NEDO’s Activities for Promotion of Renewable Energy Technologies

May 19, 2014
Takashi NAKAYAMA
Executive Director
New Energy and Industrial Technology Development Organization (NEDO)
1. Outline of NEDO
2. Japan’s Energy Policy
3. NEDO’s Promotion of Renewable Energy Technologies
4. Energy System Optimization
5. Development of Hydrogen and Fuel Cell Technologies
1. Outline of NEDO
2. Japan’s Energy Policy
3. NEDO’s Promotion of Renewable Energy Technologies
4. Energy System Optimization
5. Development of Hydrogen and Fuel Cell Technologies
New Energy and Industrial Technology Development Organization (NEDO)

Mission:
- Address energy and global environmental problems
- Enhance Japan’s industrial technologies development

Organization: Established in 1980; reorganized in 2003 as an incorporated administrative agency under the Ministry of Economy, Trade and Industry of the Government of Japan

Head Office: Kawasaki City, Japan

Personnel: About 800

Budget: Approximately US$1.25 Billion (FY2013)

Chairman: Mr. Kazuo Furukawa
NEDO’s Science and Technology

Basic Research
- Renewable energy
- Energy conservation
- Energy storage
- Smart community

Technology Development
- Electronics/ICT
- Materials/nanotech
- Water treatment
- Environment/clean coal
- Robotics

Demonstration
- Bio/medical
Service Robot Demonstration Project  
- Human Assistive Limb (HAL) in Bochum -

In collaboration with NRW, NEDO has started a demonstration project to develop the HAL service robot through the following:

1. Establishment of testing environment  
   a) Integrated information management system for using HAL  
   b) Local staff training

2. Demonstration project for patients suffering from trauma or medical disorders (e.g., spinal cord injury, stroke, brain disorder, neurological disorder, or muscular dystrophy)  
   a) Protocol preparation  
   b) Data collection  
   c) Data analysis

3. Expansion of insurance coverage beyond industrial injury insurance
Smart Community Project in Speyer

In collaboration with the City of Speyer, NEDO will start a feasibility study for a smart community project. In the project, an energy efficient system combined with the existing home energy management system (HEMS) will be developed. The goal is to control electricity generated by a PV system installed on housing complex roofs and to distribute the electricity for home energy use, battery energy storage and heat pump thermal energy storage.
1. Outline of NEDO
2. Japan’s Energy Policy
3. NEDO’s Promotion of Renewable Energy Technologies
4. Energy System Optimization
5. Development of Hydrogen and Fuel Cell Technologies
Energy Consumption Trends in Japan

Sources: Comprehensive Energy Statistics and Annual Report on National Accounts
Japan Faces an Unprecedented Challenge: The Great East Japan Earthquake and Aftershocks

Earthquakes:
- M - 9.0 quake (March 11)
- M - 7 class 5 times
- M - 6 class 71 times
- M - 5 class 380 times

(As of May 16th, 2013)
New Challenges on Energy Sources After the Great East Japan Earthquake

1. Increased dependence on imported fossil fuels

- Japan’s dependence on imported fossil fuels for electricity generation increased to 88% in FY2012 following the Great East Japan Earthquake. This is higher than first oil crisis level of 76%.

2. Impact on Japanese people and economy

1) Higher fuel costs due to substitution of thermal power for nuclear power

   - Japan’s fuel costs rose by an estimated ¥3.6 trillion in FY2013, increasing the financial burden on Japanese citizens by about ¥30,000 per person.

2) Sharp increase in cost of electricity

   - Electricity costs rose about 20% from the pre-Great East Japan Earthquake level. The monthly electricity bill for a standard household increased from ¥6,300 to ¥7,900.

3. Global warming caused by increased \( \text{CO}_2 \) emissions

   - Carbon dioxide emissions of general electricity utilities increased by 110 million tons. This accounts for about 9% of total emissions in Japan.

Source: Agency for Natural Resources and Energy
Trends in Japan’s Balance of Trade

*Information for FY2013 is preliminary.

Source: Mainichi online news
Principles of new energy policy

Principles of energy policy and viewpoints for reformation:

- Optimum energy mix
- 3E (Energy Security, Economic Efficiency, Environment) + S (Safety)

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.

3. **Coal**
   - Revaluating 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.

Source: Agency for Natural Resources and Energy
Constitution of Electric Power Supply Corresponding to Demand

Source: Agency for Natural Resources and Energy
Three objectives of electricity system reform

1. Securing a stable supply of electricity
2. Reducing electricity rates to the maximum extent possible
3. Expanding choices for consumers and business opportunities

Three steps of roadmap for reform

- **1st Stage**: Around 2015
  - Cabinet decision on Policy of Electricity System Reform
  - Establishment of the Organization for Cross-regional Coordination of Transmission Operators (OCCTO)

- **2nd Stage**: Around 2016
  - Full retail competition
  - Transitional period of electricity retail rate regulation

- **3rd Stage**: Around 2018 through 2020
  - Abolishment of electricity retail rate regulation
  - Legal unbundling of transmission/distribution sector

Source: Adapted from METI
Renewable Energy Penetration in Japan

- A feed-in tariff has provided a strong incentive for **accelerated penetration of renewable energy**.
- Introduction of facilities generating renewable energy as of January 31, 2014 has increased by 37% after the feed-in tariff scheme was introduced.

Penetration rate of renewable energy in Japan

- **Average annual growth rate:** 8%
- **Average annual growth rate:** 13%

Source: Prepared by NEDO from material for the 3rd meeting of the Basic Policy Subcommittee of the Advisory Committee for Natural Resources and Energy, Agency for Natural Resources and Energy.
## Increase in Installed Renewable Power Generation Capacity Following Introduction of Feed-in Tariff (FiT)

<table>
<thead>
<tr>
<th></th>
<th>Capacity as of end of June 2012</th>
<th>Capacity as end of January 2014</th>
<th>Total installed capacity approved by METI or local governments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before introducing FiT</strong> (Cumulative basis)</td>
<td><strong>19 months after introducing FiT</strong> (Cumulative basis)</td>
<td>From July 2012 to the end of January 2014</td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>560*</td>
<td>1,301.4 (741.4)</td>
<td>3,114.4</td>
</tr>
<tr>
<td>Wind</td>
<td>260*</td>
<td>267.4 (7.4)</td>
<td>95.7</td>
</tr>
<tr>
<td>Conventional hydro</td>
<td>960*</td>
<td>960.5 (0.5)</td>
<td>25.3</td>
</tr>
<tr>
<td>Biomass</td>
<td>230*</td>
<td>241.9 (11.9)</td>
<td>84.6</td>
</tr>
<tr>
<td>Geothermal</td>
<td>50*</td>
<td>50.1 (0.1)</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,060*</td>
<td>2,821.3 (761.3)</td>
<td>3,322.3</td>
</tr>
</tbody>
</table>

* Figures are rounded.

** Figures in parentheses show increases.

Unit: Ten thousand kW

Source: Prepared by NEDO based on data provided by the Ministry of Economy, Trade and Industry.
Renewable Energy Policy

In July 2012, **a fixed price purchase (feed-in-tariff) system was initiated.** Under this system, electric utilities are obligated to purchase renewable electricity from renewable energy producers such as companies and individuals at the procurement price for the procurement period specified by the government. Renewable energy includes solar photovoltaic, wind power, geothermal, small/medium-scale hydroelectric and biomass.

### Procurement price and period for new entrants as of FY2014

<table>
<thead>
<tr>
<th>Solar photovoltaic power generation</th>
<th>10 kW or more</th>
<th>10 kW or less</th>
<th>Wind power generation</th>
<th>20 kW or more</th>
<th>20 kW or less</th>
<th>Offshore wind power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price (excluding tax)</td>
<td>32 yen</td>
<td>37 yen</td>
<td>Purchase price (excluding tax)</td>
<td>22 yen</td>
<td>55 yen</td>
<td>36 yen</td>
</tr>
<tr>
<td>Purchase period</td>
<td>20 years</td>
<td>10 years</td>
<td>Purchase period</td>
<td>20 years</td>
<td>20 years</td>
<td>20 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Small and medium hydropower</th>
<th>Less than 200 kW</th>
<th>From 200 kW to less than 1000 kW</th>
<th>From 1000 kW to less than 30,000 kW</th>
<th>Geothermal power</th>
<th>15,000 kW or more</th>
<th>15,000 kW or less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price (excluding tax)</td>
<td>Utilizing existing head race channels</td>
<td>25 yen</td>
<td>21 yen</td>
<td>14 yen</td>
<td>Purchase price (excluding tax)</td>
<td>26 yen</td>
</tr>
<tr>
<td>Purchase period</td>
<td>20 years</td>
<td>20 years</td>
<td>20 years</td>
<td>Purchase period</td>
<td>15 years</td>
<td>15 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biomass</th>
<th>Methane fermentation gasification power generation</th>
<th>Unused wood-combustion power generation</th>
<th>General wood-combustion power generation</th>
<th>Waste combustion power generation</th>
<th>Recycled wood combustion power generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price (excluding tax)</td>
<td>39 yen</td>
<td>32 yen</td>
<td>24 yen</td>
<td>17 yen</td>
<td>13 yen</td>
</tr>
<tr>
<td>Purchase period</td>
<td>20 years</td>
<td>20 years</td>
<td>20 years</td>
<td>20 years</td>
<td>20 years</td>
</tr>
</tbody>
</table>

Source: Adapted from data on Agency for Natural Resources and Energy web site.
1. Outline of NEDO
2. Japan’s Energy Policy
3. NEDO’s Promotion of Renewable Energy Technologies
4. Energy System Optimization
5. Development of Hydrogen and Fuel Cell Technologies
Challenges for Renewable Energy Introduction

- Cost Reduction
- Diversifying Applications
- Enhancement of New Business Entry to Market
- Utilization of Local Resources
Challenge: Cost Reduction

Solar photovoltaic (PV)

Power generation cost

- Reduction of power generation cost through contribution of NEDO projects
- Equivalent to commercial electricity price in Japan
- Equivalent to conventional power generation cost in Japan

Power generation cost:
- 26 yen/kWh, equivalent to commercial electricity price in Japan

Timeline:
- 2013
- 2015
- 2020
- 2025
- 2030
Challenge: Cost Reduction

- From on-shore to off-Shore
- Trend to further increases in scale
Challenge: Diversifying Application
Solar Photovoltaic (PV)

- Technology development for promoting installation in unused areas

1. Buildings
   - Building wall surfaces, condominium balconies, etc.

2. Farming-related areas
   - Plastic greenhouses, cattle stalls, upper spaces over cultivated land, cultivated land surfaces, etc.

3. Sloping land
   - Cultivated land border slopes, forested mountains, embankment areas, noise barriers, etc.

4. Water surface
   - Retention basins, ponds, lakes, sea surface, etc.

Challenge: Diversifying Application

Solar Photovoltaic (PV)

Realize higher value-added of solar photovoltaic power generation by means of exploring new uses, designability, etc. with a view to enhancing competitiveness by differentiation and expansion of use as well as creation of new businesses by value addition.

Design Solar Lantern

Solar Signage

Power generating sunshades

The red-framed area represents transparent type dye-sensitized solar cells.
Challenge: Enhancement of New Business Entry to the Market

Development and establishment of a solar radiation database, wind resource map and biomass reserve map
Challenge: Enhancement of New Business Entry to the Market

Current process for environmental impact assessment of wind and geothermal power takes three to four years

<table>
<thead>
<tr>
<th>Current process</th>
<th>Image of reduced process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary environmental impact document</td>
<td>Primary environmental impact document</td>
</tr>
<tr>
<td>Scoping document</td>
<td>Scoping document</td>
</tr>
<tr>
<td>Environmental impact survey (Local survey, forecast and assessment)</td>
<td>Target period shortened</td>
</tr>
<tr>
<td>Drafting of environmental impact statement (EIS)</td>
<td>Drafting of environmental impact statement (EIS)</td>
</tr>
<tr>
<td>EIS</td>
<td>EIS</td>
</tr>
</tbody>
</table>
Challenge: Utilization of Local Resources

Biomass energy
Development of biomass technologies to meet local needs and establishment of a local recycling renewable energy system

1. R&D of wet methane fermentation technology with glycerin
   - Anaerobic digestion
   - Crude glycerin
   - Garbage
   - Cattle manure
   - Digester tank
   - Utilization of digested manure

2. Development of desulfate system with pure oxygen
   - Bio desulfur
   - Chemical desulfur tank
   - Utilization of biogas
   - Pure oxygen

Thinning woods, branches and leaves
   - Collection
   - Unmanned grapple
   - Mobile chip crusher
   - Full-trailer transportation
   - Dried chips

Demonstration plant for biogas production from cattle manure and food waste in Nanae, Hokkaido

Wood biomass gasification and power generation plant utilizing thinning woods in Koshu City, Yamanashi Prefecture
Challenge: Utilization of Local Resources

Geothermal energy

NEDO pursues technology development of geothermal energy for national parks and thermal springs as follows.

◆ Development of components for environment-conscious high-performance geothermal power generation systems

◆ Development of binary power generation systems for efficient utilization of low-temperature geothermal resources
1. Outline of NEDO
2. Japan’s Energy Policy
3. NEDO’s Promotion of Renewable Energy Technologies
4. Energy System Optimization
5. Development of Hydrogen and Fuel Cell Technologies
Energy System Optimization

- Grid Stabilization
- Energy Storage
- Energy Efficiency
  - Efficient energy production
  - Efficient energy transmission
  - Efficient energy use
Grid Stabilization

Grid support
Development of a high-accuracy wind power forecasting system to avoid sudden output fluctuation

I. Optimization based on forecast

II. Optimization based on control

III. Optimization based on management
Energy Storage
Ongoing NEDO Energy Storage Technology Projects

**Elemental Technology**

**Common Fundamental Technology**
Development of Technology for Assessment of Next-generation Battery Material (FY2010-FY2014, FY2013-FY2022)

**Applied and Practical Technology**

**Vehicle and Other Uses**
- Applied and Practical LiB Development for Automobiles and Multiple Applications (FY2012-FY2016)

**Stationary Use**

**Demonstrative research**
- Applied and practical technology development

**Elemental technology development**
- Advanced fundamental research
Efficient Energy Production

High-efficiency Coal Energy Production

Japan has achieved the world’s highest efficiency levels for coal-fired thermal power generation technology.

![Graph showing thermal efficiency comparison between countries over years.]

- **USC**: Ultra-supercritical
- **IGCC**: Integrated coal gasification combined cycle
- **CCS**: Carbon dioxide capture and storage

![Images of USC and IGCC power plants.]

- **USC power plant**: Misumi coal-fired power plant
  - 1000 MW, 24.5 MPa x 600°C/600°C
  - Operation started in 1998

- **IGCC plant**: Nakoso IGCC demonstration plant
  - 250 MW operation started in 2007

---

*International comparison of fossil power generation efficiency (ECOFYS) (2010)*
Efficient Energy Transmission
High-temperature Superconducting Cable

In Grid Demonstration of Superconducting Cable

- Japan’s first high-temperature superconducting cable verification project
- System has exhibited stable control for more than one year
- Three-in-one superconducting cable with capacity of 200 MVA
### Efficient Energy Use

#### Energy Conservation Building

Model Project for Reducing Energy Consumption in a Commercial Building (FY2010-FY2013)

<table>
<thead>
<tr>
<th>1. <strong>Project site:</strong></th>
<th>Amari Watergate Hotel, Thailand</th>
</tr>
</thead>
</table>
| 2. **Project purpose:** | To implement energy efficiency measures through introduction of high efficiency equipment  
To reduce energy consumption through use of inverters and optimize energy conservation using BEMS |
| 3. **Counterpart:** | Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy |
| 4. **Japan side:** | The Chugoku Electric Power Co., Inc. |
| 5. **Energy conservation:** | 31.3 TJ/y |

---

**Schematic diagram of project**

- **Amari**
- **Heat exchanger**
- **Heat pump**
- **LED**
- **Insulator**
- **Boiler**
- **Cooling tower**
- **Inverter control**
- **Chiller**
- **Fan belt**
- **BEMS**
- **AHU**
- **Laundry**
- **Boiler**
- **AHU: Air handling unit**
- **Hot water system**
- **Corridor**
- **Guest room**
- **Lobby**
- **Meeting room**

---

Amari Watergate Hotel
1. Outline of NEDO
2. Japan’s Energy Policy
3. NEDO’s Promotion of Renewable Energy Technologies
4. Energy System Optimization
5. Development of Hydrogen and Fuel Cell Technologies
Why Promoting Hydrogen Energy Technologies?

Because hydrogen is ....

• **Clean energy**
  It has no air pollutants or greenhouse effect gas emissions.

• **Flexible secondary energy**
  It can be produced from various resources and also meet a wide range of demand.
The fuel cell cogeneration system, called “ENE-FARM”, produces electricity by a chemical reaction between hydrogen extracted from city gas or LP gas and oxygen in the air. The heat generated as a byproduct is used for supplying hot water.
The current “ENE-FARM” system sales price is one-fourth of the original price. Cumulative sales total about 70,000 units.

Transition of “ENE-FARM” sales price and number of installed units

Large-scale demonstration and development of peripheral equipment
3,500 units

Cumulative sales data are from the Advanced Cogeneration and Energy Utilization Center Japan. Data for FY2013 shows a cumulative sales figure only to September 2013. ENE-FARM sales price data up to FY2009 are from Demonstration of Residential Polymer Electrolyte Fuel Cell (PEFC) Systems for Market Creation by NEDO. Data for and after FY2010 was prepared by NEDO based on news sources.
**“ENE-FARM” Features and Positive Impact**

**High energy efficiency**
A combined heat and power system has 90% or greater energy efficiency.

**Positive impact of “ENE-FARM”**

- Primary energy reduction: 12,230 MJ per year (Energy reduction of 23%)
- CO₂ reduction: 1,330 kg CO₂ per year (CO₂ reduction of 38%)

Energy saving is equivalent to 18.5 barrels of oil.
*One barrel of oil contains 18 liters.*

Equivalent to CO₂ amount absorbed by 2,460 square meters of forest land.

---

Japan Revitalization Strategy
(Cabinet decision in June 2013)

**Goal:** Deployment of 5.3 million units

↓

Seven million tons of CO₂ emissions can be reduced annually.
Fuel cell vehicles will be out in 2015.

Toyota FCV concept

Honda FCEV concept

Nissan TeRRA SUV concept

Nissan plans to start sales in 2017.

Sources: Official company websites
Hydrogen Stations

- Development of a high pressure hydrogen tank with a pressure of 70 MPa
- Commercial-scale hydrogen stations opened in 2013

Ebina City opened Japan’s first official hydrogen station in April 2013.
Japan is introducing hydrogen technologies to establish a new social system that utilizes renewable energies to the maximum extent.
NEDO’s Multifaceted approaches

Production

Transmission and Storage

Consumption
Vielen Dank!

NEDO website: