidies, (2) aid through placing an obligation on electric power companies to source part of their electricity from renewable sources (the RPS scheme), to (3) the feed-in tariff (FIT) scheme that requires electric power companies to purchase electricity at fixed prices.

(1) Support through subsidies (1997–)
- Enactment of the Act on the Promotion of New Energy Usage (New Energy Act)
  ✓ Provides partial financial aid to private companies implementing new-energy projects and guarantee on loans taken from financial institutions.
  ✓ Provides financial aid to local governments implementing new-energy projects.

(2) Support through placing an obligation (the RPS scheme) (2003–2012)
- Launch of the RPS Scheme in 2003
  ✓ Requires electric power companies to source a specified proportion of their electricity from renewable sources (without fixed prices).

(3) Support through buyback at fixed prices (to give prospects for recovering investment) (2009–)
- Launch of the Residential Surplus Electricity Purchasing Scheme in 2009
  ✓ Requires electric power companies to purchase home-generated solar power of less than 500 kW at the procurement price and for the procurement period set by the government.

- Launch of the Feed-in Tariff (FIT) Scheme in 2012
  ✓ Requires electric power companies to purchase electricity produced from renewable sources, including solar, wind, hydro, geothermal and biomass at the procurement price and for the procurement period set by the government.
Among the total electricity generated in fiscal 2012, renewable energy, etc. accounted for approximately 10%; 8.4% of which is hydraulic power generation.

Renewable energy other than hydro is still cost prohibitive.

Note: “Etc.” of “Renewable energy, etc.” includes the recovery of energy derived from waste, refuse derived fuel (RDF) products, heat supply utilizing waste heat, industrial steam recovery, and industrial electricity recovery.

Source: Prepared based on the Agency for Natural Resources and Energy’s “Outline of Electric Power Development in FY 2010”
Under the feed-in tariff scheme, if a renewable energy producer requests an electric utility to sign a contract to purchase electricity at a fixed price and for a long-term period guaranteed by the government, the electric utility is obligated to accept this request.
This Act obliges electric utilities to purchase electricity generated from renewable energy sources (PV, wind power, hydraulic power, geothermal and biomass) at the procurement price and for the procurement period.

Approved at the 177th session of the Diet 2011 and started on July 1st, 2012.

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Solar PV</th>
<th>Wind power</th>
<th>Geothermal power</th>
<th>Small- and medium-scale hydraulic power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement category</td>
<td>Solar PV</td>
<td>Wind power</td>
<td>Geothermal power</td>
<td>Small- and medium-scale hydraulic power</td>
</tr>
<tr>
<td>Procurement category</td>
<td>10 kW or more</td>
<td>20 kW or more</td>
<td>15,000 kW or more</td>
<td>1,000 kW or more</td>
</tr>
<tr>
<td>Installation cost</td>
<td>280,000 yen/kW</td>
<td>300,000 yen/kW</td>
<td>790,000 yen/kW</td>
<td>850,000 yen/kW</td>
</tr>
<tr>
<td>Operating and maintenance costs</td>
<td>9,000 yen/kW</td>
<td>6,000 yen/kW</td>
<td>33,000 yen/kW</td>
<td>9,500 yen/kW</td>
</tr>
<tr>
<td>Pre-tax IRR</td>
<td>6%</td>
<td>8%</td>
<td>1.8%</td>
<td>7%</td>
</tr>
<tr>
<td>Procurement price per kWh</td>
<td>34.56 yen</td>
<td>23.76 yen</td>
<td>28.08 yen</td>
<td>25.92 yen</td>
</tr>
<tr>
<td>Tax inclusive ((\text{\textdollar}}) )</td>
<td>37 yen</td>
<td>59.4 yen</td>
<td>43.20 yen</td>
<td>31.32 yen</td>
</tr>
<tr>
<td>Procurement period</td>
<td>20 years</td>
<td>20 years</td>
<td>15 years</td>
<td>20 years</td>
</tr>
<tr>
<td>Tax exclusive</td>
<td>32 yen</td>
<td>22 yen</td>
<td>26 yen</td>
<td>24 yen</td>
</tr>
<tr>
<td>Procurement period</td>
<td>10 years</td>
<td>20 years</td>
<td>15 years</td>
<td>20 years</td>
</tr>
</tbody>
</table>
### Tariffs and Durations (Biomass)

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Biomass type</th>
<th>Biogas</th>
<th>Wood fired power plant (Timber from forest thinning)</th>
<th>Wood fired power plant (Other wood materials)</th>
<th>Wastes (excluding woody wastes)</th>
<th>Wood fired power plant (Recycled wood)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation cost</td>
<td></td>
<td></td>
<td>3,920,000 yen/kW</td>
<td>410,000 yen/kW</td>
<td>310,000 yen/kW</td>
<td>350,000 yen/kW</td>
</tr>
<tr>
<td>Operating and</td>
<td></td>
<td></td>
<td>184,000 yen/kW</td>
<td>27,000 yen/kW</td>
<td>22,000 yen/kW</td>
<td>27,000 yen/kW</td>
</tr>
<tr>
<td>maintenance costs</td>
<td></td>
<td></td>
<td>(per year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-tax IRR (Internal Rate of Return)</td>
<td></td>
<td></td>
<td>1%</td>
<td>8%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Tax ( per kWh)</td>
<td></td>
<td></td>
<td>42.12 yen</td>
<td>34.56 yen</td>
<td>25.92 yen</td>
<td>18.36 yen</td>
</tr>
<tr>
<td>Tax inclusive</td>
<td></td>
<td></td>
<td>39 yen</td>
<td>32 yen</td>
<td>24 yen</td>
<td>17 yen</td>
</tr>
<tr>
<td>Tax exclusive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20 years</td>
</tr>
</tbody>
</table>
State of approval and operational start of RE facilities under the FIT program

- The approval of the Minister of Economy, Trade and Industry is required for renewable energy power generation facilities for the FIT program to apply. The total output of facilities approved up to December 2013 is approx. 30.3 GW.
- In comparison, the amount for facilities that began operation during the same period was 7.0 GW (a roughly 30% increase over the year the program started).

### [State of adoption of renewable energy power generation]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar (Residential)</td>
<td>Approx. 4.7 GW</td>
<td>1.0 GW</td>
<td>1.1 GW</td>
<td>2.3 GW</td>
</tr>
<tr>
<td>Solar (Non Residential)</td>
<td>Approx. 0.9 GW</td>
<td>0.7 GW</td>
<td>4.1 GW</td>
<td>26.1 GW</td>
</tr>
<tr>
<td>Others</td>
<td>Approx. 15.0 GW</td>
<td>0.1 GW</td>
<td>0.1 GW</td>
<td>1.9 GW</td>
</tr>
<tr>
<td>Total</td>
<td>Approx. 20.6 GW</td>
<td>1.8 GW</td>
<td>5.3 GW</td>
<td>30.3 GW</td>
</tr>
</tbody>
</table>

(Note) converted to amount of power generated, this is approx. 2.4 billion kWh for 2012, which is the equivalent of 0.3 nuclear plants (one plant: 1.2 million kW given 70% facility utilization).
A comparison of solar installations and estimates in different countries

- With 2,000,000 kW of capacity, Japan ranks 5th in the world for solar installations in 2012.
- Some private research institutes (IHS and Bloomberg in the U.S.) publish reports which forecast the Japanese market will become the largest in the world.

Top five solar installations and estimates

<table>
<thead>
<tr>
<th>Country</th>
<th>Installations in 2012 (IEA)</th>
<th>Estimates for 2013 (Bloomberg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Germany 7,600,000 kW</td>
<td>Japan 6,900,000–9,400,000 kW</td>
</tr>
<tr>
<td>2nd</td>
<td>China 3,500,000 kW</td>
<td>China 6,300,000–9,300,000 kW</td>
</tr>
<tr>
<td>3rd</td>
<td>Italy 3,300,000 kW</td>
<td>U.S. 3,700,000–4,300,000 kW</td>
</tr>
<tr>
<td>4th</td>
<td>U.S. 3,300,000 kW</td>
<td>Germany 2,900,000–3,300,000 kW</td>
</tr>
<tr>
<td>5th</td>
<td>Japan 2,000,000 kW</td>
<td>Italy 1,500,000–2,500,000 kW</td>
</tr>
</tbody>
</table>

Before the launch of the Feed-in Tariff Scheme, residential use accounted for the majority of the market. The commercial market grew over time following the launch of the scheme, as seen in the increasing construction of mega solar power facilities (with capacity of 1000 kW or more), which were scarce before the launch.
Wind power generation costs are favorable even compared to thermal and hydro sources. As wind power is cost effective relative to other renewable sources, it is seen as a key to increasing the use of renewable energy. However, it should be noted that it has economies of scale.

66% of areas that have wind speed of over 6.5 meters per second—the level considered necessary to ensure business profitability—are concentrated in Hokkaido (45%) and Tohoku (21%).

Challenges to increase installations of wind power include improving the power grid in sites suitable for wind power generation (part of Hokkaido and Tohoku) and streamlining regulations.

Estimated wind power generation costs by capacity
(by NEDO)

Sites suitable for wind power generation
(part of Hokkaido and Tohoku)

Source: NEDO Renewable Energy Technology White Paper
Current Status of Geothermal Power

- Geothermal power, which has a higher operating rate (70%) compared to other renewable sources of energy, is expected to serve as a long-term stable energy source.
- Japan has the world's third largest reserve of geothermal resources (23,400,000 kW) but has only 520,000 kW of installed capacity.
- The government eased regulations on development in designated national parks and monuments that have abundant geothermal reserves and are concentrated with sites that allows for power generation at low cost (March 2012). Projects are underway in Hokkaido, Tohoku and Kyushu.
- Three Japanese manufacturers, Mitsubishi Heavy Industries, Toshiba and Fuji Electric, account for 70% of the global market for geothermal turbines.

### World geothermal resources

<table>
<thead>
<tr>
<th>Country</th>
<th>Geothermal resources (10,000 kW)</th>
<th>Installed capacity of geothermal power (10,000 kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>3,000</td>
<td>309.3</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2,779</td>
<td>119.7</td>
</tr>
<tr>
<td>Japan</td>
<td>2,347</td>
<td>52.0</td>
</tr>
<tr>
<td>Philippines</td>
<td>600</td>
<td>190.4</td>
</tr>
<tr>
<td>Mexico</td>
<td>600</td>
<td>95.8</td>
</tr>
<tr>
<td>Iceland</td>
<td>580</td>
<td>57.5</td>
</tr>
<tr>
<td>New Zealand</td>
<td>365</td>
<td>62.8</td>
</tr>
<tr>
<td>Italy</td>
<td>327</td>
<td>84.3</td>
</tr>
</tbody>
</table>

### Geothermal reserves in Japan

- Reserves 23,400,000 kW
  - Inside National park: 79%
  - Outside National park: 21%

### Global geothermal turbine market share

- Japan (70%)
  - Toshiba: 25%
  - Mitsubishi: 23%
  - Fuji: 19%
  - Others: 10%

Source: Materials provided by the National Institute of Advanced Industrial Science and Technology, 2007

Source: National Institute of Advanced Industrial Science and Technology, 2011

Source: Bloomberg
7. Energy Efficiency
Japan’s Energy Conservation Efforts after the Oil Crises

- Japan has improved energy efficiency by approx. 40% after the oil crises in the 1970s as a result of positive actions by both public and private industrial sectors.
- Japan intensively introduced "Energy Management System based on Energy Conservation Law", then achieved the lowest level of energy consumption per GDP in the world.

**Primary energy use per real GDP of Japan**

(Oil converted Mt /1 trillion yen)

**Primary energy supply per GDP unit of each country**

(Index : Japan=1.0) (2009)

Source: Total Energy Statistics by ANRE/METI

Calculated according to IEA statistics

Approx. 40% improvement
Energy Conservation Law

- “Energy Conservation Law” was introduced in 1979.
- The Law covers energy consumption in industry, commercial & residential and transportation sectors.
- The Law specifies
  1) the framework which requires the business operators to annually measure and report their energy consumption to the Government,
  2) energy efficiency standards for buildings and houses, and
  3) the “Top Runner program” which is applied to household appliances, equipment and automobiles.

<table>
<thead>
<tr>
<th>Industry sector</th>
<th>Consumer sector</th>
<th>Transportation sector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Commercial sector</td>
<td>Residential sector</td>
</tr>
<tr>
<td>Regulatory measures</td>
<td>✓ Annual reports to the Government by business operators with 1,500 or more kl/yr energy consumption</td>
<td>✓ Periodic reports by freight carriers and consigners</td>
</tr>
<tr>
<td></td>
<td>✓ 15,000 manufacturing plants &amp; offices</td>
<td>✓ Reduction efforts of 1% per year</td>
</tr>
<tr>
<td></td>
<td>✓ Reduction efforts of 1% per year</td>
<td>✓ Energy efficiency standards for buildings and houses (300m² or more)</td>
</tr>
<tr>
<td></td>
<td>✓ Energy efficiency standards for buildings and houses (300m² or more)</td>
<td>✓ Top runner standards for household appliances, equipment, automobiles etc., 28 items in total (Account for about 70% of household energy consumption)</td>
</tr>
</tbody>
</table>
Current Regulatory Scheme at Manufacturing Plants, etc.

- Business operators with overall annual energy consumption (head office, manufacturing plants, branch offices, sales offices, etc.) of at least 1,500kl in crude oil equivalent are subject to regulations.
- Business modes, such as franchised chains of stores, are also considered single business operators and those consuming at least 1,500kl for the whole chain are subject to regulations.

On the basis of energy consumption, about 90% of the industry sector and about 40% of the commercial sector are covered subject to regulations.

Obligation to report periodically

1. Transition of energy unit consumption
2. Status of activities relating to energy conserving measures
3. Obligation to annually report on status of benchmark indices (for subject business lines only), etc.

Measures, such as instructions, public notices and orders (fines in case of violation against orders) implemented when energy conservation activities of a business operator are significantly inadequate.

Guidelines pertaining to energy conservation measures:
- Stipulation of standards (guidelines) based on the Energy Conservation Law as observance items for energy management.
  - Energy conservation measures for business operators overall
    - Maintenance of energy management organization.
    - Allocation of persons in charge.
    - Formulation of policies for activities pertaining to energy conservation targets, etc.
  - Energy conservation measures at individual manufacturing plants and business establishments (Example: Air conditioning systems.)
    - Preparation and implementation of management standards (manuals) pertaining to the following measures:
      - Operational management (operating time, set temperature, etc.).
      - Periodical measurement and recording of temperature, humidity, etc.
      - Periodical maintenance and inspection of facilities.

Numerical targets: Reduction of annual average by at least 1%.

New numerical targets to include in addition to existing targets
Benchmark indices and standards to be targeted
- Currently set business lines: Iron and steel, electric power, cement, paper manufacturing, petroleum refining and chemical.
- Standards to be aimed for: Levels satisfied by most superior business operators in respective industries (10 to 20%).

* Fines imposed when orders are not followed.
The "Top Runner Program" is a mandatory program for companies (manufacturers and importers), to fulfill the efficiency targets within 3 to 10 years, which encourages competition and innovation among the companies without increasing market prices.

Companies make efforts toward those goals, so the program has contributed to improving energy efficiency of consumer electronics and automobiles in Japan.

For instance, we had expected energy efficiency improvements of 16.0km/L for medium class gasoline passenger vehicles in fiscal year 1999, but actually, it attained 19.9km/L.

### Achievement of Top Runner Program

- **Gasoline passenger vehicles**: 48.8% (FY1995→FY2010)
- **Air-conditioners**
  - (Types other than direct airflow & wall-mount): 32.3% (FY1997→FY2007)
- **Electric refrigerators**: 43.0% (FY2005→FY2010)
- **TV sets** (LCD and PDP TVs): 29.6% (FY2004→FY2008)

### Basic mechanism of Top Runner Program

**The case of gasoline passenger vehicles**

- **Current maximum (15.8km/L)**
- **Current maximum (16.0km/L)**
- **2010fy target standard**
- **To improve energy efficiency, setting the target beyond the current maximum level.**
- **2010fy actual fuel efficiency (19.9km/L)**
- **1997fy actual fuel efficiency (12.9km/L)**
- **Achievement of the regulation**
- **Vehicle weight category**
  - (Light class)
  - (Medium class)
  - (Heavy class)
The challenge is to keep consumer efforts focused on energy conservation.

Standard energy conservation

Peak Demand Management

Power demand (kW)

- Power supply
- Demand curve

Peak hours

morning
daytime
night

Improve Energy efficiency of houses and buildings

Promote Energy Management Systems
Energy Conservation Measures in Consumer Sector

**Top Runner Program for Building Materials etc.**

- Items that do not consume energy themselves but contribute to higher efficiency of energy consumption in housing, buildings, or other equipment were added to the Top Runner program.

(Products currently subject to the program): 28 products including passenger vehicles, air conditioners, TVs, Luminaires and refrigerators

(Newly added products): building insulation materials

---

Peak Demand Reduction

**Measures on demand side**

- Consumers’ efforts to reduce the use of electricity from utility grids during the peak demand hours will be able to evaluat.
  
  *For example, using storage batteries, energy management systems in buildings and households, private power generation etc.

- Specifically, the procedures to calculate the target of efforts under the Energy Conservation Law will be reviewed.
“Energy Management System” is a product that systematically works together with other equipment and intelligently manages energy usage with sensors and ICT tools.

For efficient and effective support, the “BEMS Aggregators” provide energy management and operation services to small- and medium-sized buildings.

In future, it is expected that the “BEMS Aggregators” will provide Demand Response (DR) services, in which consumers are allowed to adjust electricity consumption taking into account fees for peak hours, point systems, and megawatt trade.
Handle electricity supply-demand problem with promotion of introduction of HEMS / BEMS, high efficient air conditioners, lighting and hot-water supply.

Pursue energy efficiency of entire systems by managing entire houses and buildings.

In addition, more efficient energy management can be realized by cross-management of houses and buildings, or regional management.

Cooperate by buying equipment such as efficient air conditioners and lighting, and controlling them with HEMS or BEMS.

“Net zero energy” means that net annual primary energy consumption is approximately zero.

Next step in Energy Management
Demonstration of Smart Communities in Japan

Starting in FY2011, large-scale smart community demonstration projects have been proceeding in 4 regions across Japan that constitute representative examples of different concepts, with the participation of many residents, local governments, and corporations.

<table>
<thead>
<tr>
<th>Region</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yokohama City</td>
<td><strong>Wide-area metropolis</strong>&lt;br&gt;Introduction of an energy management system for an existing wide-area metropolis. As the sample number is high (4,000 households), demonstration using a variety of strategies is possible.</td>
</tr>
<tr>
<td>Toyota City</td>
<td><strong>Separated housing</strong>&lt;br&gt;Automatic control of home appliances in 67 homes. Secondary cells equipped in vehicles are used to supply energy to households. Approaches to drivers for reducing a traffic jam</td>
</tr>
<tr>
<td>Keihanna Science City</td>
<td><strong>Housing development</strong>&lt;br&gt;Demand response demonstration based on a point system is being implemented for general households (approximately 700 households) where PV or HEMS automatic control has not been introduced.</td>
</tr>
<tr>
<td>Kitakyushu City</td>
<td><strong>Designated supply area</strong>&lt;br&gt;In an area where power is supplied by Nippon Steel Corporation, a pricing system is being implemented where the energy price fluctuates for 2 hours afterwards in accordance with the state of supply and demand of energy for the day, applicable to 50 business establishments and 230 households.</td>
</tr>
</tbody>
</table>
8. New Technologies
Coal-Fired Thermal Power (Promotion of Low-Carbon Technologies)

Coal-fired thermal power generation in Japan achieved the highest level of efficiency in the world through utilization of efficient technology (Super Critical / Ultra Super Critical) and operation / management know-how. Its efficiency is maintained for long periods after operation.

If the most advanced technology in operation in Japan is applied to coal-fired thermal power generation in the US, China and India, it is estimated that CO2 emission could be reduced by about 1.5 billion tons.

Change in efficiency across the ages

Gross thermal efficiency (%, HHV)

- Coal-fired thermal power generation in Takasago, Japan
- Maintenance of efficiency by appropriate operation
- Designed thermal efficiency
- Efficiency degradation

Coal-fired thermal power generation in developing countries

CO2 emission reduction by application of Japan’s best practices

- Japan: 255 Mt CO2 (2009), 276 Mt CO2 (2011)
- US: 1729 Mt CO2 (2009), 1368 Mt CO2 (2011)
- China: 3262 Mt CO2 (2009), 2451 Mt CO2 (2011)
- India: 785 Mt CO2 (2009), 493 Mt CO2 (2011)


1.47 billion tons
Fuel Cells: Lower cost for Residential FC & expansion forecast

- In 2009, ahead of the rest of the world, Japan was successful in commercializing the Residential Fuel Cell (ENE-FARM). As of December 2013, operating base of 62,000 units. Cumulative goal of 5.3 million units by 2030.

- Support introduction by 2015 based on the assumption that the ENE-FARM system price drops to around ¥700,000-¥800,000 in 2016.

- PEFC (polymer electrolyte fuel cell) is the most common type in circulation in the market. The solid oxide fuel cell (SOFC), which has a high power generation efficiency, was commercialized in 2011.

Residential Fuel Cell expansion scenario

Large-scale trial → Create market via support policies → Build an autonomous market

异味排除のため、加熱排気システムの採用

- Begin introduction subsidies
- End introduction subsidies

Large-scale trial
- 2005
- ¥8 million
- 500 units

Create market via support policies
- 2009
- ¥3.0 mn - ¥3.5 mn
- Roughly 5,000 units
- ¥700,000-¥800,000

Build an autonomous market
- 2015
- ¥500,000-¥600,000

Market scale (units)
- Full-fledged expansion period
- (METI forecast)
- 2020–2030

Sales price (per unit)
- *0.7kW-1.0kW per unit
Vehicle powered by hydrogen-fuel cells

- Vehicles powered by hydrogen fuel cells generate electricity by fuel batteries using hydrogen as fuel and being driven by an electric motor. Vehicles powered by hydrogen fuel cells are suitable for large vehicles traveling long distances while electric vehicles are suited for small vehicles traveling short distances.

- The beginning of vehicles powered by hydrogen cells was GM’s prototype production in 1968. In the 1990’s, Japanese auto manufacturers such as Toyota, Nissan, and Honda also started development. Since 2002, METI has had vehicle and hydrogen filling station demonstrations.

- Hydrogen is inferior to gasoline in the energy density per unit volume by one sixth. However, hydrogen is three times superior to gasoline in the energy density per unit weight and thus hydrogen becomes available for automobile energies by being compressed. Also, hydrogen can be produced from various energy sources such as fossil fuel and renewable energies.
Current status on vehicle powered by hydrogen-fuel cells

- Current technology achieves cruising distance and fuel filling time equivalent to gasoline cars.
- Japan will deploy 100 commercial hydrogen power stations in three years, that mainly focus on the four large metropolitan areas, namely Tokyo, Aichi, Osaka, and Fukuoka.

Joint development with foreign manufactures

<table>
<thead>
<tr>
<th>Toyota, BMW</th>
<th>Nissan, Daimler, and Ford</th>
<th>Honda, GM</th>
</tr>
</thead>
</table>

※Source: Toyota motor company

Plan for hydrogen stand deployment until 2015

- 50 stations
  - Federal Ministry for Transport, Building and Housing, Germany

- 68 stations
  - California Fuel cell partnership

- 43 stations
  - Korean government

- 100 stations
  - Japan’s reconstruction strategy