Economic Impact of Japanese nuclear shutdown

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Topics

- Nuclear units shutdown after March 2011 earthquake and tsunami
- Nuclear electricity replaced by thermal
  - Initial surge of oil-fired generation
  - Now more gas and coal generation
  - FIT program increased renewable generation
- Impact on economy is large, but lowering
- Long-term implications of nuclear shutdown
Nuclear situation

- All nuclear units shut down this winter
- Unclear when (if) nuclear plants will be returned to operation
  - Extensive work at some nuclear stations
  - New NRA standards; review of restart applications
  - Agreement on restart of 2 Kashiwazaki-Kariwa units in mid-2014

Source: FEPC and NERA analysis
Nuclear replaced by thermal

- Nuclear generation mostly replaced by thermal generation
- Use of existing thermal power plants with low utilization and return of old mothballed units
- Mix of oil, LNG, and coal, with changes over time

Source: FEPC and NERA analysis
Oil for electricity generation

- Prior to 2011 earthquake, much of the oil-fired generation was used for peaking units or was mothballed because of high costs.

- After earthquake, utilities increased output from operational oil-fired plants and returned some mothballed oil-fired plants to service – avoiding blackouts at a high cost.

- Increase in gas and coal generation allowed utilities to lower oil consumption by late 2013.
Oil consumption changes

- Crude oil burned for power increased by 230% from 2010 to 2012
- Heavy Fuel Oil for power increased by 180% from 2010 to 2012
- By first half of FY 2013, oil use for power was reduced

Source: FEPC and NERA analysis
Initial response to 2011 earthquake was increased gas-fired generation, using spot and short-term LNG

As new gas-fired units are completed, they will displace oil-fired generation

Source: FEPC and NERA analysis
Gas-fired Generation

- Utilities plan to build a significant number of new gas-fired power plants over the next few years.
- New gas-fired generation allows reduction of generation using expensive crude and fuel oil.
- The new gas-fired plants, even if not operated heavily in future (i.e., if nuclear restarted) will provide additional reliability.
LNG contract approach

- Initial 2011 response increased spot and short-term LNG

- Future LNG contracts
  - Lower cost than past contracts
  - Longer-term
  - Avoid link to international oil prices (e.g., Kansai Electric 2012 contract linked to US Henry Hub gas price)
TEPCO LNG Purchasing Group

- TEPCO’s recovery plan includes joining with other big LNG purchasers (e.g., Kansai Electric Power and Tokyo Gas) to negotiate LNG contracts

- A unified purchasing group of electric utilities and gas companies could enhance negotiating power and bring down prices

- Purchases of up to 40m tons of LNG per year
Coal consumption

- Coal use level in 2011 and 2012 - coal-fired plants near Fukushima were damaged
- Plants repaired and new ones built
- Coal use increased in the first half of 2013 (e.g., Dec 2013 coal use at 15% more than Dec 2012)

Source: FEPC and NERA analysis
Coal-fired Generation

- Coal generation is lower cost than oil or LNG

- 3 new coal-fired power plants with a combined capacity of 1.85 GW came online in 2013

- 2 GW of capacity at the Haramachi plant came back online in 2013 after 2011 earthquake damage was repaired

- Utilities building more coal-fired capacity due to less stringent environmental regulations for construction and for burning coal
## Planned Coal Generation

<table>
<thead>
<tr>
<th>Company</th>
<th>Plant</th>
<th>Output (MWe)</th>
<th>Ops Start</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joban Kyodo</td>
<td>Nakoso No.10</td>
<td>250</td>
<td>April 2013</td>
</tr>
<tr>
<td>TEPCO</td>
<td>Hirono No.6</td>
<td>600</td>
<td>Dec 2013</td>
</tr>
<tr>
<td>TEPCO</td>
<td>Hitachinaka No.2</td>
<td>1,000</td>
<td>Dec 2013</td>
</tr>
<tr>
<td>Osaki CoolGen</td>
<td>Osaki</td>
<td>166</td>
<td>Mar 2017</td>
</tr>
<tr>
<td>TEPCO, Mitsubishi group</td>
<td>Nakoso</td>
<td>500</td>
<td>Around 2020</td>
</tr>
<tr>
<td>TEPCO, Mitsubishi group</td>
<td>Hirono</td>
<td>500</td>
<td>Around 2020</td>
</tr>
<tr>
<td>TEPCO, Chubu</td>
<td>Hitachinaka</td>
<td>600</td>
<td>2020/21</td>
</tr>
<tr>
<td>J-Power</td>
<td>Takehara New No.1</td>
<td>600</td>
<td>2020/21</td>
</tr>
<tr>
<td>Nippon Steel, J-Power</td>
<td>Kashima</td>
<td>600</td>
<td>2020/21</td>
</tr>
<tr>
<td>Kyushu Electric</td>
<td>Matsuura No.2</td>
<td>1,000</td>
<td>2023 at earliest</td>
</tr>
<tr>
<td>Chugoku Electric</td>
<td>Misumi No.2</td>
<td>400</td>
<td>2027 at earliest</td>
</tr>
<tr>
<td>Tohoku Electric</td>
<td>Noshiro No.3</td>
<td>600</td>
<td>2028 at earliest</td>
</tr>
<tr>
<td>12 units</td>
<td></td>
<td>6,816</td>
<td></td>
</tr>
</tbody>
</table>

Renewable Generation

- New renewable feed-in tariff (FIT) approved after 2011 earthquake:
  - FIT contracts are 10 to 20 years, depending on the type and amount of energy
  - Wind, solar, geothermal, biomass and hydropower
  - Costs shared by government and end users

- Effective
  - Renewables now about 10% of total generation
  - About 1.4 GW of renewable energy capacity installed between July 2012 and February 2013
The shift from nuclear to thermal avoided electricity outages, but at a high cost

METI estimates that 9 nuclear utilities would spend ¥7.5 trillion on thermal fuel in this FY
- ¥3.6 trillion more due to closed nuclear power plants
- Lower than earlier estimate of ¥3.8 trillion in April 2013
- 8 of 9 nine nuclear utilities posted net losses in the last fiscal year due to the higher fuel bills

Total added fuel costs for thermal power stations will amount to ¥9.2 trillion by the end of 2013
Impact on Economy

- Added cost to run thermal power stations is compounded by weaker yen
- Japan is now running trade deficits for the first time in three decades
- Added thermal power plant fuel costs were a third of Japan’s total imports, increasing Japan's trade deficit through 2013
- Businesses and consumers face much higher electricity costs in Japan than in many countries
Near-term Implications

- In face of uncertain nuclear restart, Japan is
  - Adding coal and natural gas generation
  - Adding long-term LNG contracts
  - Adding renewables with long-term FIT contracts

- If nuclear restart is delayed or not allowed, power sector will be ready for long-term shift to thermal generation

- If nuclear restart is approved, additional thermal and renewable generation available
Long-Term Implications

- Investment in new thermal power plants will make system more reliable, but at a cost
- Permanently replacing nuclear with thermal generation will make electricity more expensive
- Significant shift to coal generation (even if nuclear restart) is likely due to low cost
- Japan’s nuclear power industry, without new investments in Japan, will shift focus to export markets (e.g., UK and Turkey)
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