



# China's Progress in Energy Efficiency and Emission Reduction and Implications for CHINA-JAPAN-U.S. Cooperation

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## Outlines



- Background: rising China's greatest transformation
- Progress in China's the energy efficiency and emission reduction
- PESD's research for China's low carbon future: CCS in China as a case study
- Implications: understanding China's domestic political economy and align with China's domestic incentives
- Conclusion and implications

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## Background: Rising China's Greatest Social Economic Transformation



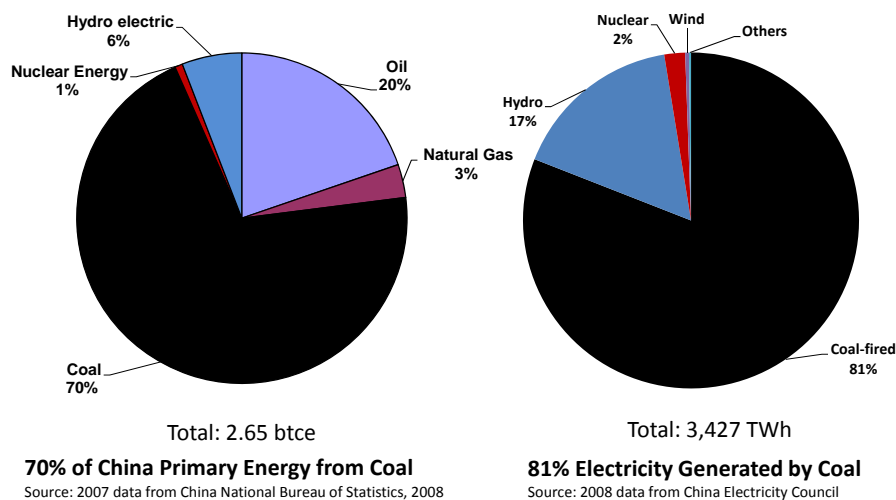
- Greatest transformation
- Four major socio-economic transformations
  - Industrialization
  - Urbanization
  - Motorization
  - Modernization
- General socio-economic target
  - 2000, well off society
  - 2020, all round well off society
  - 2050, middle developed countries level

Why China's energy and climate problems are extremely challenging?

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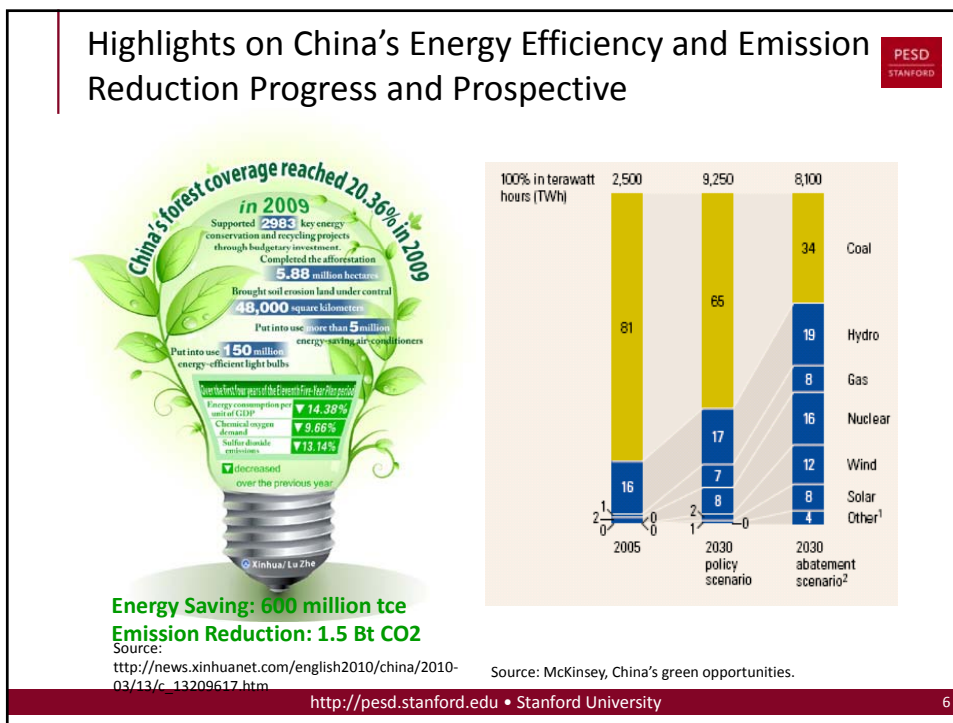
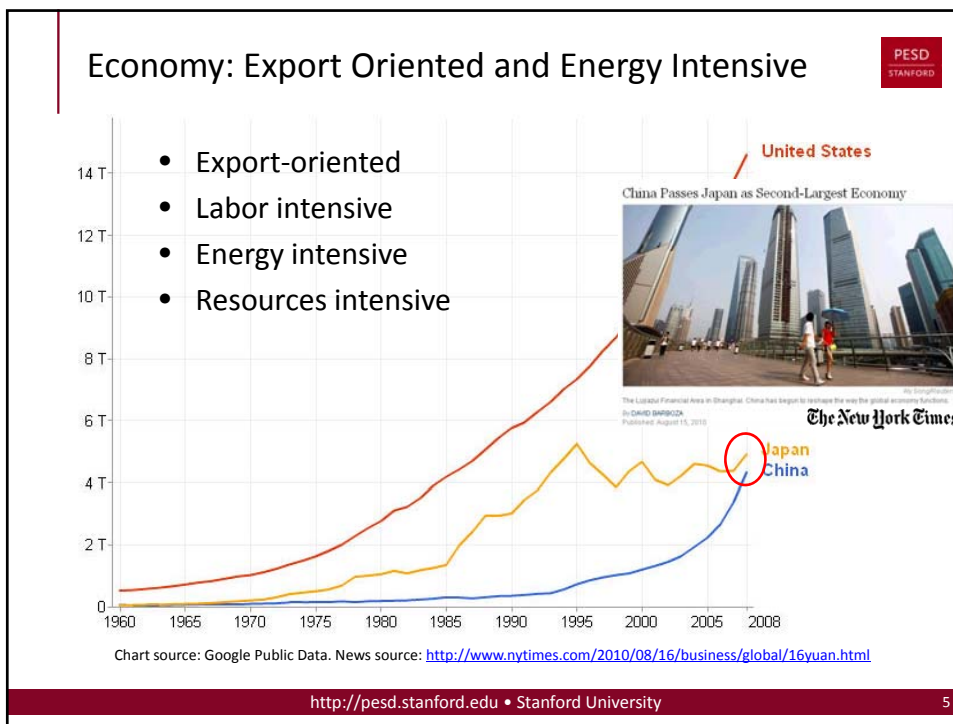
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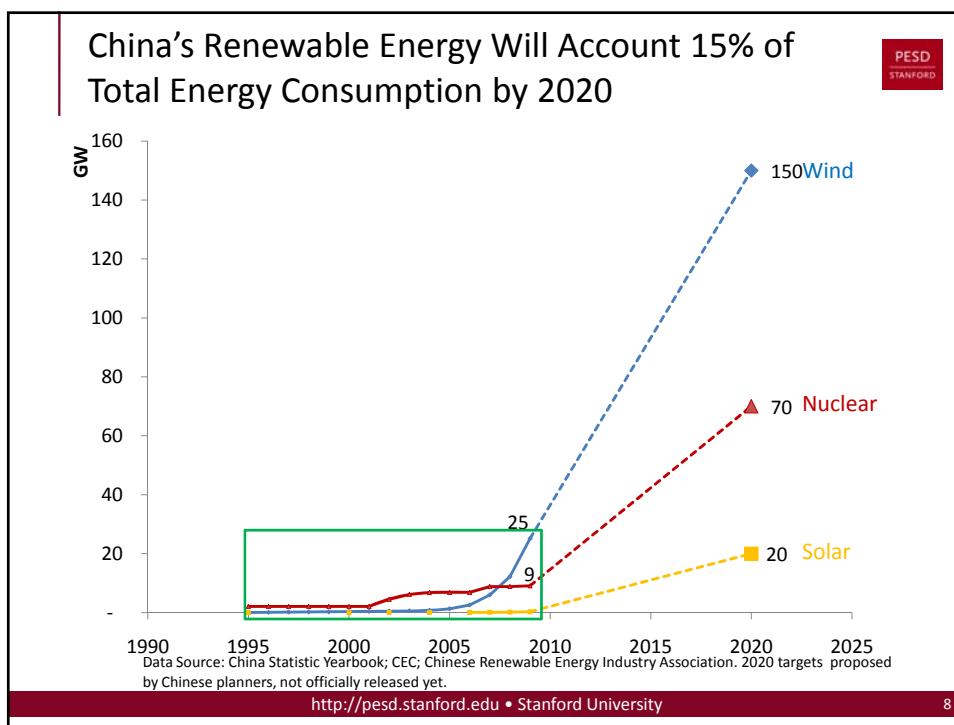
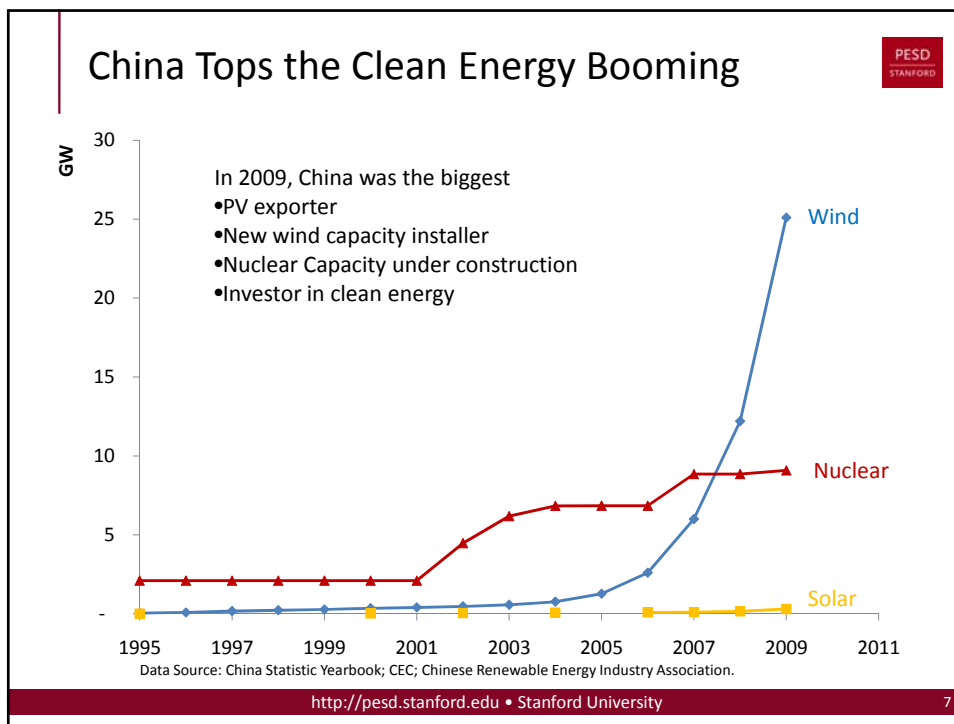
## Coal Dominates China's Primary Energy and Power Supply



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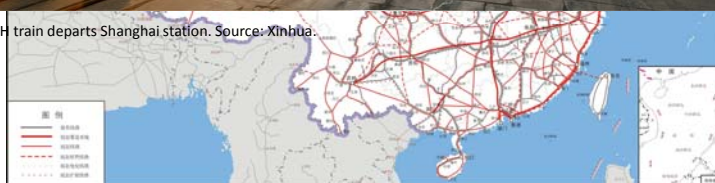


## China's Green Infrastructure: High-speed train and High-voltage Transmission Lines

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A CRH train departs Shanghai station. Source: Xinhua.



Source: Ministry of Railway, 2008

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## Towards Market Oriented Environment and Climate Governance

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- 11<sup>th</sup> five year plan mostly rely on command and control
- Carbon tax, environmental tax and climate tax in discussion
- China is discussing a Cap-and-Trade demonstration project
  - Key energy intensive sectors: power, oil, chemical; SOEs
  - Low-carbon demonstration cities: Tianjin, Liaoning, etc
- It's not a big deal but has big implications
  - Domestically: show the transformation, building the capacity and infrastructure for future implementation
  - Internationally: deliver a clear message of China's take on climate change
- Try and test: will first be voluntary , to see how it can work

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## Stanford University Program on Energy and Sustainable Development

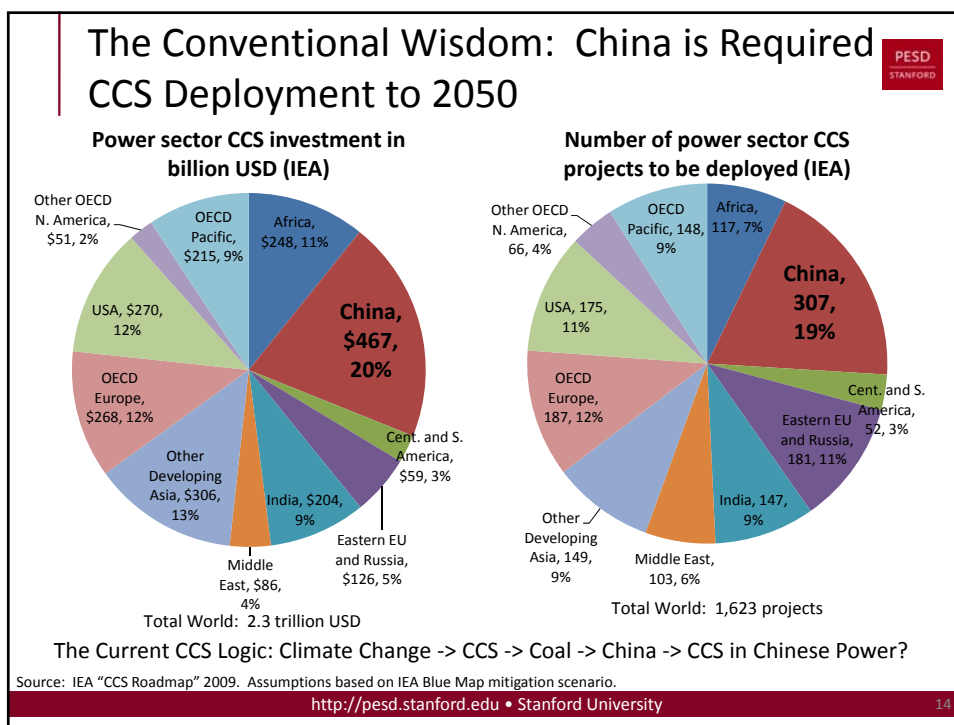
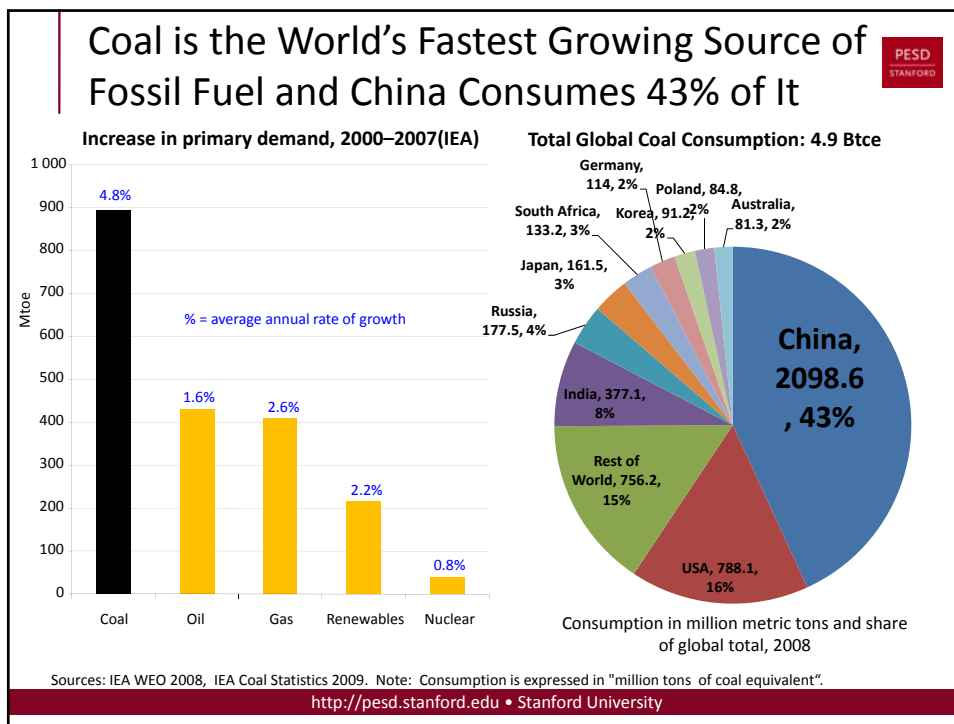


- Initiated in 2001
- Works on political, economic and institutional perspective of global energy system
- Completed research
  - 1) Electricity Markets and Power Sector Reform
  - 2) Global Natural Gas Markets
- Active research
  - 1) Climate Change Policy
  - 2) The Global Coal Market
    - Business Models for Carbon Capture & Storage (CCS)
  - 3) National Oil Companies and the World Market
  - 4) Building a Low-Carbon Electricity Industry and the “Smart Grid”
  - 5) Low-Income Energy Services

## Highlight Research on China's Low Carbon Future



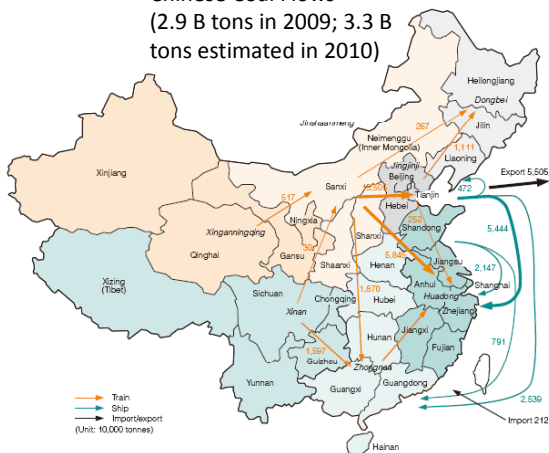
- China's coal and power sector
  - Industry organization
  - Coal and power sector reform
  - China's clean coal technology
    - Carbon capture and storage
- Carbon policy and Clean Development Mechanism Reform
- Increasing research on
  - Fuel switch to natural gas
  - Integrating renewable energy to the smart grid



## CCS at Scale Could Harm China's Energy Security



Chinese Coal Flows  
(2.9 B tons in 2009; 3.3 B tons estimated in 2010)



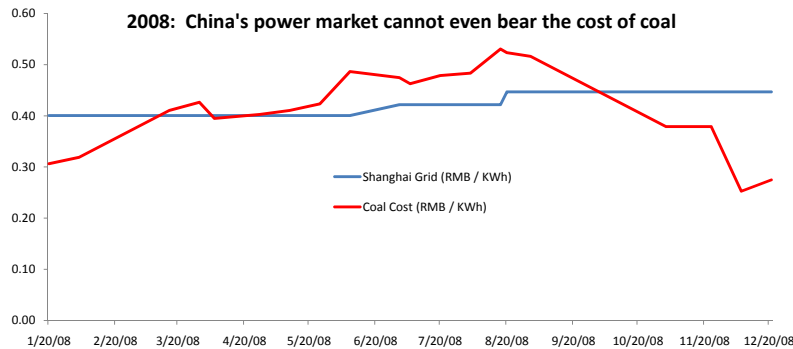
CCS at scale requires an extra 200-300 million tonnes of coal

- Coal railway bottlenecks already a major constraint
- CCS at scale implies huge additional infrastructure costs
  - new coal production
  - additional rail build
  - additional port capacity
  - additional shipping capacity
  - **Total est. additional costs: ~USD 50 billion**

Source: IEA CCC 2007, Coal Supply Challenges for China.

Note: Our calculations show that achieving IEA's Blue scale requires 375 GW (gross) CCS-equipped coal capacity. Assumptions: 50% gross efficiency; 5% auxiliary consumption; 10% efficiency loss from capture; that is, 35% net efficiency with capture; 85% capture rate; 0.8 plant load factor. Given that today's ~600 GW of coal capacity consumes 1.2 billion tonnes per year coal, an additional 25% for 375 GW (due to decreased efficiency) would represent an additional 190 million tonnes of coal (conservatively).

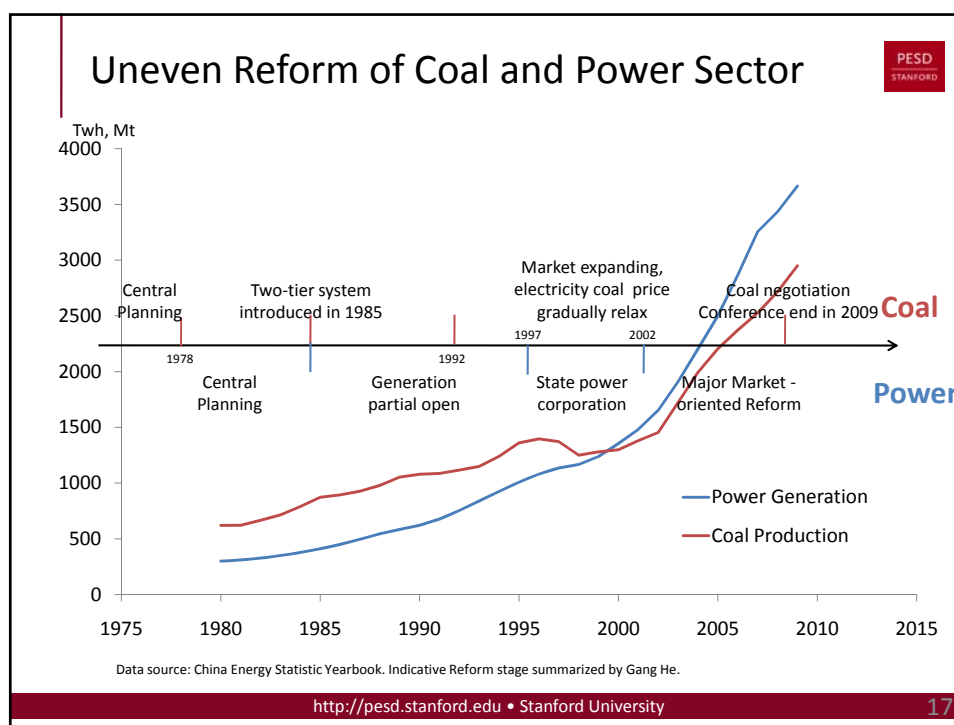
## Coal-power Conflict: Why International Financial Mechanism is Needed for Scaling up CCS in China



- Cheap power to fuel economic development and tame inflation is a political imperative that constrains cost recovery for CCS at scale
- Chinese power companies lost RMB 70 billion (USD 10 billion) in 2008 because power prices remain tightly controlled by the central government while coal prices are not, illustrating a key problem: the power market cannot internalize increased costs
- Without power markets that allow for cost recovery, scaling of CCS technology is likely to prove elusive

Source: He and Morse. Power price is Shanghai grid as reported by Shanghai Development and Reform Commission. Coal price is Qinhuangdao spot price as reported by Reuters.





## China's Core Interests in Energy Supply and Climate Policy Implications

- Economic growth and macroeconomic/social stability
  - "Energy security": ensure lack of energy doesn't impede growth → supply diversification, efficiency improvement
  - Keep energy prices low to end users: economic growth and social stability
  - Develop leadership in energy technology manufacture
- Reduction of local pollution
  - Pollution controls on coal plants
  - Efficiency improvement
  - Fuel switching away from coal
- Climate change mitigation
  - Efficiency improvement
  - Fuel switching away from coal

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## Lessons: Strongest Motivation Emerges Where Goals Align!



### For Example

- Higher-efficiency coal technology (e.g., USC, IGCC)
  - Energy Security: **POSITIVE** (better efficiency)
  - Technology Capability Development: **POSITIVE**
  - Pollution Reduction: **POSITIVE** (better efficiency, less pollutant)
  - Climate Mitigation: **POSITIVE** (better efficiency)
- Post-Combustion Carbon Capture and Storage (CCS)
  - Energy Security: **NEGATIVE** (energy penalty need even more coal)
  - Technology Capability Development: **POSITIVE**
  - Pollution Reduction: **NEUTRAL**
  - Climate Mitigation: **POSITIVE**

## China's CCS Projects Align with the Analysis



CCS Projects	Technology	Partnership model	Financial arrangement	Status
GreenGen Corporation	IGCC Pre-combustion de-carbonisation Gasification or partial oxidation shift plus CO <sub>2</sub> separation.	Huaneng with seven other state-owned companies Peabody Energy	Registered capital: RMB 300 million (USD 44 million) Huaneng 51%, and other 7 in the group 7% each Total investment will reach RMB 7 billion.	Under construction
Shenhua CTL	Coal to synfuels (direct coal liquefaction)	Shenhua Group Sasol West Virginia University	USD 1.4 billion	CTL operational, CCS expected to start in late 2009
Huaneng Beijing Thermal Power	Post-combustion	Huaneng Australia CSIRO	USD 4 million research project by CSIRO	Operational since 2008
Near Zero Emission Coal	R&DD	UK China Ministry of Science and Technology	USD 5.6 million equivalent from the UK Government's Department of Energy and Climate Change	In planning stages
COACH Project (Cooperation Action within CCS China-EU)	R&DD	COACH project groups 20 partners (R&D, Manufacturers, Oil & Gas Companies, etc) 12 for Europe and 8 for China	Partially funded by European Union	In planning stages
Shanghai Huaneng Shidongkou	Post-combustion	Huaneng	Corporation investment	Under construction

Source: Summarized from company profile and news.

## Final Comments: Low-Carbon Opportunities in China's Energy/Power Sector



- Efficiency: Using coal more efficiently
  - Supercritical/Ultra-supercritical technology
  - Integrated Coal Gasification Combined Cycle (IGCC)
  - Poly-generation and co-generation
- CCS: Capture and store CO<sub>2</sub> from coal plants
- Displace coal
  - Nuclear power
  - Natural gas
- Increase the use of renewable energy
  - Won't be significant in the near future but can be a game changer
  - Not just about renewable *capacity*, need actual generation

## Things to Watch...



- 12<sup>th</sup> five-year plan: continuing energy conservation and emission reduction effort; the target won't more aggressive, but the implementation will be more market oriented
- Two major targets by 2020:
  - 40-45% emission intensity
  - 15% renewable energy
- Booming of new energy
  - Nuclear, wind, solar, biomass, ...
- Others
  - Low carbon cities demonstration
  - Environment exchange, carbon exchange setting up the infrastructure of market oriented approach
  - Carbon tax, environmental tax

## Conclusions and Take-home Messages



- China is under its greatest social economic transformation and the opportunities lie with challenges
- China is progressing aggressively in energy efficiency and emission reduction, and is leading the global clean energy revolution
- Domestic political economy has huge implication on applying international climate policy to China
- The best way to work with China is engaging China's core interests.

**Thanks!**

Questions and comments are welcome:

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