Japan’s experience in incentivizing the development of high-efficiency coal-fired power plants

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5. Summary
1-1 Energy Efficiency of Coal-Fired Power Plants

Thermal Efficiency of Coal-Fired Power Generation
(LHV basis)

Source: Ecofys International Comparison of Fossil Power Efficiency and CO2 Intensity 2010
1-2 SOx and NOx emissions of Coal-Fired Power Plants

Source: Federation of Electric Power Companies, Japan (and actual data for Isogo)
1-3  J-POWER’s Thermal Efficiency Development

Development of Coal Power plant steam conditions

- Sub-Critical (Drum type)
- Super-Critical (SC)
- Ultra-Super-Critical (USC)

Improved Thermal Efficiency through
- Upgrading steam condition
- Scale-up

Transition of single unit capacity

Vertical Line: Steam Condition ; primary/ reheat temperature & pressure

- Tachibanawan (1050MW × 2U)
  - 600/610°C
  - 25.0MPa

- Isogo New #1 (600MW)
  - 600/610°C
  - 25.0MPa

- Isogo New #2 (600MW)
  - 600/620°C
  - 25.0MPa

- Matsuura #1 (1000MW)
  - 593/593°C
  - 24.1MPa

- Matsuura #2 (1000MW)
  - 593/593°C
  - 24.1MPa

- Matsushima (500MW)
  - 538/538°C
  - 24.1MPa

- 1,050MW (2000)

- Takehara #1 (250MW)
  - 566/538°C
  - 16.6MPa

- 500MW (1981)

- 1,000MW (1990)

- Transition of single unit capacity

- Designed energy Efficiency (%)
  - (Gross / HHV)
  - 41 ~ 43%
  - 40 ~ 42%
  - 38 ~ 40%

Improved Thermal Efficiency through
- Upgrading steam condition
- Scale-up

Vertical Line: Steam Condition ; primary/ reheat temperature & pressure
1-4 Maintaining Thermal Efficiency at its Designed Level

Thermal Efficiency (%, HHV)

Takasago Power Station Unit 1 (red) & Unit 2 (blue)

Designed Efficiency

Efficiency Degradation

Coal-fired Plant in Country-X

Year since Commissioning

Source: Federation of Electric Power Companies, Japan (actual data for Takasago)
2. Power Mix before Fukushima

After Oil Crisis (1973, 1979)
- Away from Oil: Development of Nuclear and Renewables
- High-efficiency power technology development

- Kyoto Protocol (1997): CO2 emissions 6% cut from 1990 level
- “Basic Energy Plan” (June 2010):

<table>
<thead>
<tr>
<th>Power mix</th>
<th>2009</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 emissions (compared to 1990)</td>
<td>▲6% (~2012)</td>
<td>▲30%</td>
</tr>
<tr>
<td>Power mix</td>
<td>Renewable</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>Nuclear</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>Coal-fired</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>LNG-fired</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>Oil-fired</td>
<td>7%</td>
</tr>
</tbody>
</table>
3-1 Power Mix after Fukushima

Japan’s “Innovative Energy and Environment Strategy” (Sep 2012)

- Realization of a society without nuclear power

→ Mobilize all policy resources to enable zero operation of nuclear power plants in the 2030’s

<table>
<thead>
<tr>
<th>Power mix</th>
<th>2010</th>
<th>2030’s</th>
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<tbody>
<tr>
<td>Renweable</td>
<td>10%</td>
<td>35%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>26%</td>
<td>0%</td>
</tr>
<tr>
<td>Coal-fired</td>
<td>24%</td>
<td>21%</td>
</tr>
<tr>
<td>LNG-fired</td>
<td>29%</td>
<td>38%</td>
</tr>
<tr>
<td>Oil-fired</td>
<td>10%</td>
<td>6%</td>
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</tbody>
</table>
3-2 Opposition to the “Strategy” and Reaction of the Cabinet

- Oppositions from Keidanren and other organizations
  - Jeopardizes stable power supply
  - Inconsistency with economic growth strategy
  - Loss of contribution opportunities to peacefully use of nuclear energy worldwide

- Concerns from various countries
  - USA: Nuclear proliferation problems
  - France: Nowhere to go for the fuel reprocessed in France

The Cabinet in disarray
- “Strategy” failed to be endorsed by the Cabinet.
- Retardation of formulating new “Basic Energy Plan”

Uncertainty of Japan's energy policy
4-1 Coal-Fired Power to be Re-valued in Japan

Energy-Mix to be

- Well-balanced-mix
- Flexibility and Substitutability

Time for Coal to be Re-valued in Japan

Critical Path: Demonstrate Potential of Coal for Climate Change Issue

Continuous efforts for;
- Development of High-Efficiency Coal Power
- Readiness for CCS
- Contribution to worldwide CO2 emissions reduction through CCTs
4-2 Future Technology Development for High-Efficiency

**Future Technology Development**

<table>
<thead>
<tr>
<th>Ageing coal-fired</th>
<th>Latest coal-fired</th>
<th>Next generation coal-fired power plant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub-Critical</strong></td>
<td><strong>USC</strong> (Ultra Super Critical)</td>
<td><strong>A-USC</strong> (Advanced-USC)</td>
</tr>
<tr>
<td>Efficiency: 36% (Net / HHV basis)</td>
<td>Efficiency: 41%</td>
<td>Efficiency: 46%</td>
</tr>
<tr>
<td><strong>IGCC</strong> (Integrated Coal Gasification Combined Cycle)</td>
<td>Efficiency: 46～48%</td>
<td>Efficiency: at least 55%</td>
</tr>
<tr>
<td>(Pulverized coal-fired)</td>
<td>(Coal gasification)</td>
<td></td>
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</tbody>
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**Osaki project ~Oxygen-blown Coal Gasification~**

- Demonstration project for large scale IGCC[170MWe]
- Construction starts in 2013, demonstration from 2016
- J-POWER and Chugoku-Electric joint project
1. Osaki Project
   - Demonstration project for large scale IGCC
   - CO2 capture

2. Australia Callide Project  (Oxy-Fuel and CCS)
   - Demonstration project for oxy-fuel CO2 capture and storage
   - Japan and Australia joint project (J-POWER participates)

3. Japan CCS Co., Ltd.
   - Established in 2008 by Japanese leading companies (J-POWER participates)
   - Investigating the operability of large-scale CCS demonstration projects in Japan
   - Conducting surveys and studies on 3 sites
4-4 Contribute to Worldwide CO₂ Emissions Cut through CCTs

**Japan**

Further Development of CCTs ➔ CCTs Commercialization

Cash Return, CO₂ Credit etc.

Proven CCTs with Preferred Finance, Technical Transfer, Joint Venture etc.

Bilateral/Multilateral agreement

Support

Major Coal-use Countries

Coal saving and CO₂ emissions reduction ➔ Wide deployments of latest CCTs

Government

**New Coal-fired Project in Indonesia**

- Large scale base-load power plant in Central Java
- 1000MW X 2 units, one of the largest scale Asian IPP
- USC for the first time in Indonesia

Project Location: 250 km east of Jakarta
5 Summary

Before Fukushima: Nuclear Dependency / Coal-Phasing-out

After Fukushima: Nuclear-Phasing-out, Confusion

Energy-Mix to be
- Well-balanced-mix
- Flexibility and Substitutability

Time for Coal to be re-valued in Japan

Demonstrating the potential of coal
- Development of Higher-Efficiency Coal Power
- Development of CCS technology
- Dissemination of High-Efficiency technology to the world
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