Energy Situation of Japan and Policy Review and NEDO’s Activities

April 20th, 2018
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Executive Director
New Energy and Industrial Technology Development Organization (NEDO)
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3. Demonstration project on Germany
4. Other efforts toward climate change
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2. Hydrogen strategy
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Japan’s Energy Supply Structure

Japan’s Primary Energy Source

* “Renewables etc.” consists of solar power (1.5%), wind power (0.2%), geothermal heat (0.1%), and biomass (1.9%), effective recovery use of wasted energy (2.2%).

Source: Prepared based on “Comprehensive Energy Statistics 2016” issued by the Agency for Natural Resources and Energy.
Energy demand and primary energy supply

**Energy demand**

- Electric power: 25%
  - 361 million kl, 2013 (Actual result)
- Heat, gasoline, town gas, etc.: 75%
- Final energy consumption: 326 million kl

**Primary energy supply**

- Electric power: 28%
  - 361 million kl, 2030 (After energy conservation measures)
- Heat, gasoline, town gas, etc.: 72%

**Thorough energy efficiency and conservation**

- 50.3 million kl
- 13% lower than before the implementation of the energy conservation measures
- Economic growth: 1.7%/year

**2030**

- Primary energy supply:
  - Renewable energy: 13 to 14%
  - Nuclear power: 10 to 11%
  - Natural gas: 18%
  - Coal: 25%
  - LPG: 3%
  - Petroleum: 30%
- 489 million kl, Self-sufficiency rate 24.3%

*Values are approximate.*
Major Stream of Energy Shifts

First shift
From domestic coal to petroleum (1960s)

Energy self-sufficiency rates
1960 1970 58% → 15%

Second shift
Two oil crises (1970s)

Electricity rates (1970=100)
1970 1980 100 → 203

Third shift
Liberalization of markets and global warming (1990s-)

Kyoto Protocol (1997)

Fourth shift
Great East Japan Earthquake and Fukushima Accidents (2011-)

We are here

Fifth shift
Paris Agreement 2050 Reduction targets (2030-)

1960 - 1970 - 1990 - 2011 - 2030 -
Strategic Energy Plan 2014 setting goals to be achieved by 2030; progress made therein (as of FY2016)

[i] Scenario for cutting CO2 emissions
→ From 10% (2013) to 17% (2016) (44% in 2030)
(approx. renewable energy: 15%; nuclear energy: 2%)

[ii] Scenario for improving energy self-sufficiency rates
→ From 6% (2013) to 8% (2016) (24% in 2030)

[iii] Scenario for curbing costs
→ Electricity rate hike by 30% after the occurrence of Great East Japan Earthquake
(recently by 10% after this)
(oil price ↓, purchase cost of renewable energy ↑, coal-fired as an alternative for nuclear ↑)

Identifying issues standing in the way of realization

2030 = Working with a focus on realization

Paris Agreement
- Developed countries share very ambitious, high-level goals for decreasing greenhouse gas emissions by 2050.

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<tbody>
<tr>
<td>2030</td>
<td>Down by 26%</td>
<td>Down by 26-28%</td>
<td>Down by 30%</td>
<td>Down by 40%</td>
<td>Down by 40%</td>
</tr>
<tr>
<td>2050</td>
<td>Down by 80%</td>
<td>Down by 80%</td>
<td>Down by 80%</td>
<td>Down by 80-95%</td>
<td>Down by 75%</td>
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* As for Japan, no base year for the 2050 target is determined yet.
* As for the U.S., 2025 target = decrease emissions by 26-28% from 2005 level.

Establish industrial structures and policies under which Japan can engage in technological innovation and investment as well as in contributions to related efforts overseas, as indispensable initiatives

2050 = pursuing all possibilities

Advisory Committee for Natural Resources and Energy

Round Table for Studying Energy Situations
Recommendations by the Round Table for Studying Energy Situations
- Initiatives for Energy Transitions -

- Possibility → Ambitious scenario: Energy transitions and taking on decarbonization through the transitions

- Uncertainty → Multiple track scenario: Seeking possibility in all choices
  ※ Currently, no such energy source that is economic and fully decarbonized exists.

- Unclarity → Scientific review mechanism: Flexible determination of priority issues in light of the latest situations
  ※ All consequences derived from geopolitical situations, geoeconomic situations and inter-technology competitions are unclear.

- Energy transitions in complicated and uncertain environments
  → Sophistication of energy policy requirements; "3E+S"
  ※ Safety, Energy security, Economic efficiency, Environment

- Accidents at the Fukushima Daiichi Nuclear Power Station
  → Efforts for renewable energy aiming to place economically-independent decarbonized major power sources, meanwhile decrease the dependency on nuclear energy

- Full-scale efforts for successful energy transitions
  [i] Domestic policy/diplomacy; [ii] enhancement of competitiveness of industries and reconstruction of infrastructures; [iii] finance

2. Hydrogen strategy

3. Demonstration project on Germany

4. Other efforts toward climate change
“Basic Hydrogen Strategy” (Prime Minister Abe’s Initiative)

- World’s first national strategy
- 2050 Vision: position H\textsubscript{2} as a new energy option (following Renewables)
- Target: make H\textsubscript{2} affordable ($3/kg by 2030 \Rightarrow $2/kg by 2050)

3 conditions for realizing affordable hydrogen

- **Supply**
  1. Inexpensive feedstock (unused resources, renewables)
  2. Large scale H\textsubscript{2} supply chains

- **Demand**
  3. Mass usage (Mobility \Rightarrow Power Generation \Rightarrow Industry)

Key Technologies to be Developed

- **Production**
  - Electrolysis System
  - Gasification + CCS

- **Transportation**
  - Energy Carrier (LH\textsubscript{2}, MCH, NH\textsubscript{3}, etc.)

- **Use**
  - Fuel Cells (Mobility, Generation)
  - H\textsubscript{2}-fired Generation
## Direction of Activities to Realize a “Hydrogen Society”

### Production

- **Domestic fossil fuels**
  - City gas
  - LP gas
  - Byproduct hydrogen

- **Overseas unused energy**
  - Brown coal
  - Byproduct hydrogen
  - Overseas renewable energy

- **Renewable energy**
  - Solar power
  - Wind power

- *Use hydrogen as a means of energy storage (absorb fluctuations in intermittent RES)*

### Transportation and supply (supply chain)

- **Hydrogen station**
  - City gas pipeline/LPG supply network
  - Liquefied hydrogen lorry
  - Hydrogen pipeline

- **Fuel cell vehicles** (e.g., FCV, FC bus, etc.)
  - Installation of 100 stations nationwide
  - Promotion of regulatory reform for cost reduction
  - Demonstration of the world’s first international hydrogen supply chain in 2020

### Use

- **Fuel cell cogeneration (e.g., Ene-Farm)**
  - For Business and Industry use, some models have already been launched in 2017

- **Hydrogen power generation** (CO₂-free thermal power plants)
  - Combined heat and power supply using hydrogen cogeneration in Kobe in early 2018

- **Use in the industrial sector (Power-to-X)**
  - Enter service in Tokyo in March 2017
  - 100 buses by 2020

- **Other**
  - Demonstration of large-scale power-to-gas @Fukushima/aiming for use in the 2020 Tokyo Olympic and Paralympic Games

- **Reforming**
  - Byproduct hydrogen
  - Gasification
  - CCS

- **Water electrolysis**
  - Large-scale hydrogen ocean transportation network

- **Liquefied hydrogen lorry**
  - Demonstration of large-scale power-to-gas @Fukushima/aiming for use in the 2020 Tokyo Olympic and Paralympic Games

- **Combined heat and power supply using hydrogen cogeneration in Kobe in early 2018**

- **Over 230,000 units installed**

- **2,400 vehicles installed**
  - 40,000 vehicles by 2020
Scenario for Basic Hydrogen Strategy

### Present picture

**Supply**
- Fossil fuel-based hydrogen (by-product hydrogen, natural gas reformation)
- Supply chain development and demonstration, scale-up
- Developing international hydrogen supply chains
- Developing domestic Power-to-Gas for renewable hydrogen supply

- **Hydrogen volume (t/year):**
  - (Present) 200
  - (2020) 4k
  - (2030) 300k (commercial supply chain capacity)
  - Target future picture: 5~10m + α (depending heavily on consumption for power generation)

- **Cost ($/kg):**
  - (Present) ~10
  - (R&D stage) —

- **Power generation**
  - Demonstrating hydrogen power generation, establishing an environmental value assessment system
  - Reference comparison:
    - Natural gas imports: 85 million t/y
    - Natural gas import price: $1.6/kg*
    - Unit LNG power generation cost: ¥12/kWh
    - Fossil power generation capacity: 132GW
    - Number of gas stations: 31,500
    - Number of passenger cars: 62 million

### 2030

- **Hydrogen Stations (locations):**
  - (Present) 100
  - (2020) 160
  - (2030) some 900
  - Halving hydrogen station costs

- **FCV (units):**
  - (Present) 25k
  - (2020) 40k
  - (2030) 800k
  - FCV/Hydrogen stations becoming independent

- **FC buses (units):**
  - (Present) 2
  - (2020) 100
  - (2030) 1.2k
  - *2nd half of the 2020s

- **Forklifts (units):**
  - (Present) 40
  - (2020) 500
  - (2030) 10k

### Target future picture

- **Use**
  - Replacing gas power generation
  - (Reference) 5-10 million t represents 15-30 GW in power generation capacity

- **Mobility**
  - Replacing gas stations
  - Replacing conventional gasoline mobility
  - Introducing large FCVs
  - Replacing traditional residential energy systems

- **Utilization of fuel cells**
  - Ene-Farms becoming independent
  - Ene-Farms becoming independent

- **Roadmap” targets**
  - Hydrogen volume: 200-300k
  - Cost: ¥17/kWh (Commercial stage)
  - Replacing gas power generation

*Conversion based on hydrogen’s calorific value

**Utilization of fuel cells**
- 230k
- Ene-Farms becoming independent
- 5.3m

**Location**
- Present picture: 2020
- 2030
- Target future picture: 2030

**Scenario for Basic Hydrogen Strategy**

References:
- (1/3 or less)
- (1/5 or less)
- ¥17/kWh
- ¥12/kWh
- ¥12/kWh
### Next Generation Vehicle Target

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>2017 (Result)</th>
<th>2030 (Target)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline Vehicle</td>
<td>63.97%</td>
<td>30~50%</td>
</tr>
<tr>
<td><strong>Next Generation Vehicle</strong></td>
<td><strong>36.02%</strong></td>
<td><strong>50~70%</strong></td>
</tr>
<tr>
<td>Hybrid Vehicle</td>
<td>31.2%</td>
<td>30~40%</td>
</tr>
<tr>
<td>Electric Vehicle</td>
<td>0.41%</td>
<td>20~30%</td>
</tr>
<tr>
<td>Plug-in Hybrid Vehicle</td>
<td>0.82%</td>
<td></td>
</tr>
<tr>
<td>Fuel Cell Vehicle</td>
<td>0.02%</td>
<td>~3%</td>
</tr>
<tr>
<td>Clean Diesel Vehicle</td>
<td>3.52%</td>
<td>5~10%</td>
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</table>

【Source】Next Generation Automotive Strategy 2010 Automotive Industrial Strategy 2014

The Japanese government is aiming at increasing the market share of Next Generation Vehicles among new car sales to between 50% and 70% by 2030.
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Outline of NEDO

As Japan's largest public management organization promoting research and development as well as the dissemination of energy, environmental and industrial technologies, NEDO has a crucial mission to carry out.

Addressing energy and global environmental problems
Enhancement of Japan’s industrial technologies

Chairman: Mr. Hiroaki Ishizuka
Organization: - Incorporated administrative agency under the Ministry of Economy, Trade and Industry (METI) of the Japanese government
- Established in 1980
Location: Kawasaki City, Japan
Personnel: About 940
Budget: Approximately 1.1 billion EUR (2017 fiscal year)
Germany: Speyer
Local Energy Production and Consumption Project

Environment in German electricity business before the start of demonstration

- **German Government**
  - 1998: Full liberalization of electricity market
  - 2000: Introduction of feed-in tariff policy of renewable energy generation
  - 2050: Set a target of 80% renewable energy rate

- **Utility Company**
  - Increase facility investment of distribution system due to increase in reverse power flow
  - In intensified liberalization competition, seek a new business model other than selling electricity in preparation for lower sales electricity due to dissemination of PV

- **Consumer**
  - Electricity price raised and economic burden increased due to renewable energy surcharge
  - Due to the decrease of FIT, it is better to consume at house as economic merit increases rather than selling solar power generated electricity to utilities

In Germany, it is anticipated that local energy production and consumption will progress

Combining technologies such as electricity storage, thermal storage, information and communication in Japan to establish local energy production and consumption technology is regarded effective
**Grid Tied Model**

- PV
- Sell all PV-generated electricity
- Purchase electricity
- Utility grid

**Self-consumption Model**

- PV
- Sell surplus electricity
- Self-consume
- Purchase electricity for shortfall
- Utility grid

- Heat pump
- Hot water
- Lithium ion battery
Germany: Speyer
Local Energy Production and Consumption Project

※1 MOU: Memorandum of Understanding
※2 ID: Implementation Document
Germany: Speyer
Local Energy Production and Consumption Project

Type A
For each household
(16 Room)

PV
HEMS
Battery
Heat pump

Ginsterweg

Type B
For building
(16 Room)

PV
HEMS
Battery
Heat pump

Rainer-Maria-Rilke-Weg
Average electricity consumption per household is **2028 kWh** in one year (2017/1~2017/12)

60% of electricity is covered by PV power generation throughout the demonstration period.
PV generation per household (amount of self consumption)

Of the PV power generation, self-consumption rate per household is **67%** (2017/1~2017/12)
 Improvement effect of self-consumption rate by battery and HP is **39%**

<table>
<thead>
<tr>
<th>Year</th>
<th>To GRID</th>
<th>To Room</th>
<th>To Heat pump</th>
<th>To Battery</th>
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<tbody>
<tr>
<td>2016</td>
<td>370.0</td>
<td>177.5</td>
<td>226.5</td>
<td>11.8</td>
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<tr>
<td>2017</td>
<td>306.8</td>
<td>122.1</td>
<td>278.3</td>
<td>44.6</td>
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<td>2018</td>
<td>319.6</td>
<td>132.5</td>
<td>317.3</td>
<td>44.4</td>
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<tr>
<td>2019</td>
<td>287.5</td>
<td>113.2</td>
<td>368.9</td>
<td>44.3</td>
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**Self consumption rate (%)**

<table>
<thead>
<tr>
<th>Month</th>
<th>JUL</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APR</th>
<th>MAY</th>
<th>JUN</th>
<th>JUL</th>
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<th>NOV</th>
<th>DEC</th>
<th>JAN</th>
<th>FEB</th>
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<tbody>
<tr>
<td>2016</td>
<td>18.1</td>
<td>22.2</td>
<td>29.3</td>
<td>37.4</td>
<td>43.4</td>
<td>59.2</td>
<td>61.2</td>
<td>52.4</td>
<td>81.8</td>
<td>80.2</td>
<td>73.9</td>
<td>62.5</td>
<td>79.9</td>
<td>80.0</td>
<td>90.0</td>
<td>133.5</td>
<td>16.6</td>
<td>135.2</td>
<td>113.2</td>
<td>206.7</td>
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<tr>
<td>2017</td>
<td>27.5</td>
<td>44.6</td>
<td>57.9</td>
<td>30.2</td>
<td>199.2</td>
<td>71.7</td>
<td>62.5</td>
<td>62.0</td>
<td>82.0</td>
<td>68.9</td>
<td>186.6</td>
<td>135.2</td>
<td>113.2</td>
<td>287.5</td>
<td>40.2</td>
<td>128.2</td>
<td>21.8</td>
<td>31.2</td>
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**CO2 reduction (kg-CO2)**

<table>
<thead>
<tr>
<th>Year</th>
<th>JUL</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
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<tbody>
<tr>
<td>2016</td>
<td>47</td>
<td>56</td>
<td>52</td>
<td>33</td>
<td>17</td>
<td>17</td>
<td>29</td>
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<td>53</td>
<td>51</td>
<td>38</td>
<td>15</td>
<td>9</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>2017</td>
<td>24.3</td>
<td>28.0</td>
<td>21.8</td>
<td>35.5</td>
<td>31.2</td>
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Total 717kg-CO2 per household

This amount is same as that 51 trees absorb in a year (equivalent to 816 in 16 households)
8 Electricity consumption

- The 16 households power consumption was about 39,000 kWh/year in 2017.
- PV power covered approximately 70% of electricity consumption in 2017.
9 PV-generation

- Self-consumption rate was 88% in 2017.
- Battery and HP increased the self-consumption rate by 34% in 2017.

Total 17,175 kg CO₂ = CO₂ amount absorbed by 1,228 trees per year
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What’s ICEF?

About ICEF

- Initiative of Prime Minister Shinzo Abe
- Held in Tokyo every October
- Leaders in academia, industry and government
- Solving climate change through innovation

<Plenary session>

<Networking>
4th Annual Meeting

- **Date:** October 4-5, 2017
- **Main Theme:** Net-zero anthropogenic CO$_2$ emissions
- **Participants:** 1,000+ experts from about 80 countries

Source: IPCC WG1 AR5, SPM, 2013
Outcome of ICEF2017

ICEF Statement

- Ultimate necessity of net-zero CO2 emissions
- Importance of technology innovation
- Promotion of social innovation
- Role of the industrial sector
- Strategy to accelerate innovation in a holistic system
SAVE THE DATE

Innovation for Cool Earth Forum
5th Annual Meeting
OCTOBER 10-11 2018 TOKYO
http://www.icef-forum.org/
http://www.nedo.go.jp/english

Thank you very much for your kind attention!