China’s Electric Power Industry and Its Trends

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2. Power supply/demand and future outlook
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1. Structure of China’s Electric Power Industry

- Central government owned power companies: five major generators and two nuclear power generators (50%) (Local government owned power companies (40%))
- Private&foreign IPPs (10%)

Regional monopoly

- State Grid — Five regional grid companies

Provincial monopoly

- Provincial power companies
- Prefectural power distribution companies
- County power distribution companies
- Users

Cross-regional power interchanges

- China Southern Power Grid
- Provincial power companies
- Prefectural power distribution companies
- County power distribution companies
- Users

Local government owned power companies
2.1. Power supply and demand (1)

Installed capacity and power generation output are both the second largest to the world’s electricity industry following the United States.

By 2005, installed capacity reached 508 GW.

By 2005, power generation reached 2,475 TWh.

2.1. Power supply and demand (2)

Power generation per capita is one-tenth that of the United States, one-seventh of Japan and less than half of the world’s average amount (2002 figures)

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>U.S.</th>
<th>Japan</th>
<th>World Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed capacity (GW)</td>
<td>356.6</td>
<td>979.6</td>
<td>266.1</td>
<td>3,372.8</td>
</tr>
<tr>
<td>(% of world total)</td>
<td>(9.6%)</td>
<td>(26.4%)</td>
<td>(7.2%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>Power generation (TWh)</td>
<td>1,654.2</td>
<td>3,858.5</td>
<td>1,097.2</td>
<td>15,614.1</td>
</tr>
<tr>
<td>(% of world total)</td>
<td>(10.6%)</td>
<td>(24.7%)</td>
<td>(7.0%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>Power generation per capita (kWh/person)</td>
<td><strong>1,288</strong></td>
<td><strong>13,120</strong></td>
<td><strong>8,612</strong></td>
<td><strong>2,578</strong></td>
</tr>
</tbody>
</table>

Source: Japan Electric Power Information Center (2005), *Overseas Electric Power Industry Statistics.*
2.1. Power supply and demand (3)

Secondary industrial accounts for approximately 70 percent, whereas residential only accounts for 10 percent of the total consumption.

Note: 2005 figures.

Note: 2002 figures.
Source: Japan Electric Power Information Center (2005), *Overseas Electric Power Industry Statistics*. 
2.1. Power supply and demand (4)

In 1997, balance between power demand and supply was first maintained.

Since 2002, severe power shortages has occurred nationwide.

Economy loss around 1 trillion Yuan.

- 2002: 12 Provinces (Autonomous & Municipalities)
- 2003: 22 Provinces (Autonomous & Municipalities)
- 2004: 24 Provinces (Autonomous & Municipalities)
- 2005: 26 Provinces (Autonomous & Municipalities)
## Rolling Blackouts in China

### Rolling blackouts implemented in China (2002 – Aug. 2005)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>North China</td>
<td>Hebei, Shanxi, Inner Mongolia</td>
<td>Hebei, Shanxi, Inner Mongolia</td>
<td>Tianjin, Hebei, Shanxi, Inner Mongolia, Shandong</td>
<td>Tianjin, Hebei, Shanxi, Inner Mongolia, Shandong, Beijing</td>
</tr>
<tr>
<td>Northeast China</td>
<td>-</td>
<td>-</td>
<td></td>
<td>Liaoning</td>
</tr>
<tr>
<td>East China</td>
<td>Shanghai, Jiangsu, Zhejiang</td>
<td>Shanghai, Jiangsu, Zhejiang, Anhui, Fujian</td>
<td>Shanghai, Jiangsu, Zhejiang, Anhui, Fujian</td>
<td>Shanghai, Jiangsu, Zhejiang, Anhui, Fujian</td>
</tr>
<tr>
<td>Central China</td>
<td>Henan, Hubei, Sichuan, Chongqing</td>
<td>Henan, Hubei, Sichuan, Chongqing, Jiangxi, Hunan</td>
<td>Henan, Hubei, Sichuan, Chongqing, Jiangxi, Hunan</td>
<td>Henan, Hubei, Sichuan, Chongqing, Jiangxi, Hunan</td>
</tr>
<tr>
<td>Northwest China</td>
<td>-</td>
<td>Gansu, Qinghai, Ningxia</td>
<td>Gansu, Qinghai, Ningxia, Shanxi</td>
<td>Gansu, Qinghai, Ningxia, Shanxi</td>
</tr>
<tr>
<td>South China</td>
<td>Guangdong, Guizhou</td>
<td>Guangdong, Guangxi, Guizhou, Yunnan, Hainan</td>
<td>Guangdong, Guangxi, Guizhou, Yunnan, Hainan</td>
<td>Guangdong, Guangxi, Guizhou, Yunnan, Hainan</td>
</tr>
<tr>
<td>Nation wide</td>
<td>Guangdong, Guizhou</td>
<td></td>
<td>35 GW</td>
<td>25-30 GW</td>
</tr>
<tr>
<td>power shortages</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2. Causes of power shortages (1)

- **Responsible entity**: 
  - Central government: Power generation development plan was downwardly revised in the later of the “Ninth-Five Year Plan (1996-2000)” – “the construction of new thermal power plants is being suspended for the next three years”

- **Others major factors**: 
  - Rapid demand growth (driving by rapid economic growth, soaring demand from large electric power consumers, and the diffusion of household electrical appliances)

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Growth rate of power consumption and installed capacity

<table>
<thead>
<tr>
<th>Year</th>
<th>Growth rate of power consumption</th>
<th>Growth rate of installed capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-1987</td>
<td>6.6%</td>
<td></td>
</tr>
<tr>
<td>1988-1995</td>
<td>9.2%</td>
<td></td>
</tr>
<tr>
<td>1996-2000</td>
<td>8.0%</td>
<td></td>
</tr>
<tr>
<td>2001-2005</td>
<td>12.8%</td>
<td></td>
</tr>
</tbody>
</table>

2.2. Causes of power shortages (2)

- **Others major factors (continued):**
  - Issues based on coal industry:
    - imbalance between coal supply and demand & transport bottlenecks
    - escalating coal prices and decreased quality of coal
  - Climatic influences (droughts and heat weaves):
    - power shortages in provinces such as Hunan, Fujian and Qinghai where there are many hydro power plants

### History of coal price

<table>
<thead>
<tr>
<th>Type</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned price*</td>
<td>144.7 (-0.9%)</td>
<td>152.2 (5.2%)</td>
<td>155.8 (2.4%)</td>
<td>220.2 (41.3%)</td>
<td>less than 8% from Sept. 2004 base</td>
</tr>
<tr>
<td>Market price</td>
<td>141.9 (1.9%)</td>
<td>168.8 (18.3%)</td>
<td>173.8 (3.6%)</td>
<td>302.0 (73.8%)</td>
<td></td>
</tr>
</tbody>
</table>

Note: planned price is the price only for generators.
Source: Japan Electric Power Information Center.
2.3. Countermeasures against power shortages

- **Demand countermeasures:**
  - Peak shift: nighttime and weekend factory operations (expand TOU rate differentials and so on)
  - Peak cut: equipment inspections and load interrupts ("rolling shutdowns", and "three days on, four days off")

- **Supply countermeasures:**
  - Moving up of power generation development (promotion of nuclear power generation)
  - Power network improvements
2.4. Outlook of power supply and demand (1)

- **Short-term**:
  - Gradual decrease in growth of power demand (10% in 2006, 7% in 2007)
  - Net capacity increase is projected to reach **150 GW** during 2006 and 2007 (80 GW in 2006 and 70 GW in 2007)
  - In 2006, power shortages will be limited to certain regions and time slots
  - In 2007, balance between supply and demand will be maintained

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed capacity (GW)</td>
<td>442 (12.6%)</td>
<td>508 (14.9%)</td>
<td>591 (16.3%)</td>
</tr>
<tr>
<td>Net capacity increase (MW)</td>
<td>49,300</td>
<td>70,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Power consumption (TWh)</td>
<td>2,176.1 (14.9%)</td>
<td>2,468.9 (13.5%)</td>
<td><strong>2,668.0 (11.4%)</strong></td>
</tr>
<tr>
<td>Max. power shortage (MW)</td>
<td>35,000</td>
<td>25,000-30,000</td>
<td><strong>6,000-10,000</strong></td>
</tr>
</tbody>
</table>

Source: State Power Information Center, (http://www.sp.com.cn/).
2.4. Outlook of power supply and demand (2)

- **Long-term:**
  - At the end of 2010, installed capacity is projected to reach 560 GW and 950 GW by the end of 2020.
  - At the end of 2010, power demand is projected to reach 3,000 TWh, and 4,600 TWh by the end of 2020.

**Outlook of generation component from 2010 to 2020** (Unit: GW)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total installed capacity</strong></td>
<td>543-559 (100%)</td>
<td>865-947 (100%)</td>
</tr>
<tr>
<td>Coal</td>
<td>338-384 (62-69%)</td>
<td>509-661 (56-69%)</td>
</tr>
<tr>
<td>Oil</td>
<td>3-4 (1%)</td>
<td>1-6 (1%)</td>
</tr>
<tr>
<td>Natural gas</td>
<td>25-28 (5%)</td>
<td>43-46 (5%)</td>
</tr>
<tr>
<td>Hydro power</td>
<td>132-154 (24-28%)</td>
<td>191-240 (22-25%)</td>
</tr>
<tr>
<td>Nuclear power</td>
<td>9-15 (2-3%)</td>
<td>31-40 (3-4%)</td>
</tr>
<tr>
<td>Renewable sources</td>
<td>3-7 (1%)</td>
<td>11-30 (1-3%)</td>
</tr>
</tbody>
</table>

**Outlook of power demand from 2010 to 2020**

|                | 2010       | 2015       | 2020       |
|----------------|------------|------------|
| **Low case**   | TWh        |            |            |
| Coal           | 1,350.8    | 2,917.9    | 3,558.2    |
| Oil            | 11.0       | 5.1        | 3.2        |
| Natural gas    | 10.5       | 6.0        | 4.5        |
| Hydro power    | 11.0       | 6.0        | 4.5        |
| Nuclear power  | 11.6       | 7.3        | 6.7        |
| Renewable sources | 11.6 (1.3%) | 7.3 (1.8%) | 6.7 (2.2%) |
| **Reference case** | TWh        |            |            |
| Coal           | 1,350.8    | 3,044.4    | 4,630.8    |
| Oil            | 10.5       | 4.5        | 4.0        |
| Natural gas    | 11.0       | 6.0        | 4.5        |
| Hydro power    | 11.0       | 6.0        | 4.5        |
| Nuclear power  | 11.6       | 7.3        | 6.7        |
| Renewable sources | 11.6 (1.3%) | 7.3 (1.8%) | 6.7 (2.2%) |
| **High case**  | TWh        |            |            |
| Coal           | 1,350.8    | 2,336.6    | 4,219.9    |
| Oil            | 10.5       | 4.5        | 4.0        |
| Natural gas    | 11.0       | 6.0        | 4.5        |
| Hydro power    | 11.0       | 6.0        | 4.5        |
| Nuclear power  | 11.6       | 7.3        | 6.7        |
| Renewable sources | 11.6 (1.3%) | 7.3 (1.8%) | 6.7 (2.2%) |


Power generation will continually be based on coal-fired thermal power!
2.4. Outlook of power supply and demand (3)

- In 2010, power consumption per capita will be approximately 2,130 kWh and daily power consumption per capita will reach 258 kWh.
- In 2020, power consumption per capita will be approximately 3,200 kWh and daily power consumption per capita will reach 560 kWh.

### International Comparison

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power consumption per capita</strong></td>
<td>International Comparison</td>
<td>Power consumption per capita</td>
</tr>
<tr>
<td>2,130 kWh</td>
<td>U.S. and Germany in the early of 1950s, Japan in the middle of 1960s</td>
<td>3,200 kWh</td>
</tr>
<tr>
<td><strong>Daily power consumption per capita</strong></td>
<td>International Comparison</td>
<td>Daily power consumption per capita</td>
</tr>
<tr>
<td>258 kWh</td>
<td>Japan in the early of 1960s, France in the middle of 1960s</td>
<td>560 kWh</td>
</tr>
</tbody>
</table>

Source: State Power Economic Research Center.
3. Future power development plans (2006-2010)

- **Generation sector:**
  - Proactively work on the development of hydropower
  - Implement large-scale expansions of coal-fired thermal power, and upgrade technology
  - Proactive development of nuclear power
  - Appropriate introduction of natural gas power generation
  - Introduce renewable energy
  - Intensify energy conservation, and improve the efficiency of energy utilization

- **Network sector:**
  - Pace of power generation construction and power grid construction (power generation, transmission and distribution investment ratio in 1990s was:1:0.2:0.2)
  - Realize nationwide interconnection based on “West-East Power Transmission” and “South-North Power Transmission”
  - Optimize power resources allocation based on renewal and construction of regional transmission and distribution networks
(Appendix) West-East Power Transmission Project

- West-East Power Transmission:

  **North Route:**
  - 7,000 MW by 2005
  - 18 GW by 2010
  - 40 GW by 2020

  **Middle Route:**
  - 7,000 MW by 2005
  - 21.8 GW by 2010
  - 40 – 45 GW by 2020

  **South Route:**
  - 11 GW by 2005
  - 15 GW by 2010
  - 20 – 25 GW by 2020
(Appendix) South-North Power Transmission

South-North Power Transmission:

- Northeast & North China interconnection
- Shandong & North China interconnection
- Central China & North China AV/BTB interconnection
- Central China & Northwest China BTB interconnection
- Fujian & East China interconnection
- Three Gorges Dam & Guangdong DC interconnection
(Appendix) Nationwide interconnection by Dec. 2005

4. Regulation reform trends (1)

“introduce competition and break the market monopoly” - separation of generation and transmission sectors

Restructuring of the *State Power Corporation of China*
December 2002
4. Regulation reform trends (2)

- **Generation sector**: 
  1. Power Grids
     (in the purpose of ancillary service and funding for network construction)
  2. Five major power generators

### 2. Five major power generators

<table>
<thead>
<tr>
<th>Five major generators</th>
<th>Installed capacity</th>
<th>Power components</th>
<th>Assets (Billion Yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huaneng</td>
<td>38.0GW</td>
<td>18% 82%</td>
<td>126.5</td>
</tr>
<tr>
<td>Datang</td>
<td>32.5GW</td>
<td>21% 79%</td>
<td>71.6</td>
</tr>
<tr>
<td>Huadian</td>
<td>31.3GW</td>
<td>19% 81%</td>
<td>71.2</td>
</tr>
<tr>
<td>Guodian</td>
<td>30.8GW</td>
<td>15% 85%</td>
<td>73.3</td>
</tr>
<tr>
<td>Chian Power Investment</td>
<td>30.2GW</td>
<td>26% 70%</td>
<td>76.9</td>
</tr>
</tbody>
</table>

Note: Each company’s market share is less than 20% in each region and less than 10% in nationwide.
4. Regulation reform trends (3)

**Transmission Sector:**

State Grid Corporation of China (SGCC) & China Southern Power Grid (CSPG)

SGCC:

- **Northeast China Power Grid:** Heilongjiang, Jilin, Liaoning, East Inner Mongolia
- **North China Power Grid:** Beijing, Tianjin, Hebei, Shanxi, Shandong, West Inner Mongolia
- **East China Power Grid:** Shanghai, Zhejiang, Anhui, Jiangsu, Fujian
- **Central China Power Grid:** Jiangxi, Henan, Hubei, Hunan, Chongqing, Sichuan
- **Northwest China Power Grid:** Shanxi, Gansu, Qinghai, Ningxia, Xinjiang
- **China Southern Power Grid:** Guangdong, Guangxi, Yunnan, Guizhou, Hainan
(Appendix) Installed capacity and load in each regional power grid company by Feb. 2005

Northeast China Power Grid
Installed capacity: 41.3 GW
Max. load: 30.0 GW

Northwest China Power Grid
Installed capacity: 25.8 GW
Max. load: 18.5 GW

Tibet Power Grid
(temporarily run by the SGCC)
Installed capacity: 240 MW

North China Power Grid
Installed capacity: 75.5 GW
Max. load: 65.8 GW

East China Power Grid
Installed capacity: 77.1 GW
Max. load: 65.2 GW

Central China Power Grid
Installed capacity: 69.9 GW
Max. load: 52.8 GW

China Southern Power Grid
Installed capacity: 52.4 GW
Max. load: 44.6 GW

4. Regulation reform trends (4)

- Establishment of the State Electricity Regulatory Commission (SERC) in March 2003
- Major responsibilities:
  - Develop laws and regulations;
  - Monitor electricity operations,
  - Propose tariff and adjustments to governmental pricing authority,
  - Investigate any possible violations of laws and regulations,
  - Supervise the implementation of universal service provisions, etc.

SERC

North China Bureau
  - Taiyuan Office
  - Jinan Office

Northeast China Bureau

Northwest China Bureau
  - Lanzhou Office

East China Bureau
  - Hangzhou Office
  - Nanjing Office
  - Fuzhou Office

Central China Bureau
  - Zhengzhou Office
  - Changsha Office
  - Chengdu Office

South China Bureau
  - Kunming Office
  - Guiyang Office
4. Regulation reform trends (5)

- Implementation of pilot program of wholesale power market since April 2004

- Short-term goal (2006-2010): Separation of transmission and distribution sectors, partial liberalization

- Long-term goal (2010-): full liberalization
5. Retail electricity rate trends

**History of retail electricity rates**:

- In January 2004, whole sale prices were uniformly raised 0.007 Yuan/kWh, and industrial rates were uniformly raised 0.008 Yuan/kWh.

- In June 2004, industrial power rates were raised an average of 0.022 Yuan/kWh in China’s Northern, Eastern, Central and Southern regions.

- In May 2005, national average retail prices were raised 0.0252 Yuan/kWh due to the introduction of the [fuel costs adjustment system](#).
## 6.1. Issues

<table>
<thead>
<tr>
<th>Fuel sector:</th>
<th>Negotiation between coal suppliers and generators for coal price has became onerous since 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>security and stablity of coal supply?</td>
</tr>
<tr>
<td>Generation</td>
<td>In 2004, unauthorized construction/project totaled to 120 GW</td>
</tr>
<tr>
<td></td>
<td>control of excess investment in generation sector?</td>
</tr>
<tr>
<td></td>
<td>At the end of 2004, power generating facilities with desulfurizing apparatuses totaled a mere 6% of facilities</td>
</tr>
<tr>
<td></td>
<td>promotion of desulfurization system?</td>
</tr>
<tr>
<td>Transmission</td>
<td>Debt percentages for power network companies ranged from 70% – 80%</td>
</tr>
<tr>
<td></td>
<td>promotion of investments in power networks?</td>
</tr>
<tr>
<td>Retail sector:</td>
<td>Industrial power rates are high in comparison to household rates</td>
</tr>
<tr>
<td></td>
<td>create a rational electricity rates system?</td>
</tr>
<tr>
<td>Regulation</td>
<td>Transmission operators hold their own generation capacities</td>
</tr>
<tr>
<td></td>
<td>equity, fairness and transparency of network operators?</td>
</tr>
</tbody>
</table>
6.2. Points to be checked (1)

- **Generation sector:**
  
  During the 11\textsuperscript{th} Five-year Plan: 300 MW and above thermal plants will account for 50\% of the total; only 600 MW and above new thermal plants will be allowed to be built; the building of supercritical and ultra-supercritical power units will be encouraged; by 2020, nuclear power will be 40 GW.

  International ordering & bidding for supercritical, ultra-supercritical and large-scale gas-turbine plants, nuclear power plants will be expanded.
6.2. Points to be checked (2)

Generation sector:

During the 11th Five-year plan: 3,000 MW new wind power plants will be installed; more than 70% of the wind power units will be domestically produced

Domestic production of wind power plants will be accelerated
6.2. Points to be checked (3)

- Generation sector:

  “Regulated power rate system” and introduction of wholesale power market

  The withdrawal of foreign IPPs will accelerate (for example: Siemens, Vattenfall, American Electric Power, Alston, etc.)
6.2. Points to be checked (4)

Generation sector:

During the 11th Five-year plan: SO2 emission: 12 million-13 million tons/year (10% reduction from 2005); soot emission: 3 million tons/year (more than 25% reduction from 2005); coal consumption/kWh: less than 360 g; transmission loss rate: less than 7%; consolidated usage rate of particulates: 70%, etc.

The latent potential of energy conservation and environmental countermeasures in power generation sector is quite great, consequently in the future, increased international (governmental and private sector) activity can be anticipated in concerned sectors.
6.2. Points to be checked (5)

Transmission sector:

During the 11th Five-year plan: construction of 330 kV and above power grids will reach 75,000 km; transformer capacity will reach 360 million kVA; investment scale will be around 1.5 trillion Yuan.

Overseas orders of medium, high and ultra-high voltage transmission (1,000 kV) and transformer facilities will be expanded; technological collaborations (private sector) will be invigorated in regards to network security and stable operations.
6.2. Points to be checked (6)

- Retail sector:
  - Introduction of Renewable Energy Law & revision of electricity rate system
  - Retail prices tend to continually increased
6.2. Points to be checked (7)

- Market liberalization:

Power supply and demand is projected to be maintained in 2007

Implementation of regional power market will be accelerated and it is anticipated that small generators will exit and major generators will concentrate on the market due to fierce market competition.