Perspectives on Northeast Asian System Interconnection
S. Korea

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CONTENTS

- Review of Korean Power Industry
- Views on Northeast Asian interconnection
- Suggestions
Introduction

- **South Korea**
  - Poor in natural resources: import 97% of primary energy
  - Mountainous country: 70% territory covered with mountains

- **South Korean Power System**
  - Isolated in 1945 from North Korean System
  - Limitations to expanding power system due to military and political tension between South and North Korea

- **Difficulties and uncertainties**
  - Restructuring power industry and so on
## Power Demand and Supply

*5th long term planning of power supply by MOCIE*

Power demand, supply and reserve

- Increase rate of peak demand: 4.3%/year
- Peak demand: 1.65 times during the next 15 years

<table>
<thead>
<tr>
<th></th>
<th>‘00</th>
<th>‘05</th>
<th>‘10</th>
<th>‘15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak</strong></td>
<td>40.9</td>
<td>51.7</td>
<td>60.7</td>
<td>67.5</td>
</tr>
<tr>
<td><strong>Cap.</strong></td>
<td>48.0</td>
<td>60.4</td>
<td>71.4</td>
<td>78.5</td>
</tr>
<tr>
<td><strong>Res. (%)</strong></td>
<td>7.1 (17.4)</td>
<td>8.7 (16.8)</td>
<td>10.7 (17.6)</td>
<td>11.0 (16.2)</td>
</tr>
</tbody>
</table>

*2015 DSM: 7.43[GW] (10%)*
### Generation Mix [GW]
- More dependent on nuclear
- Thermal more than 50%

![Graph of Generation Mix](image)

<table>
<thead>
<tr>
<th>Year</th>
<th>Nuclear</th>
<th>Coal</th>
<th>LNG</th>
<th>Oil</th>
<th>Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>'00</td>
<td>9.9%</td>
<td>28.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>'05</td>
<td>27.1%</td>
<td>28.6%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>'10</td>
<td>28.6%</td>
<td>28.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>'15</td>
<td>28.0%</td>
<td>28.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Electrical Energy Consumption

5th long term planning of power supply by MOCIE

- Annual consumption [kWh]
  - Annual increase rate: 4.1%
  - Much room for increase of consumption

<table>
<thead>
<tr>
<th></th>
<th>‘00</th>
<th>‘05</th>
<th>‘10</th>
<th>‘15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>*10⁹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per person</td>
<td>4,740</td>
<td>6,000</td>
<td>6,780</td>
<td>7,390</td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6,273 [kWh/person] in 1997</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12,434 [kWh/person] in 1997</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Electricity Tariff

*statistics of power industry in 2000 by MOCIE*

### Tariff of neighboring countries[•/kWh]

- Nearly equal to Chinese and about 1/3 of Japanese

A( agriculture), S( street lighting), C( commercial), R( residential), I( industry) : [ • ]

<table>
<thead>
<tr>
<th></th>
<th>Korea</th>
<th>Russia</th>
<th>China*¹</th>
<th>Japan</th>
<th>U.S.A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>A</td>
<td></td>
<td>S</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>44.04</td>
<td></td>
<td>118.92</td>
<td>52.23</td>
<td></td>
</tr>
<tr>
<td>Max</td>
<td>C</td>
<td></td>
<td>R</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>102.45</td>
<td></td>
<td>253.31</td>
<td>126.80</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>71.59</td>
<td>?</td>
<td>69.55</td>
<td>211.69</td>
<td>78.57</td>
</tr>
</tbody>
</table>

Exchange:

- 1 RMB = 163.67
- 1 ¥ = 11.2184
- 1 US$ = 1145.4

*¹: Statistics of Chinese power industry, 1998
Production of Electricity
5th long term planning of power supply by MOCIE

- Generation
  - Increase the weight of N/P and slightly reduce the production of T/P

![Graph showing energy production by type over time]

- NP: 40.4% - 44.5%
- Coal: 35.9% - 34.9%
- LNG: 11.5% - 10.8%
- Oil: 10.4% - 7.2%
- Others
Electricity Fraction

Research report in 2001 by KEEI and statistics of power industry in 2000 by MOCIE

- Primary energy for generation
  - Import 97.4% of primary energy
  - About 31% of total primary energy used for generation
  - Electricity fraction likely to reach 35% in 2015

<table>
<thead>
<tr>
<th></th>
<th>‘99</th>
<th>‘05</th>
<th>‘10</th>
<th>‘15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL  “T”</strong></td>
<td>181.3</td>
<td>235.7</td>
<td>275.0</td>
<td>307.1</td>
</tr>
<tr>
<td><strong>Generation “E”</strong></td>
<td>56.2</td>
<td>78.6</td>
<td>92.9</td>
<td>100.5</td>
</tr>
<tr>
<td>T/E * 100 [%]</td>
<td>31.0</td>
<td>33.3</td>
<td>33.8</td>
<td>? 32.7</td>
</tr>
</tbody>
</table>

*Except for non-utility generation in common use (10%)
Air Pollution
5th long term planning of power supply by MOCIE

- Statistics of air pollution in ‘99 : regarding CO₂
  - About 22.6% emitted by generation
  - Estimated price : about 600 million $US based on $25/ton

- Kyoto Protocol : to reduce 20 ~ 40% of the total emission expected in 2010 or 2020

<table>
<thead>
<tr>
<th></th>
<th>SOx [k-ton]</th>
<th>NOx [k-ton]</th>
<th>Dust [k-ton]</th>
<th>CO₂ [k-ton]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total “T”</strong></td>
<td>1,320</td>
<td>1,230</td>
<td>430</td>
<td>103,820</td>
</tr>
<tr>
<td><strong>KEPCO “E”</strong></td>
<td>217</td>
<td>153</td>
<td>11</td>
<td>23,460</td>
</tr>
<tr>
<td><strong>E/T * 100 [%]</strong></td>
<td>16.5</td>
<td>12.5</td>
<td>2.6</td>
<td>22.6</td>
</tr>
</tbody>
</table>

* CO₂ [kg-C/kWh] : 0.1185 in 2000 and 0.1145 in 2010
Development of Generating Plants

5th long term planning of power supply by MOCIE

- Construct 106 units by 2015
  - 67 units by 2010
  - 43 units under construction

- Need to site 24 units
  - 9 sites for 18 units decided and 2 more sites needed

- Difficulty in siting, now
  - Become more and more difficult in the future
  - Need more construction cost
Reinforcement of Network
5th long term planning of power supply by MOCIE

■ Transmission lines
  - Construct about 10,000[C-km] T/L during the next 15 years including 1,335[C-km] of 765[kV] T/L
  - Totally 35,165[C-km] T/L in 2015

■ Substations
  - Construct about 200 substations during the next 15 years including six 765[kV] substations
  - Totally 756 substations in 2015
Financial Costs

5th long term planning of power supply by MOCIE

Costs for the next 15 years
- Based on fixed price at 1999
- Generation: 32.6 billion $ US
- Transmission and substation: 14.1 billion $ US
- Total: 46.7 billion $ US
Load Curve

- **Daily load variation in 2000: max and min**
  - Annually minimum load: about 18[GW] on New Year’s Day and Thanks Given Day
  - Minimum load on average: about 25[GW]
System Interconnection

- Siberia in Russia
- Far East in Russia
- Shenyang in China
- Pyungyang in N. Korea
- Seoul in S. Korea
- Jaejoo in S. Korea
- Honshyu in Japan
- Kyushyu in Japan
National Energy Security

- Nearly not source but load
- Max continuous power inflow
  - 2 ~ 3 [GW] in 2000 and 3 ~ 4 in 2015
  - Considering min load on average, capacity of nuclear power plants, stability and reliability
- Little impact on energy security until 2015
  - Not so much difficulty in developing additional power plants
  - Power inflow is about 10% of additional generating capacity
Economic Impacts

statistics of power industry by MOCIE

- **New projects**
  - Expected to cost 6 or more billion $ US

- **Effects of the tariff: in the case of 1% increase**
  - **Price**
    - Consumer’s price: 0.0142% increase
    - Producer’s price: 0.0259% increase
  - **Production costs**
    - Steel companies: 3.6% increase
    - Manufacturing industry: 1.7% increase
Economic Impacts - cont’

- Difficulty in estimating its effects on the tariff
  - Due to being at the beginning stage of deregulation
  - Expected to reduce the tariff: 1% or more(?)
    - Import of electricity: 2 [GW] * 8760[hr] = 17,520[GWh]
    - Expected margins: 10 [$/kWh] * 17,520 * 10^6[kWh] = 175.2 billion[$]
    - Total sales of electricity in 2000: 17,220 billion[$]
    - Reduction of operation cost in UCPTE: 3%

- Reduction of environmental costs
  - Reduction of CO₂ emission: 85 billion[$]
    - 23,460[k-ton] * 17,520/144,990[GWh] * 25,000[$/k-ton]
  - Development of renewable energy in neighboring countries
Environmental Impacts

- To reduce air pollution
- To protect the coast and countryside being destroyed by siting new plants
- To increase opportunity to develop renewable energy
- Too dependent on each other country: increase of pollutant inflow from neighboring country
Barriers

■ Political
  - Extremely sensitive to the political relationship, between North and South Korea, of great uncertainty
  - Weak trust in each other’s country resulting in considerable concern for national energy security

■ Institutional, or other barriers
  - Lack of .....?
Impacts of Deregulation

■ Negative impacts
  – Many companies pursuing for their own interests
  – Many different views difficult to reach an agreement

■ Positive views
  – GENCO’s : opportunity to develop generating resources in the neighboring countries
  – TRANCO : opportunity to enlarge the business
  – Consumers : possibility to lower the tariff
Countermeasures

■ Periodical meeting of the government officials
  - Reinforce the role or function of APEC

■ Start a feasibility study sponsored by
  - International organization such as ADB and WB
  - Neighboring countries
Mechanism for Financing

■ Funded by an international consortium
  - Include ABRD, WB..
  - Require the investment of the member countries

■ Multilateral guarantee agreement or guarantee of international organization
  - in order to hedge against risk
Decision Making Body

- **State Council**
  - Likely to be decided politically due to its extreme sensitivity to political situation in the Korean peninsula

- **Ministry of Commerce, Industry and Energy**
  - Decide long term plan for power supply
  - Biggest stockholder of network company [TRANCO]
  - Director general of energy policy officer

- **Electricity Council and TRANCO**
Suggestions

- **Start a feasibility study**
  - Carried out by international consortium
  - Funded by every member country or international organization such as ABRD, WB..
  - Managed by international steering committee

- **Join pre-feasibility study**
  - Each member organization should fund
  - KERI in Korea is likely to get sponsorship from the government