The Potential for CCS Deployment in China

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GTSP Partner Meeting, 29 May 2008
These slides represent preliminary findings from the *China: Regional Opportunities for CO₂ Capture and Storage* project, as presented in:


The final report is expected to be released in late 2008.
Regional Opportunities for Carbon Dioxide Capture and Storage in China

A Joint China-U.S. Research Collaboration

Sponsoring Government Agencies
- United States Department of Energy
- Chinese Ministry of Science and Technology

Project Team
- U.S./China Energy and Environmental Technology Center
- Leonardo Technologies, Inc.
- Battelle
- Institute of Rock and Soil Mechanics, Chinese Academy of Sciences
- Pacific Northwest National Laboratory
- Tsinghua University
- Montana State University
Why China?

- Rapidly expanding economy and energy needs (WEO 2007)
  - By 2010, China projected to become the world’s largest energy consumer and its single largest CO₂ emitter
  - Energy demand to increase at least 120% between 2005 and 2030
  - 1300 GW electric generation capacity needed by 2030
  - $3.7 trillion (2006USD) in energy supply investment needed between 2006-2030 (75% to the power sector)
  - Between 1994 and 2004, installed generation capacity more than doubled from 199 GW to 440 GW

- World’s largest coal, cement and steel producer

- Emerging CTL industry
China and Global CO₂ Storage Capacity: Improving our Understanding of a Distributed Resource

• Very preliminary estimates available for most regions of the world
• Previous and ongoing assessments in U.S., Canada, Europe, Australia, India, etc.
• Estimates for China primarily from early high level and overly conservative global assessment
• Better estimates of CO₂ storage resource and CO₂ point sources will enable more robust analyses of climate change mitigation opportunities and costs

Implications if CCS Potential is Limited in China

The use of fossil fuels is severely curtailed in carbon-constrained world.

Nuclear power and biomass must be pushed beyond cost-effective limits to meet energy demand.

These combine to result in higher energy prices and lower standards of living than if CCS were able to deploy more widely in China.
A cataloging of existing CO₂ point sources and the following types of candidate CO₂ storage reservoirs:

- Deep saline formations
- Deep unmineable coal seams
- Depleted oil and gas fields

Incorporate data integrated into GIS modeling framework to enable integrated spatial and economic analyses:

- Build CO₂ cost curve describing CCS potential versus cost
- Examine regional opportunities, economics, and technical constraints
- Collaborative effort drawing on wealth of team experience
Inventory of Large CO₂ Point Sources

- Over 1,600 CO₂ sources (100+ ktCO₂/yr each)
  - 4,300 MtCO₂/yr
  - +80% of all Chinese CO₂ emissions

Source Emissions by Type, Region (MtCO₂/yr)

- Power (74% of Emissions)
- Ethylene (1%)
- Hydrogen (2%)
- Iron & Steel (7%)
- Cement (13%)
- Ammonia (3%)
- Refineries (3%)
- Hydrogen (2%)
- Ethylene (1%)
- Ammonia (3%)
- Refineries (3%)
- Iron & Steel (7%)
- Cement (13%)
- Power (74% of Emissions)
The 500 largest sources account for over 80% of the total emissions from all 1,600+ sources.

The 100 largest sources account for over a third of China's total emissions from its 1,600+ large, stationary CO$_2$ point sources.
Understanding Regional Heterogeneities

- Nearly 250 CO₂ sources (100+ ktCO₂/yr each)
- Total estimated CO₂ emissions from these sources: 800 MtCO₂/yr
- Roughly 20% of China’s CO₂ is emitted in this region
Preliminary results indicate as much as 2,300,000 MtCO$_2$ storage capacity in onshore basins, predominantly in deep saline formations.
The Value of Cost Curves

The Net Cost of Employing CCS within the United States - Current Sources and Technology

- Large, coal-fired power plant / nearby (<25 miles) deep saline formation
- Gas-fired power plant / distant (>50 miles) deep saline formation
- Cement plant / nearby (<10 miles) depleted gas field
- Smaller coal-fired power plant / nearby (<25 miles) deep saline basalt formation
- Iron & steel plant / nearby (<10 miles) depleted gas field
- Coal-fired power plant / moderately distant (<50 miles) depleted gas field
- High purity hydrogen production facility / nearby (<25 miles) depleted gas field
- High purity natural gas processing facility / moderately distant (~50 miles) EOR opportunity
- Large, coal-fired power plant / nearby (<10 miles) ECBM opportunity
- Coal-fired power plant / moderately distant (<50 miles) depleted gas field

Net CCS Cost

- CO2 Captured and Stored (MtCO2)
- Cost of Capture ($/tonne)

Example CCS Cost Pair

Power Plants
- Post-Combustion
- Pre-Combustion

Iron / Steel Facilities

Refineries

Cement Plants

Gas Processing Plants

Cost of Capture ($/tonne)
The Value of Improving Estimates of the $CO_2$ Storage Resource in China

CCS Deployment in China is Limited

- The use of fossil fuels is severely curtailed in carbon-constrained world
- Nuclear power and biomass must be pushed beyond cost-effective limits to meet energy demand
- These combine to result in high energy prices

CCS Allowed to Deploy to Full Potential

- CCS allows increased fossil fuel use while emissions are curtailed
- A balanced, stable electricity generation portfolio is maintained
- Lower energy prices result
- $100$s of billions to a $1$ trillion in economic benefits
Cost Curve Development: Next Steps

- Finalize CO₂ source inventory and storage reservoir capacity analyses

- Complete development of economic variables and assumptions to help understand China-specific cost drivers:
  - Offshore capacity near areas with high emissions density suggests a need to better understand the economics associated with near-offshore transport and storage (e.g., Sleipner) as a key option for China

- Combine economic, demand and resource inputs into geospatial framework

- Source-sink matching via cost-minimizing algorithm to derive cost curve for CO₂ transport and storage