Sustainable Development of Coal Value Chain in China and the U.S.

Linwei Ma

Tsinghua-BP Clean Energy Center
Department of Thermal Engineering
Tsinghua University, Beijing 100084

March 7 2013 @ Washington DC
Outline

Part 1
Energy use of coal in China and a comparison with US

Part 2
Three strategic issues for the sustainable development of coal value chain in China and policy implications for Sino-US collaboration
The role of coal in the energy use of the two countries

**China**
- The dominant energy source, occupying 68% in total primary energy consumption in 2011
- Total coal consumption is rapidly increasing

**The U.S.**
- The 3rd largest energy source, occupying 20% in primary energy consumption @ 2011
- Total coal consumption is rapidly decreasing
How coal is used in China - energy flow diagrams

- Main characteristics: underground mining, diversified end-use, industrial demand
- Ongoing trends: surface mining↑, coal import ↑, coal washing↑, and power generation↑
The structure of coal use in conversion and end-use

China’s coal use in coal conversion stage

- Direct Fuel Use: 30.0%
- Electricity & Heat: 48.7%
- Coking & Gas Works: 19.5%
- Non-Fuel Use: 2.4%

2005

China’s coal use in end-use sectors

- Industry & Construction: 71.4%
- Own Use: 20.2%
- Other: 8.6%
- Non-Fuel Use: 2.4%

2005

2010

2010
The energy efficiency of coal use in China

- Improving total efficiency of coal use: 52.5% @2005 → 53.1% @2010
- Improving efficiency of power generation: 374 gce/kWh @2005 → 335 gce/kWh @2010

Energy Efficiency Diagram of Coal, China, 2005
Unit: 100 million tce

Energy Efficiency Diagram of Coal, China, 2010
Unit: 100 million tce
Comparing the coal use in the U.S. and China (2010)

- Total scale: 6.8 Mtce for US and 22.7 Mtce for China as measured by coal products supply
- Raw coal supply: US has more surface mining and is a net exporter of coal
- Coal conversion: US uses 95.6% of coal for power generation
- Energy end-use: US had more diversified use (industrial, residential and commercial etc.)

The structure of coal utilization in conversion sectors of China and the U.S.

The structure of coal utilization in end-use sectors of China and the U.S.

Simplified Coal Flow Diagram, China, 2010
Unit: 100 million tce

The definitions of end-use sectors are different with previous charts.
Strategic issues for the sustainable development of coal value chain in China

① How to control the energy demand for coal?

② How to avoid overcapacity problems?

③ How to use coal more efficiency and cleaner?
① How to control the energy demand for coal?

<table>
<thead>
<tr>
<th>Why is it important?</th>
<th>Underlying mechanism</th>
<th>Strategic solution and collaboration opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Indigenous coal production capacity is restricted by many factors</td>
<td>• The demand of coal is decided by end-use energy demand and the scale of alternative energy sources</td>
<td>• To promote the development of energy-saving &amp; low carbon towns as economic structure and energy service level is shaping during the rapid urbanization</td>
</tr>
<tr>
<td>• Coal contains more potential pollutants and carbon per unit energy</td>
<td>• The huge end-use energy demand is mainly because of infrastructure building and products export</td>
<td>• Energy consumption towns</td>
</tr>
<tr>
<td>• The problems is not that we like coal, but have no other choice once huge new energy demand generated</td>
<td>• Urbanization will become more important than industrialization as energy demand driver</td>
<td>• Energy supply towns</td>
</tr>
</tbody>
</table>
Coal demand for power generation – 2030 scenarios
① How to control the energy demand for coal?

<table>
<thead>
<tr>
<th>Why is it important?</th>
<th>Underlying mechanism</th>
<th>Strategic solution and collaboration opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Indigenous coal production capacity is restricted</td>
<td>• The demand of coal is decided by total energy demand of specific energy and the scale of alternative energy</td>
<td></td>
</tr>
<tr>
<td>• Coal contains more potential pollutants and carbon per unit energy</td>
<td>• The huge end-use energy demand is mainly because of infrastructure building and products export</td>
<td></td>
</tr>
<tr>
<td>• The problems is not that we like coal, but have no other choice once huge new energy demand generated</td>
<td>• Urbanization will become more important than industrialization as energy demand driver</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• To promote the development of energy-saving &amp; low carbon towns as economic structure and energy service level is shaping during the rapid urbanization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Energy consumption towns</td>
<td>• Energy supply towns</td>
</tr>
</tbody>
</table>

2013/3/18
Drivers of energy demand in China

The amount of final services are all domestic consumption except structure.
① How to control the energy demand for coal?

<table>
<thead>
<tr>
<th>Why is it important?</th>
<th>Underlying mechanism</th>
<th>Strategic solution and collaboration opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Indigenous coal production capacity is restricted</td>
<td>• The demand of coal is decided by total energy demand of specific energy and the scale of alternative energy</td>
<td>• To promote the development of energy-saving &amp; low carbon towns to shape a low carbon economy and society</td>
</tr>
<tr>
<td>• Coal contains more potential pollutants and carbon per unit energy</td>
<td>• The huge end-use energy demand is mainly because of infrastructure building and products export</td>
<td>• Energy consumption towns</td>
</tr>
<tr>
<td>• The problems is not that we like coal, but have no other choice once huge new energy demand generated</td>
<td>• Urbanization will become more important than industrialization as energy demand driver</td>
<td>• Energy supply towns</td>
</tr>
</tbody>
</table>

• To promote the development of energy-saving & low carbon towns to shape a low carbon economy and society
  • Energy consumption towns
  • Energy supply towns
The development of low-carbon towns in China

A low-carbon town (LCT) in China is a town with clear targets and concrete actions planned to realize both a considerable reduction of CO₂ emissions intensity in the short term and a smooth transition to a low-carbon economy and society in the long term.
An example of the development of coal-rich regions in China – ‘Golden Triangle of Energy’

Plan in 2015

- **East Ningxia**
  - Coal production > 100 Mt/a
  - Coal power 15 GW
  - Coal chemicals 26 Mt/a

- **Ordos**
  - Coal production 550 Mt/a
  - 30% will be converted into power & chemicals
  - Coal power 20 GW, DCTL 5 Mt/a

- **Yulin**
  - Coal production 400 Mt/a
  - 50% will be converted into power & chemicals
  - Coal chemicals ~50 Mt/a
## How to avoid overcapacity problems?

<table>
<thead>
<tr>
<th>Why is it important?</th>
<th>Underlying mechanism</th>
<th>Strategic solution and collaboration opportunity</th>
</tr>
</thead>
</table>
| • Driving by rapidly growing market, overcapacity problems occurred in the whole coal value chain | Demand release ↑↑ → production capacity ↑↑ → high cost capacity ↑ → average price ↑ → economic competitiveness ↓ → price fluctuation → harmful for both supply and demand side | • To properly expect the future demand and guide the demand  
• Dynamically balancing the supply capacity including indigenous supply and global supply to realize a minimum life-cycle cost |
| • Rapid expansion of capacities of coal production, power generation and coal chemicals, including high cost capacities | | |
Overcapacity causes the waste of energy used for building the capacity

Option 1: meet the demand by maximum production capacity

Option 2: lower production capacity and compensation by import of low cost resources

A huge waste of capacity

Waste of capacity is reduced

Partially indigenous

Import
To dynamically balancing the coal supply capacity

China’s demand  \(\leftrightarrow\) Global demand

China’s supply \(\rightarrow\) Global supply

Decided by the best LC economics

Least total resource consumption and cost is the goal to pursue
How to use coal more efficient and cleaner

- Green coal mining & utilization of CBM
- Promote coal treating according to coal types
  - Thermal & coking coal: nearly 100% washing
  - Low/mid temperature pyrolysis for polygen of gas, chemicals, liquids etc.
- Promote polygen based on coal gasification/liquefaction
  - IGCC/PC + coal chemicals/coal to liquids $\rightarrow$ polygen +CCUS
  - Integrate with other energy sources (NG, oil, wind, solar, biomass etc.)
- Improve the efficiency of conventional coal-fired power
  - Existing plants: retrofit & management
  - New plant: USC $\rightarrow$ 700C $\rightarrow$ higher
- Retrofitting of coal-fired industrial boilers
- Utilization of waste heat & materials in coal use…
Thanks for your attention!

Email: malinwei@tsinghua.edu.cn