Strategy and Key Issues of Regional Air Pollution Control in China

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Outline

- Air Pollution Issues in China
- Air Pollution Control Strategy during 2010~2015
- Key Tasks of Regional Air Pollution Control
- Future directions in connection with HTAP
SO₂ emissions have been reduced

National SO₂ emissions in 2007, 2008 and 2009 were 3.18%, 8.95%, and 13.14% lower than that in 2005
Urban air quality has been improved

- Attainments of CAAQS class II have been increasing;
- However, there were still 107 cities whose air quality did not meet CAAQS class II.
Simulation of CMAQ model indicated that large regions in China were covered with high PM$_{2.5}$ concentrations.

**PM$_{2.5}$ pollution and regional haze**

January

April

July

October
Visibility in east China decreased 10km during 1957—2005, with a decreasing rate of 0.24 km/yr
NO\textsubscript{X} emissions have been increasing quickly. In 2008, the national NO\textsubscript{x} emissions were over 23 million tons.
High ozone concentration frequently occurs in Beijing, Shanghai, Tianjin, Chongqing, Shenyang, Qingdao and Guangzhou.
Acid rain is still a challengeable problem

- Heavy polluted areas with a pH < 4.5 increased
- Some northern cities observed acid deposition
Decrease of $[\text{SO}_4^{2-}] / [\text{NO}_3^-]$ ratio in precipitation in north, east, and south China decrease from 4~10 in 1992-1993 to 2~3 in 2007-2009

Xu Xiaobin, 2010
International pressure on mercury pollution

Long-range transport of atmospheric mercury

Layer 1 HGz

China

z=gem_2001_mar_5_12.nc

March 5, 2001 0:00:00
Min = 0.8 at (150.70), Max = 8.4 at (36.38)

Lin et al., 2006
Major issues of air pollution in China

- Regional air pollution complex are caused by both coal combustion, vehicle emissions, and other sources in key city clusters of China.

- Both local and regional air pollution are serious. Regional air quality, in particular, has a trend of exacerbating with the frequent occurrence of photochemical smog, regional haze, and acid deposition.

- Air pollution which is characterized by high concentrations of multi-pollutants, intensive emissions of multi-sources, and co-existence of multi-scale issues, has posed serious risks to human health and ecosystem in China.
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Multi-pollutants control strategy

**Major sources**
- Industries (power, cement, steel)
- Mobile sources (road, non-road)
- Area sources (domestic, natural sources)

**Key pollutants**
- PM
- SO$_2$
- NH$_3$
- NO$_x$
- VOC

**Environ. issues**
- API
- Regional haze
- Acid rain
- Ozone

**Multi-pollutant control strategy**
Implement control of multi-pollutants, enhance regional air pollution control, improve both local and regional air quality.

Further reduce the total SO\textsubscript{2} emissions (by 8% reduction based on 2010) and implement the total NO\textsubscript{x} emission control (by 10% reduction based on 2010) to reduce secondary pollutants.
Rapid increase of vehicle population will significantly affect the urban development, energy supply and air quality. **Vehicle pollution control** shall be enhanced through the integrated measures on **vehicle emissions**, fuel improvement, transportation planning.

**Primary PM emission control** will be emphasized. High efficiency dust collectors such as **ESP and FF** will be widely applied in **power plants, iron and steel plants, and industrial boilers**.
New ambient air quality standard (in discussion)

• Delete the specific standard for industrial areas

• Add the NOx guideline: 50 ug/m³

• Enhance NO₂ standard Class II:
  - annual average 80 ug/m³ ➞ 40 ug/m³;
  - daily average 120 ug/m³ ➞ 80 ug/m³;
  - hourly average 240 ug/m³ ➞ 120 ug/m³

• Add the 8-hr ozone standard: 100 ug/m³ for Class I and 160 ug/m³ for Class II

• Add the PM$_{2.5}$ guideline: 15 ug/m³ for Class I and 35 ug/m³ for Class II
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Key task 1: air pollution from coal burning

① Limit the total coal consumption in severe air pollution regions

Installed capacity in developed areas

<table>
<thead>
<tr>
<th></th>
<th>Installed capacity, GW</th>
<th>Capacity per capita, kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>110</td>
<td>1.3</td>
</tr>
<tr>
<td>UK</td>
<td>80</td>
<td>1.2</td>
</tr>
<tr>
<td>Guangdong</td>
<td>70</td>
<td>0.9</td>
</tr>
<tr>
<td>Zhejiang</td>
<td>54</td>
<td>1.0</td>
</tr>
<tr>
<td>Shanghai</td>
<td>25</td>
<td>1.5</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>50</td>
<td>0.8</td>
</tr>
<tr>
<td>Shandong</td>
<td>75</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Installed capacity in some areas are at same level of that in developed countries
Limit total coal consumption in some regions

BJ/TJ/HB

YRD

PRD
Develop clean energy resources

By 2020, renewable energy may account for 15% of total energy.

By 2030, coal account less than 50% of total energy consumption,
coal end-use account for less than 50% of total coal use,
coil-fired power plants account for less than 60% of total electricity.

Increase of natural gas uses
Percentage of coal power will decrease 4~5% every 5 years.
**Improve energy efficiency**

**Energy intensity will reduce 16% during 2010-2015**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Domestic Energy Efficiency</th>
<th>International Advanced Energy Efficiency</th>
<th>Energy Saving Potential</th>
<th>Average Saving Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal-fired generation</td>
<td>Efficiency 33.2%</td>
<td>Japan 40.1%</td>
<td>17%</td>
<td>17</td>
</tr>
<tr>
<td>Electric generation</td>
<td>8% used by generation</td>
<td>Japan 6% used by generation</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>Oil refining</td>
<td>14.3 kgoe/t</td>
<td>Japan 8.9 kgoe/t</td>
<td>38%</td>
<td>44</td>
</tr>
<tr>
<td>Coal production</td>
<td>13.6 toe/1,000 tons</td>
<td>US 1.24 toe/1,000 tons</td>
<td>82%</td>
<td>25</td>
</tr>
<tr>
<td>Coke oven gas</td>
<td>Recycled heat percentage 29%</td>
<td>Japan 52%</td>
<td>23%</td>
<td>22</td>
</tr>
<tr>
<td>Coking</td>
<td>196 kgoe/t</td>
<td>Japan 161 kgoe/t</td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td>Crude steel</td>
<td>781 kgoe/t</td>
<td>Japan 658 kgoe/t</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td>970 kgoe/t</td>
<td>International 664 kgoe/t</td>
<td>24%</td>
<td>26</td>
</tr>
<tr>
<td>Ethylene</td>
<td>784 kgoe/t</td>
<td>Japan 500 kgoe/t</td>
<td>36%</td>
<td></td>
</tr>
<tr>
<td>Cement</td>
<td>171 kgoe/t</td>
<td>Japan 121 kgoe/t</td>
<td>29%</td>
<td></td>
</tr>
<tr>
<td>Electrolytic aluminium</td>
<td>14.3 MWh/t</td>
<td>International 13.0 MWh/t</td>
<td>9%</td>
<td>26</td>
</tr>
<tr>
<td>Alumina</td>
<td>970 kgoe/t</td>
<td>International 454 kgoe/t</td>
<td>53%</td>
<td></td>
</tr>
<tr>
<td>Heat and hot water</td>
<td>Average efficiency 25%</td>
<td>Targets 35%</td>
<td>29%</td>
<td>29</td>
</tr>
<tr>
<td>Gasoline vehicles</td>
<td>10.8 km/L</td>
<td>Japan 13.5 km/L</td>
<td>20%</td>
<td>20</td>
</tr>
</tbody>
</table>
1. **National level**: Control the total NOx emissions from power plants to reduce nitrogen deposition.

2. **Regional level**: Ozone will be included in the air quality evaluation system. NOx emission control plan will be developed according to the regional ozone and PM$_{2.5}$ targets. Additional measures will be considered during high ozone episodes.

3. **Local level**: NOx emissions meet both the limits in emission standards and regional/national requirements.
Key task 2: Vehicle pollution control

- In 2008, national vehicle population increased to 169.9 million.
- The annual growth rate was over 20% during 2000~2008

Vehicles contribute to 40% of NOx emissions in Beijing, Shanghai, and Guangzhou.
Enhance vehicle pollution control

① Implement more strict emission standards for new vehicles

② Improve the I/M (inspection/maintenance) programs to effectively control in-use vehicle emissions

③ Enhance the emission control of non-road vehicles

④ Reduce the sulfur content and improve the fuel quality

⑤ Promote clean vehicles and increase the proportion of clean energy

⑥ Build green transport system and develop public transport
Key task 3: Industrial pollution control

Change the development pattern and implement whole process control strategy for cement, steel, and non-ferrous metal smelting industry

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cement industry:</td>
<td>Cement production reached <strong>1.4 billion tons</strong> in 2008. Cement industry emitted <strong>4.2 Mt</strong> particles and <strong>2 Mt NOx</strong></td>
</tr>
<tr>
<td></td>
<td>Close <strong>0.3 billion tons</strong> of production capacity with old technologies, promote clean production, apply <strong>fabric filters and SNCR</strong></td>
</tr>
<tr>
<td>2. Steel industry:</td>
<td>Steel production increased to <strong>570 million tons</strong> in 2009. Steel industry emitted <strong>0.5 Mt</strong> particles and <strong>0.7 Mt SO₂</strong></td>
</tr>
<tr>
<td></td>
<td>Close production capacity with old technologies, relocate the steel plants from urban areas, enhance energy saving and improve energy efficiency, apply high efficiency dust collectors and FGD</td>
</tr>
</tbody>
</table>
## Control industrial VOCs emissions

### Control I: improvement of VOCs content in paint

### Control II: improvement of the type of paint

### Control III: improvement of spraying method

### Table: Paint consumption, VOC content, emission factor, and application

<table>
<thead>
<tr>
<th>type of Paint</th>
<th>consumption</th>
<th>VOC content</th>
<th>emission factor</th>
<th>spraying technique</th>
<th>application</th>
<th>ratio</th>
<th>real use</th>
<th>kt</th>
</tr>
</thead>
<tbody>
<tr>
<td>powder</td>
<td>25%</td>
<td>0.0</td>
<td>0.00</td>
<td>Electrostatic</td>
<td>70~90%</td>
<td>100%</td>
<td>407.5</td>
<td>0.0</td>
</tr>
<tr>
<td>water-based</td>
<td>30%</td>
<td>200.0</td>
<td>200</td>
<td>air spraying</td>
<td>35~45%</td>
<td>30%</td>
<td>107.0</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>airless spraying</td>
<td>50~80%</td>
<td>70%</td>
<td>45%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>electrostatic</td>
<td>70~90%</td>
<td>00%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>by hand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>solvent-based</td>
<td>45%</td>
<td>450</td>
<td>600~750</td>
<td>air spraying</td>
<td>35~45%</td>
<td>30%</td>
<td>1085.8</td>
<td>1708.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>airless spraying</td>
<td>50~80%</td>
<td>70%</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>electrostatic</td>
<td>70~90%</td>
<td>00%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>by hand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>2738.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2253.9</td>
<td>997.3</td>
</tr>
</tbody>
</table>

### Efficiency:

<table>
<thead>
<tr>
<th>Control</th>
<th>Efficiency</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>15.7%</td>
<td>43.8%</td>
</tr>
<tr>
<td>II</td>
<td>34.5%</td>
<td>29.9%</td>
</tr>
<tr>
<td>III</td>
<td>16.8%</td>
<td>44.5%</td>
</tr>
<tr>
<td>I + II</td>
<td>52.4%</td>
<td></td>
</tr>
</tbody>
</table>

### Control industrial VOCs emissions

- **Control I**: improvement of VOCs content in paint
- **Control II**: improvement of the type of paint
- **Control III**: improvement of spraying method

### Notes:

- Efficiency calculation:
  - Control I: 15.7%
  - Control II: 34.5%
  - Control III: 16.8%
  - Control I + II: 43.8%
  - Control II + III: 29.9%
  - Control I + II + III: 44.5%

- Total emission: 997.3 kt
Key task 4: Regional air pollution in key areas

YRD for example

<table>
<thead>
<tr>
<th>Emission reduction</th>
<th>Local NOx PP</th>
<th>Local NOx Other</th>
<th>Local VOC</th>
<th>Regional NOx PP</th>
<th>Regional NOx Other</th>
<th>Regional VOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 6</td>
<td>80%</td>
<td>65%</td>
<td>65%</td>
<td>80%</td>
<td>65%</td>
<td>65%</td>
</tr>
</tbody>
</table>
Key task 5: Mercury emission control

- Oct 2009: Integrated Control Program for Heavy Metal Pollution
- May 2010: Guidance Document to Advance the Joint Prevention and Control of Atmospheric Pollution for Improving Regional Air Quality
Hg emissions were reduced by 34 tons during 2005~2008 by installation of FGD and shutting down small units.
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Future Policy Directions

1. Integrating air quality issues at local, regional and global scales
2. Pursuing policy options targeting on multiple pollutants
3. Air pollution policies based on environmental impact and cost-benefit analysis
4. Air quality management policies in connection with energy policy and climate policy
Thank you for your attention!