China’s Plans to Improve Air Quality

FEAS Lecture Series
Wesleyan University, Middletown CT

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October 25, 2012
What Images Come to Mind When You Think of China and Air Quality?

This November 2011 day was rated “mildly polluted”
Clean Air is A Goal in China Too

A “Blue Sky Day”. Each of China’s major cities has a targeted number of such days they aim to reach each year.
What Comes to Mind When You Think About China and Economic Development?

This image is one that China wants to relegate to the dust bin. Hundreds of these plants have already been closed.
This Picture is Another View: Where China is Heading.
As Is This One
What About China and Its Environment?
These Pictures Are Also Accurate
China Infrastructure Project Example
Beijing Subway Map 2007
Overview

• Discussion of China’s economic growth framed from environmental and especially air quality perspectives
• Comparison of China and United States economic development
• What indicators compelled each country to act to improve its environment?
• China and the United States actions to reduce air pollution and protect public health
• Role of the public to engage, encourage and advocate for change
• What will China look like in 2030?
• What can the United States and Europe learn from China? And vice versa.
Rate of Change in China: Environmental Affects and Opportunities

• Equivalent of two United States (600 million people) relocating from rural to urban areas
• Developing middle class: transition from heavy manufacturing to higher value products and service economy
• Annual growth in Gross Domestic Product (GDP) is 7-10%
• Annual electricity growth 10%
• Each ton of cement produced emits about one ton of CO2
• Each ton of coal combusted emits slightly more than one ton of CO2, along with many pounds of fine particles, sulfur dioxide. Coal combustion also results in mercury emissions.
• Electricity production requires water for cooling and power plant processes. Each kilowatt-hour of electricity produced uses 2.5 liters of water.
Comparison of China to United States in the 1950s and 1960s

- Post-World War II: US GDP growth rate reached 13% in 1950, was 6-7% per year for many of years 1950-1964
- Automobile driven expansion: “Eisenhower Interstate Highway System” led to rapid suburbanization, expansion of urban areas
- Chemical manufacturing and power generation increased
US Electricity Growth Rate

Figure 93. U.S. electricity demand growth, 1950-2035
(percent, 3-year moving average)
Environmental Impact of Growth in US Post- World War II

• Severe air pollution in most urban areas
• Degradation of water
  – Cuyahoga River in Cleveland caught on fire
• Degradation of land
  – Coal and uranium mining impacts
• Cavalier personal attitudes
In the early days ...
The 13th Time the Cuyahoga River Caught Fire Was Pivotal to Action to Clean Up US Waterways
This Ad Spurred Americans to Action on Earth Day 1971
State of science and knowledge about environmental affects

- 1950s/1960s: USA- focus on “black soot” and smoke. Particulate collected in buckets
- Today: we know that human lungs do not distinguish between pollutants, that cumulative affects of pollutants are important
- United States has been regulating air pollution since 1970, our economy is considered developed
- Great progress has been achieved, but today one-half of US citizens still live in areas that exceed one or more health-based air quality standards.
2008 Ozone NAAQS

Counties With Monitors Violating the March 2008 Ground-Level Ozone Standards

0.075 parts per million

(Based on 2006 – 2008 Air Quality Data)

322 of 675\(^1\) monitored counties violate the standard
Effects of China’s Economic Development on Air Quality

• Nearly all of 113 key cities have pollution that exceeds World Health Organization (WHO) and China’s air quality standards

• PM2.5 concentrations are high throughout China, and especially in Eastern China

• Urban ozone concentrations are rising
PM2.5

Van Donkelaar et al. (2010)
Air pollution in China is severe, imposing a heavy burden on society.

2009 Annual Mean PM$_{10}$ Levels in Chinese Cities

WHO Guideline: 20 µg/m$^3$
(Interim Targets 30 – 50 – 70)

China Class II: 100 µg/m$^3$

Source: WHO 2011
Haze Days

<table>
<thead>
<tr>
<th>City</th>
<th>Days</th>
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<tbody>
<tr>
<td>Xi’an</td>
<td>103 Days</td>
</tr>
<tr>
<td>Taiyuan</td>
<td>225 Days</td>
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<tr>
<td>Shijiazhuang</td>
<td>184 Days</td>
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<tr>
<td>Beijing</td>
<td>100 Days</td>
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<tr>
<td>Tianjin</td>
<td>207 Days</td>
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<tr>
<td>Qingdao</td>
<td>88 Days</td>
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<tr>
<td>Nanjing</td>
<td>211 Days</td>
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<tr>
<td>Shanghai</td>
<td>140 Days</td>
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<tr>
<td>Wenzhou</td>
<td>108 Days</td>
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<tr>
<td>Fuzhou</td>
<td>120 Days</td>
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<td>Shenzhen</td>
<td>164 Days</td>
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<tr>
<td>Guangzhou</td>
<td>131 Days</td>
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<td>Nanchang</td>
<td>152 Days</td>
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<tr>
<td>Changsha</td>
<td>107 Days</td>
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<tr>
<td>Chengdu</td>
<td>239 Days</td>
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<td>Chongqing</td>
<td>133 Days</td>
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Energy solutions for a changing world
Indicators of Change in China

- **Beijing Olympics**
  - Factories closed in Beijing and surrounding areas
- **Shanghai Expo**
  - AIRNow: first Chinese application of air quality forecasts available to public in real-time
- **Increased transparency**
  - Disclosure of industries that violate air and water quality regulations
  - China’s 113 key cities are reporting air quality data in real-time (see also smart phone app)
Change in China After 2009

• Post-Olympics: factories re-opened, or expanded and relocated outside of central business districts
• Pollution levels increase, and type of pollution changes- increased fine particulate, ozone
• Visibility impaired
• Factory closings continue, but rate of closing insufficient to keep pace with rate of economic growth
Awakening of Public Interest in Air Quality

- Daily air pollution reports: “Blue Sky Days” do not comport with what the public is seeing and breathing. “Why do I have to keep my kid home from school or sports if it’s a Blue Sky Day?”
- US Embassy, Beijing: PM2.5 monitor installed. Monitor meets US EPA requirements, data collected and reported as service for US employees and ex-pats (US does this routinely in other countries too).
- Twitter-feed, iPhone app: people compare US Embassy data with that being officially reported
- Growing middle class aware of pollution, and wants more say in approval of new plants
AirNow Operated During the 2010 Shanghai Expo

**Program Goals**

- Exchange environmental data internationally
- Make advances in air quality knowledge and applications
- Build a community of people and organizations
- Software same as U.S. system
- Share with interested countries!

**Shanghai Environmental Monitoring Center for the 2010 World Expo**
Increased Transparency of Pollution Data

• Government Initiatives
  – hourly air quality data in each monitoring stations in 113 cities
  – AirNow (EPA, Shanghai—other places)
  – Emission information of enterprises

• NGO Initiatives
  – IPE (Institute of Public and Environmental Affairs): “China Air Pollution Map”, non-compliance records+ locate major emitters + air quality data
  – NRDC: rating of cities based on transparency
  – Clean Air Initiative-Asia: scorecard for cities based on quality of air pollution program
  – Choke Point China: Wilson Institute
They discharge over 65% of China’s water and air pollutants.
“Thousands of people besieged a government office in a southern Chinese town Tuesday and blocked a highway to demand a halt to a planned coal-fired power plant because of concerns about pollution, protesters said.”
November 2011: PM2.5 Becomes Cause Celebre

- Beijing air quality in October and November consistently poor
- Over two week period:
  - China demands that US Embassy shut down their PM2.5 monitor
  - China asks US to permit China to monitor at location next to Embassy, or to have US and China co-locate monitors
  - China declares that its PM2.5 data are fine, that the US data are incorrect
  - China announces that PM2.5 pollution is a problem in Beijing, but says pollution is coming from other provinces
  - China announces that PM2.5 will be a major environmental focus during the 12th Five Year Plan. Announces plans to accelerate implementation of control measures, cleaner fuel standards, adoption of more protective PM2.5 standard, and adoption of new air quality index to supplement the existing index that is used to calculate “Blue Sky Days”
- Next slide: CCTV video clip at conference featuring top Chinese and American air quality officials
“China Isn’t Doing Anything About the Environment”

- 72 GW of older, inefficient power plants shutdown 2006-2010 (more are being closed in 2011-2015) (equivalent to capacity of nearly three New England electricity grids)
- Energy intensity targets: reduce 40-45% by 2020
- Sulfur dioxide reduced by 14.3% between 2006-2010. 12th Five Year Plan: requires additional 8% reduction in SO2 and 10% reduction in NOx (2011-2015)
- Plans to install emission to reduce NOx emissions from 300 GW of power plants between 2011-2015
- Top 1000 and Top 10,000 programs to improve energy efficiency of industrial plants
- Bonuses and promotions of government officials based on their abilities to meet targets in Five Year Plans
- Differential pricing: power companies that install air pollution controls are paid slightly higher rate and are dispatched sooner
Key Regions Described in State Council’s Regional Air Quality Guidance

1. Central Liaoning [Province] (Shenyang etc.)
2. Shandong Peninsula (Qingdao etc.)
3. Greater Wuhan
4. Changsha, Zhuzhou and Xiangtan region
5. Chengdu and Chongqing region
6. Areas around Taiwan Strait (Xiamen etc.)
7. Shanxi [Province] (Taiyuan etc.)
8. Shaanxi [Province] (Xi’an etc.)
9. Xinjiang [Province] (Ürümqi etc.)
10. Gansu [Province] (Lanzhou)

= Economic Zones
= City Clusters

Energy solutions for a changing world
Current Local Coal Cap Pilots: 2020

(3 Regions and 6 City Clusters)

- **2011-2015:**
  3 Regions:
  Beijing-Tianjin-Hebei region/
  the Yangtze River Delta/
  Pearl River Delta

- **2016-2020:**
  6 City Clusters:
  Central Liaoning
  Shandong Peninsula
  Wuhan
  both sides of the Taiwan Straits
  Changsha, Zhuzhou and Xiangtan
  Chengdu and Chongqing

Current Local Coal Cap Pilots: 2020
(3 Regions and 6 City Clusters)
Low-Carbon Demonstrations
NDRC Pilots in 5 provinces and 8 cities

Coal Production: Inner Mongolia and Shanaaxi

Coal Consumption: Jiangsu and Guangdong
Indicative Local Coal Caps: Roadmap 2010-2030

2011-2015:
Beijing, Shanghai, Guangdong pilot cities and all provincial cities in the eastern regions

2016-2020:
All cities in the eastern regions and provincial cities in the middle regions

2021-2025:
All cities in the middle regions and provincial cities in the western regions

2026-2030:
All 650 cities in the country
Current Local Coal Cap: Beijing
12th Five Year Energy Plan

- Natural Gas (100 M cm)
  - 2010: 75
  - 2015: 180
- Electricity (100 M kWh)
  - 2010: 810
  - 2015: 1100
- Fuels (10000 ton)
  - 2010: 1408
  - 2015: 1680
- Coal (10000 ton)
  - 2010: 2750
  - 2015: 2000
- Total Energy (10000 ton)
  - 2010: 6940
  - 2015: 9000
- CO₂ Emissions (10000 ton)
  - 2010: 19287
  - 2015: 23746

Date Source: Beijing 12th Five Year Energy Plan, 2011
Use of Emissions Data to Administer SO$_2$ Pricing

2007年江苏省统调燃煤机组脱硫设施运行指标变化示意图
Change in Performance at Coal-fired Units with FGD in Jiangsu Province 2007

SERC begins using CEMS data to administer price premium for FGD implementation

- Yellow line: Generation Enterprises Operating with FGD (%)
- Green line: Desulfurization Efficiency (%)
- Red line: SO2 Emissions Concentration (mg/cubic meter)
Global Wind Power Installations

ANNUAL INSTALLED CAPACITY BY REGION 2003-2010

Source: Global Wind Energy Council
Actions/ Next Steps

• Staffing and resources
  – MEP staff: hundreds (need 10x more at least)
  – National air law weak compared to US
  – National level enforcement inconsistent, low penalties
  – Local staff resources better, and some local agencies issue significant penalties

• Multi-pollutant air quality plans can be more cost-effective and achieve same or better environmental outcome
  – Current China work
  – US state approaches
Big Picture on Staffing

人员编制总览

US EPA
美国环保署
(Thousands 数千)

State Agencies
州级机构
(10s of thousands 数万)

Local Governments
地方政府
(100s of thousands 数十万)
The developed world spends approximately ~1.2% of GDP on pollution control.

This figure excludes public works projects and private investment.

SOURCE (来源): OECD Environmental Indicators, p. 104.
Synergistic Effects of Multi-pollutant Planning

Costs for reducing air pollution effects on health by 50%

- GHG emission control measures
  - Increase energy efficiency
    - of the general public
  - Increase energy efficiency
    - of industrial production
  - Implement cogeneration
  - Reduce power consumption and develop renewable energy sources
  - Air pollution control measures
  - PM control for general public
  - PM control for large production plants
  - NOx control for large production plants
  - SO2 control for large production plants

GAINS model optimization
Adopt measures for control of pollution only at terminals.

Health loss under same air pollution
Adopt synergistic control measures of the integration strategy of climate and environment
Co-control potential for project types – lessons from China’s CDM project portfolio

不同项目类型的协同控制潜力——中国CDM项目组合的经验教训

Energy eff. (Supply-side and Industry)
提高能效（供应方和工业）
Energy eff. (Own production at plant level)
提高能效（现场的能效水平）
Fossil fuel switch
化石燃料转型
Biomass PP (crop residues)
生物质电厂（秸秆）
Zero Emission Renewables (hydro, wind..new PP)
零排放可再生能源(水力、风力、新电厂)
Waste
废弃物
Coal bed methane
煤层气
Cement
水泥

(Based on Rive and Aunan, 2009, work in progress)
2004 NAS Report on Air Quality Management in the United States
Fewer Episode Days
China Announces Pilot Cap and Trade Program for Carbon Emissions

• [http://www.eenews.net/climatewire/2012/10/15/99](http://www.eenews.net/climatewire/2012/10/15/99).

• “China's Guangdong province kicked off a pilot program last month, the largest of seven such programs in the country, with four cement makers buying 1.3 million pollution permits for 60 yuan ($9.57) a metric ton. Exchanges will be set up on the national market that, in three years, will trade permits to emit 1 billion metric tons of greenhouse gases.

• China's domestic emission trade will cover 800 million to 1 billion tons in emissions, close to half the 2.18 billion tons in the E.U. system”
Conclusions

• China’s growth, expansion of middle class, causing serious environmental problems
  – We know more than we did in 1960. Problems can be solved simultaneously instead of pollutant by pollutant
  – Solutions informed, but not burdened by existing approaches
  – Learn from and adapt western models to a Chinese context
  – It’s taken US 40 years to significantly improve its environment. China needs the same sustained commitment to improve over the long-term, with short-term review and progress assessment.
Discussion Questions

• What policies could China implement to accelerate the timing when coal consumption peaks? Is there a role for other countries? If so, what?

• Much environmental damages are created from emphasis on short-term economics, how can countries properly account for environmental affects of development?

• The public pays for environmental damage and public health effects (hospital visits, lost work days, etc.) from economic inefficiencies. How could this be improved?
About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

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