Assessment of Japan’s INDC
Using AIM/Enduse[Japan]

Ken Oshiro
Mizuho Information & Research Institute

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Emissions reduction target of Japan’s INDC

• Japan’s INDC was determined coupled with the Long-term Energy Supply and Demand Outlook, and was submitted on 17th July 2015 to the UNFCCC.

• GHG emissions reduction: 26.0% wrt. 2013, 25.4% wrt 2005 (including LULUCF)

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<table>
<thead>
<tr>
<th>GHG emissions Target in the government’s INDC</th>
</tr>
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<tbody>
<tr>
<td>2005</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Energy CO₂</td>
</tr>
<tr>
<td>Non-energy CO₂</td>
</tr>
<tr>
<td>CH₄</td>
</tr>
<tr>
<td>N₂O</td>
</tr>
<tr>
<td>HFCs</td>
</tr>
<tr>
<td>PFCs</td>
</tr>
<tr>
<td>SF₆</td>
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<tr>
<td>NF₃</td>
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<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Source: Government of Japan (2015), Submission of Japan’s Intended Nationally Determined Contribution (INDC)

* emissions/sink from LULUCF are excluded in the table
# Example of Measures in INDC

Japan’s INDC is based on bottom-up calculation formed by following measures.

| Industry (ex. Iron & steel) | Efficiency improvement of electricity-consuming facilities  
                          | More chemical recycling of waste plastic at steel plants  
                          | Introduction of next-generation coke making process (SCOPE21)  
                          | Improvement of power generation efficiency  
                          | Enhanced energy efficiency and conservation facilities  
                          | Introduction of innovative ironmaking process (Ferro Coke)  
                          | Introduction of environmentally harmonized steelmaking process (COURSE50) |
|-----------------------------|---------------------------------------------------------------|
| Commercial/Residential      | Promotion of compliance of energy saving standards for newly constructed buildings  
                          | Energy efficiency and conservation buildings (remodeling)  
                          | Introduction of commercial-use water heater  
                          | Introduction of highly efficient light  
                          | Introduction of refrigerant control technology (F-gases)  
                          | Improvement of energy efficiency and conservation performance of equipment by the top runner program, etc.  
                          | Thorough implementation of energy management in commercial sector with BEMS and energy efficiency diagnosis  
                          | Promotion of nationwide campaigns (through promotion of Cool Biz/Warm Biz, repair of local government buildings)  
                          | etc. |
| Transport                   | Improvement of fuel efficiency  
                          | Promotion of next-generation automobiles  
                          | Other measures in transport sector (traffic flow improvement, promotion of public transport, etc.) |
| Energy conversion           | Expanding renewable energy introduction to the maximum extent possible  
                          | Utilizing nuclear power generations whose safety is confirmed  
                          | Pursuit of high efficiency in thermal power generation (USC, A-USC, IGCC, etc.) |

Source: Government of Japan (2015), Submission of Japan’s Intended Nationally Determined Contribution (INDC)
Electricity generation outlook in Japan

- In the Long-term Energy Supply and Demand Outlook:
  - Renewables: 22% - 24% in 2030
  - Nuclear: 20% - 22% in 2030

Energy supply and demand outlook in Japan

- In the Long-term Energy Supply and Demand Outlook:
  - FEC: 10% reduction wrt. 2013
  - Renewables: 13%-14% of TPES in 2030

Economic growth outlook in Japan

- In the Long-term Energy Supply and Demand Outlook:
  - GDP growth: 1.7% from 2024 to 2030

Objectives

• Although Japan’s INDC includes background information about the measures and energy mix, following aspects need to be clarified:

1) Feasibility and necessary effort to meet the INDC target

2) Robustness of INDC, especially in terms of the uncertainty of nuclear power

3) Consistency between INDC and 2050 target (80% reduction by 2050)

• This study aims to assess emissions pathways by 2050 using AIM/Enduse [Japan], especially focusing on the three key aspects.
MILES Project

- MILES (Modeling and Informing Low Emission Strategies) Project is convened by IDDRI (France) funded by EU

- The objective of this report is to understand the implication of INDC of the 6 regions (EU, Japan, US, Brazil, China, and India) at a national and global level.

- Japan’s analysis was conducted by NIES & RITE

- NIES team: Dr. Mikiko Kainuma, Dr. Toshihiko Masui, and Ken Oshiro

- The Synthesis Report is available online

Examples of measures in AIM/Enduse [Japan]

- Wide range of mitigation technologies are included.
- Unlike INDC, most of measures for energy conservation are excluded. (e.g. behavioral change, modal shift to public transport)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy conversion</td>
<td>efficiency improvements of power generation; coal and gas with CCS; nuclear power; hydropower; wind power; solar PV; geothermal; bioenergy; ocean; PHS; reinforcing electricity interconnection; Hydrogen generation (electrolysis)*</td>
</tr>
<tr>
<td>Transport</td>
<td>fuel economy improvement of ICE, train, maritime, and aviation; NGV; BEV*; PHEV; FCEV; biofuels; eco-driving</td>
</tr>
<tr>
<td>Residential/commercial</td>
<td>Improvement of energy-efficiency performance of buildings (e.g. insulation); high-efficiency equipment and appliances; electric heat pump water heaters; electrification for heating, cooling, and cooking; energy-management systems</td>
</tr>
<tr>
<td>Industrial (incl. agriculture)</td>
<td>energy-efficiency improvements in industrial processes; CCS for iron making and cement lime; high-efficient boiler, furnace, and motor; industrial heat pump; fuel economy improvements of agricultural machines; bioenergy use; management of nitrogen fertilizer</td>
</tr>
</tbody>
</table>

* BEV, electric water heater, and electrolysis could act as flexible resources to integrate VREs in this version of AIM/Enduse
Methodology

• Implicit carbon prices are implemented to meet:
  - 2030 target: 25.4% reduction wrt. 2005 based on INDC
    -> 22.7% reduction excluding LULUCF
  - 2050 target: 80% reduction wrt. 1990

Source: Greenhouse Gas Inventory Office of Japan, The GHGs Emissions Data of Japan (1990-2013)
* Excluding LULUCF
**Scenarios**

- **INDC Scenario**
  Implicit carbon prices are implemented to meet the INDC target by 2030, and are strengthened thereafter toward the 80% reduction by 2050.

- **Enhanced Action Scenario**
  Compared to INDC Scenario, higher carbon prices are implemented by 2030 to the level of around a half of 2050.

- **Low-Nuclear Scenario**
  All nuclear power plants operate no more than 40 years, by contrast to other scenarios considering the extension to 60 years for several plants.

### Assumptions of carbon price implementation

#### INDC Scenario

- Carbon price (2015-2050)

#### Enhanced Action Scenario

- Carbon price (2015-2050)

### Assumptions of socio-economic indicators

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population (millions)</strong></td>
<td>128</td>
<td>128</td>
<td>124</td>
<td>117</td>
<td>107</td>
<td>97</td>
</tr>
<tr>
<td><strong>Real GDP (trillion US$)_{2005}</strong></td>
<td>4.6</td>
<td>4.6</td>
<td>5.3</td>
<td>6.4</td>
<td>7.4</td>
<td>8.3</td>
</tr>
</tbody>
</table>

*Real GDP is taken from the government’s INDC by 2030, and estimated using GDP per capita of SSP5 afterward.*
Electricity supply from nuclear power (exogenous parameter)

- Lifetime: Extension to 60 years for the plants built since mid-1980s, 40 years for all others (based on IEA WEO 2014)
- Electricity supply from nuclear power: 232 TWh in 2030, 184 TWh in 2050
Result 1) Feasibility and necessary effort to meet the INDC target

GHG emissions in INDC Scenario

- Japan’s INDC target appeared technically feasible with energy efficiency improvement and low carbon energies.
- The implicit carbon price is estimated to rise to around 187 USD/t-CO$_2$ in 2030 to meet the INDC target.

* NF$_3$ emission is excluded. GWP is taken from IPCC SAR
EE and RE in INDC Scenario

- Considering high GDP growth by 2030, INDC Scenario requires substantial energy efficiency improvement.
- Unlike government’s INDC (which focuses energy security as well as environment), switch from coal to natural gas power plant contributes to reducing CO₂ emissions by 2030.
Result 2) Robustness of INDC in terms of the uncertainty of nuclear power

**GHG emissions in Low-Nuclear Scenario**

- The INDC target is still feasible with the alternative low-carbon options (renewable energies and gasification)
- Carbon price in 2030: 236 USD/t-CO₂
  (approx. 26% higher than INDC Scenario)
INDC-80% pathway by 2050 appears technically feasible with energy efficiency and low-carbon energies including CCS. However, rapid reduction is required in this period.

In the Enhanced Action Scenario, carbon prices in 2030 is increased to 220 US$/t-CO₂, however, the effort to achieve 80% target could be reduced.
Result 3) Consistency between INDC and 2050 target

Energy system transformation in supply side by 2050

- INDC-80% pathways require substantial energy system transformation, especially challenges to decarbonize electricity by low carbon energies (renewable, nuclear, and CCS)

- Because of large scale diffusion of solar PV and wind power, additional efforts to integrate VREs are required
Energy system transformation in demand side by 2050

• Between 2030 and 2050, FEC is reduced by approx. 40%.
• Electrification in demand side contributes to reducing CO₂ emission largely, coupled with decarbonization of electricity.

Final energy consumption by sources
Result 3) Consistency between INDC and 2050 target

Co-benefit: import dependency and import bills

• Due to energy system transformation by 2050:
  ➢ Import dependency is reduced by a half of PES by 2050
  ➢ Import bills falls to approx. 100 billion US$ by 2050

* Nuclear power is accounted as a domestic production complied with the IEA statistics
Conclusions

• Japan’s INDC requires energy efficiency improvement and promotion of renewable energies. Carbon price in 2030 rises to 187 US$/t-CO$_2$.

• In Low-Nuclear Scenario, additional deployment of renewable and natural gas are required to meet the INDC target. In this case, carbon price in 2030 rises to 236 US$/t-CO$_2$.

• INDC-80% pathways are technically feasible, however, they require the challenges to transform energy systems between 2030 and 2050.

• Energy system transformation could contribute to enhancing energy security indicators, even with low dependency on nuclear power in the long-term.
Thank you for your attention

- MILES Project 2015 Synthesis Report

- DDPP Japan 2015 Report