GTSP

Global Energy Technology Strategy Program

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The Potential for CCS Deployment in China

Casie Davidson

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Battelle
Office of Science
U.S. DEPARTMENT OF ENERGY
JGCRI Joint Global Change Research Institute
UNIVERSITY OF MARYLAND
Pacific Northwest National Laboratory
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These slides represent preliminary findings from the ***China: Regional Opportunities for CO_2 Capture and Storage*** project, as presented in:

> Dahowski RT, X Li, CL Davidson, N Wei, W Chen, F Teng, JJ Dooley, and R Gentile. 2008. "Developing Cost Curves for Carbon Dioxide Transport and Storage in China ." In *Proceedings of the Seventh Annual Conference on Carbon Capture and Sequestration*. PNWD-SA-8180, Battelle — Pacific Northwest Division, Richland, WA.

The final report is expected to be released in late 2008.

Regional Opportunities for Carbon Dioxide Capture and Storage in China

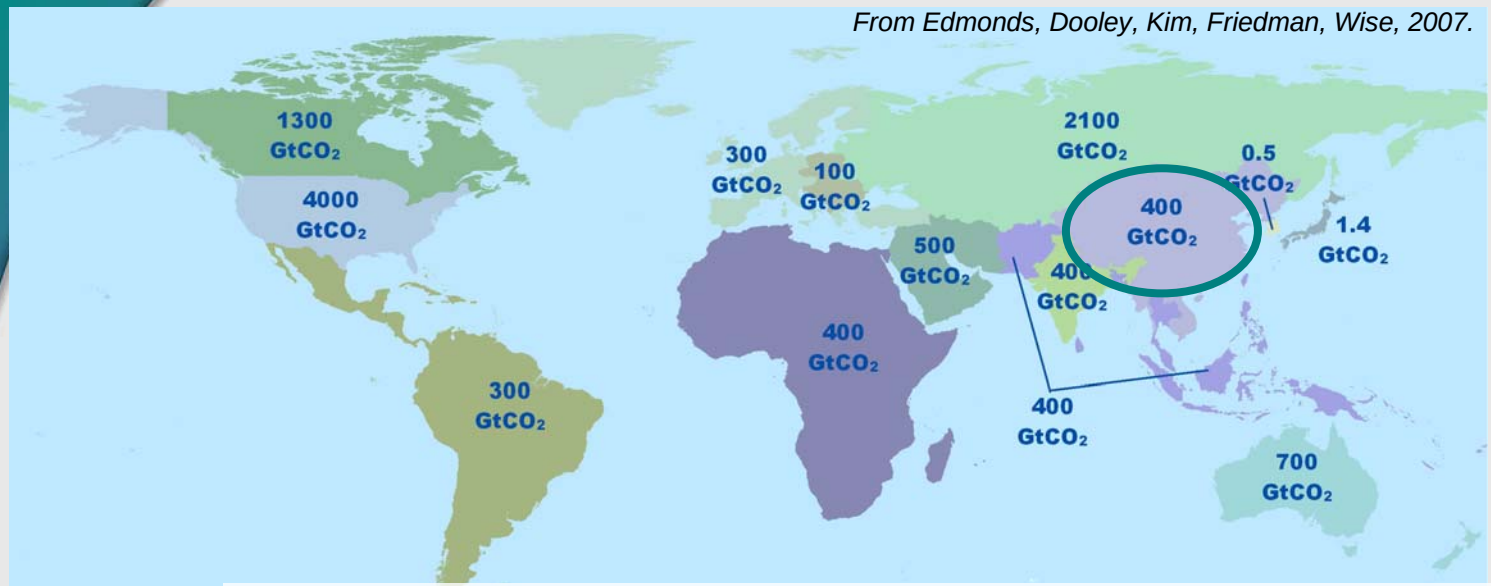
A Joint China-U.S. Research Collaboration

- 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 CO_2 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

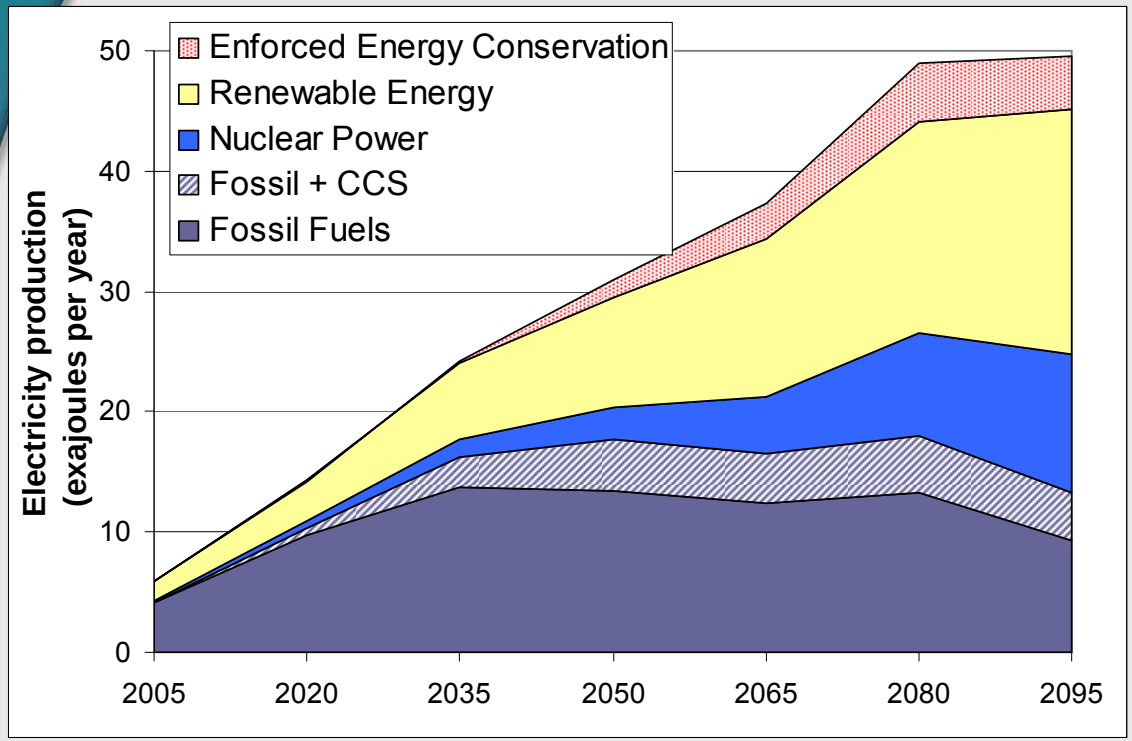
China and Global CO_2 Storage Capacity: *Improving our Understanding of a Distributed Resource*



- 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 CO_2 storage resource and CO_2 point sources will enable more robust analyses of climate change mitigation opportunities and costs

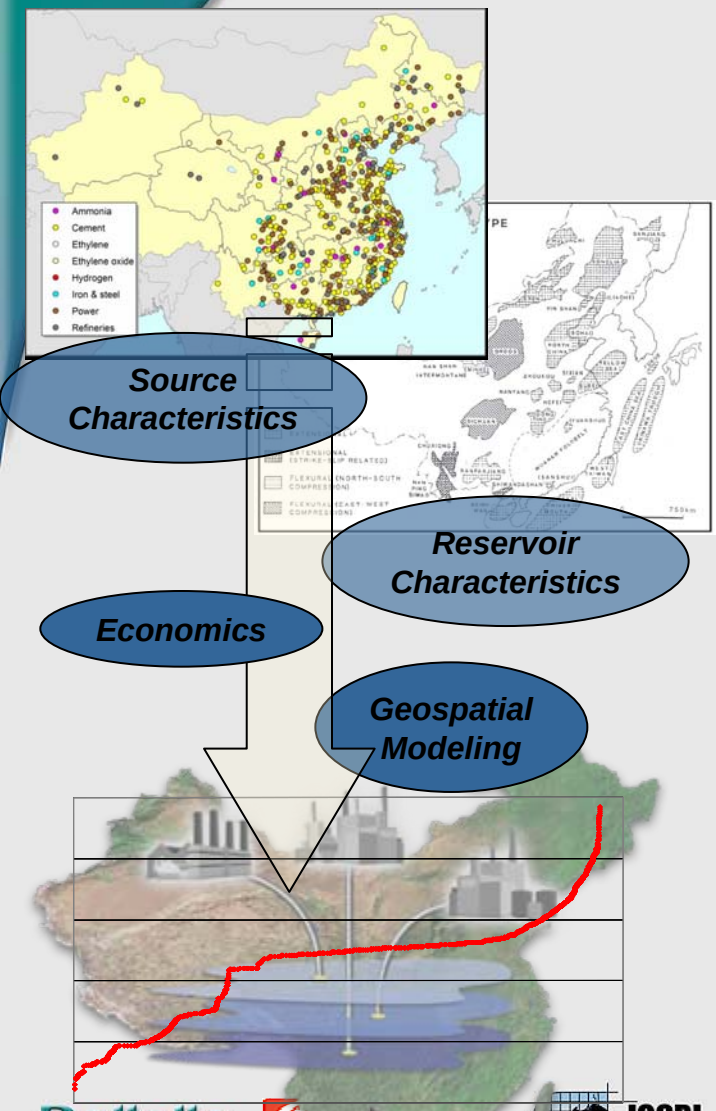
Implications if CCS Potential is Limited in China

If CCS Potential 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 higher energy prices and lower standards of living than if CCS were able to deploy more widely in China

Research Methodology

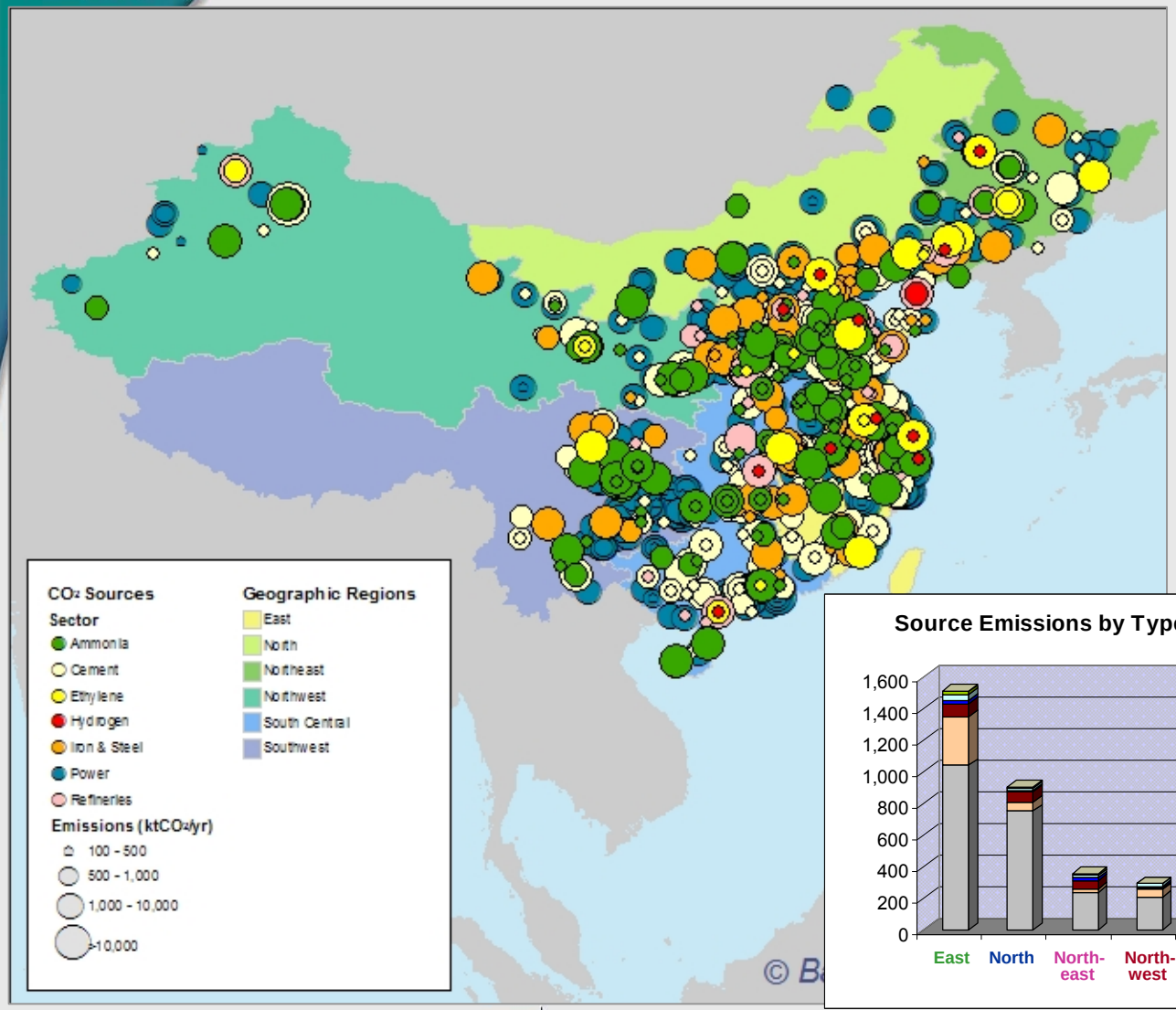


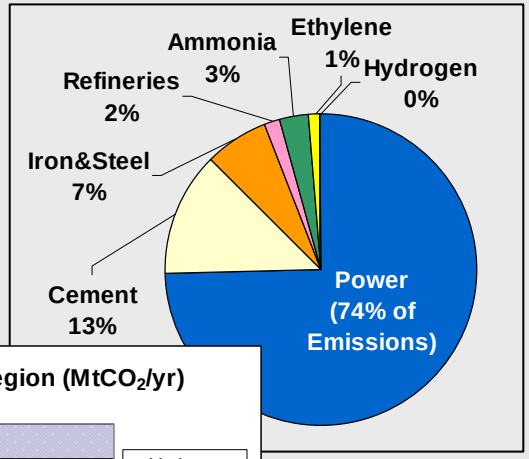
Sources + reservoirs + economics + analysis ⟶ <u>cost curves</u>

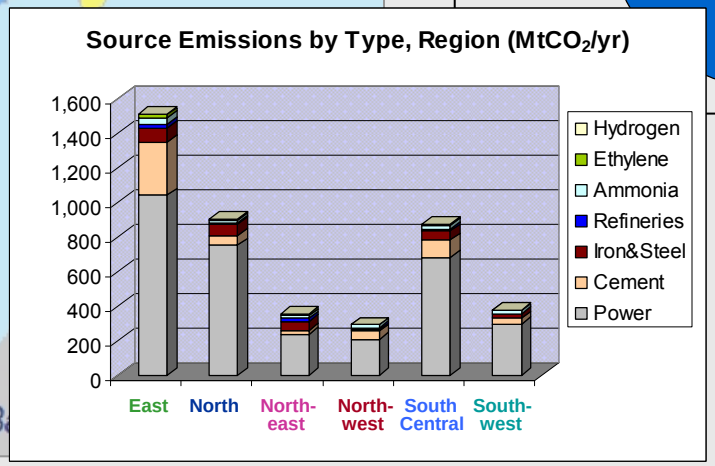
- A cataloging of existing CO_2 point sources and the following types of candidate CO_2 storage reservoirs:
  - Deep saline formations
  - Deep unmineable coal seams
  - Depleted oil and gas fields
- Incorporate data integrated into GIS modeling framework to enable integrated spatial and economic analyses
- Build CO_2 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 CO_2 Point Sources

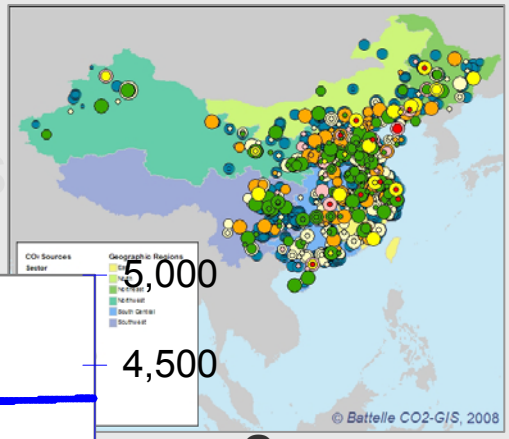
- Over 1,600 CO_2 sources (100+ $ktCO_2$/yr each)
  - 4,300 $MtCO_2$/yr
  - +80% of all Chinese CO_2 emissions

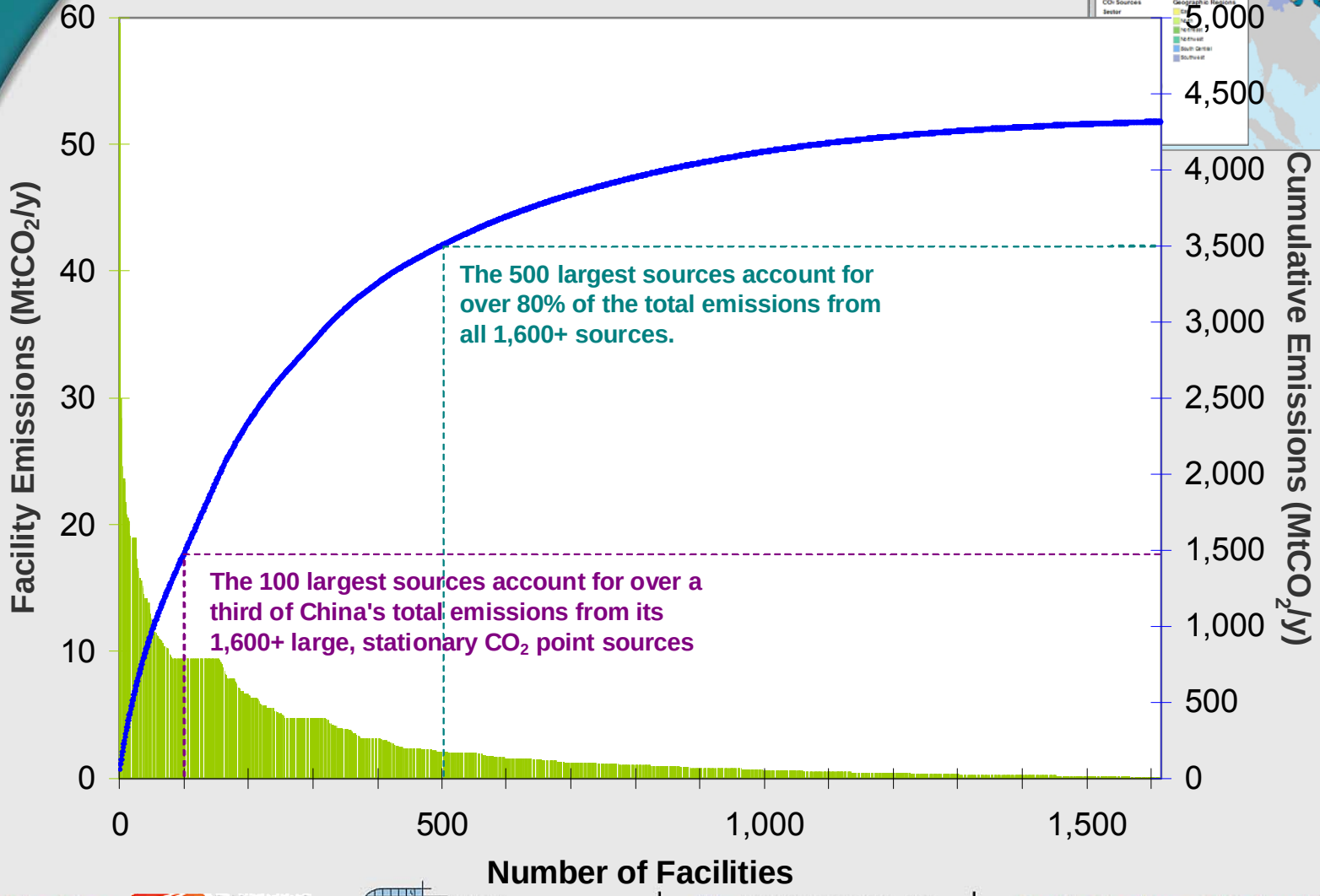




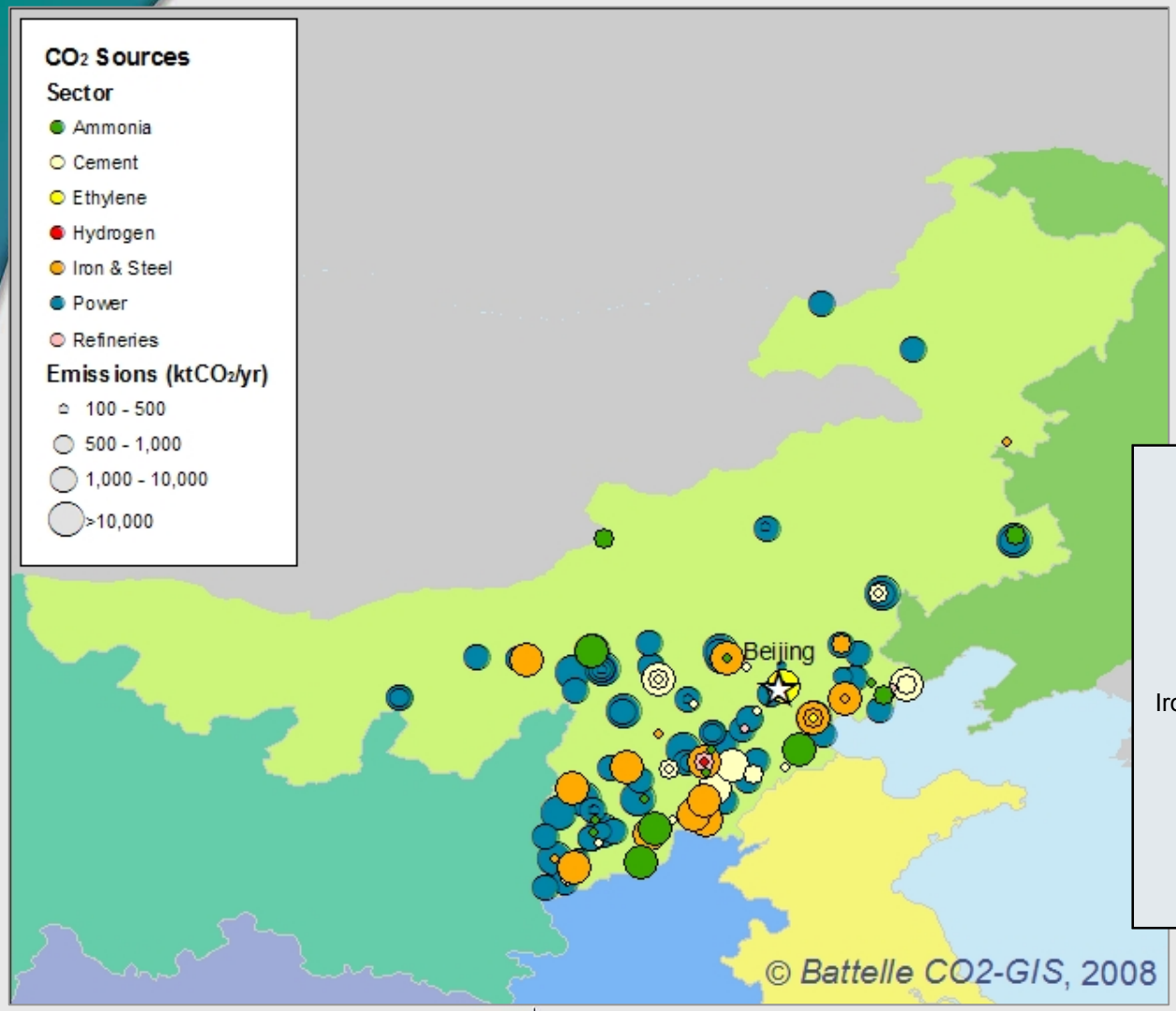


Distribution by Size of Large CO_2 Point Sources

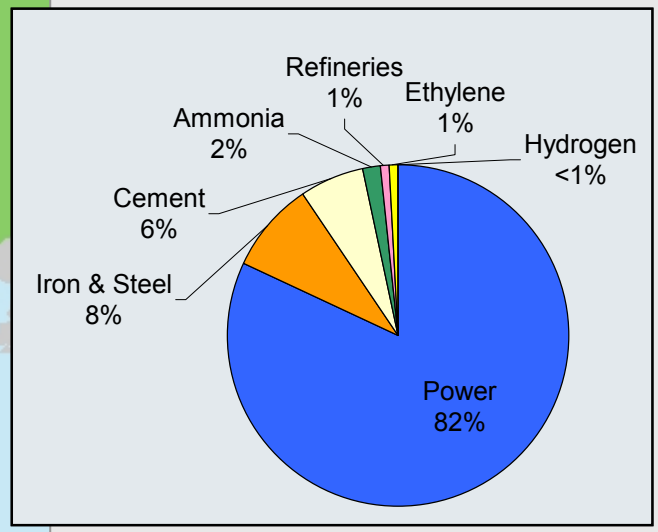




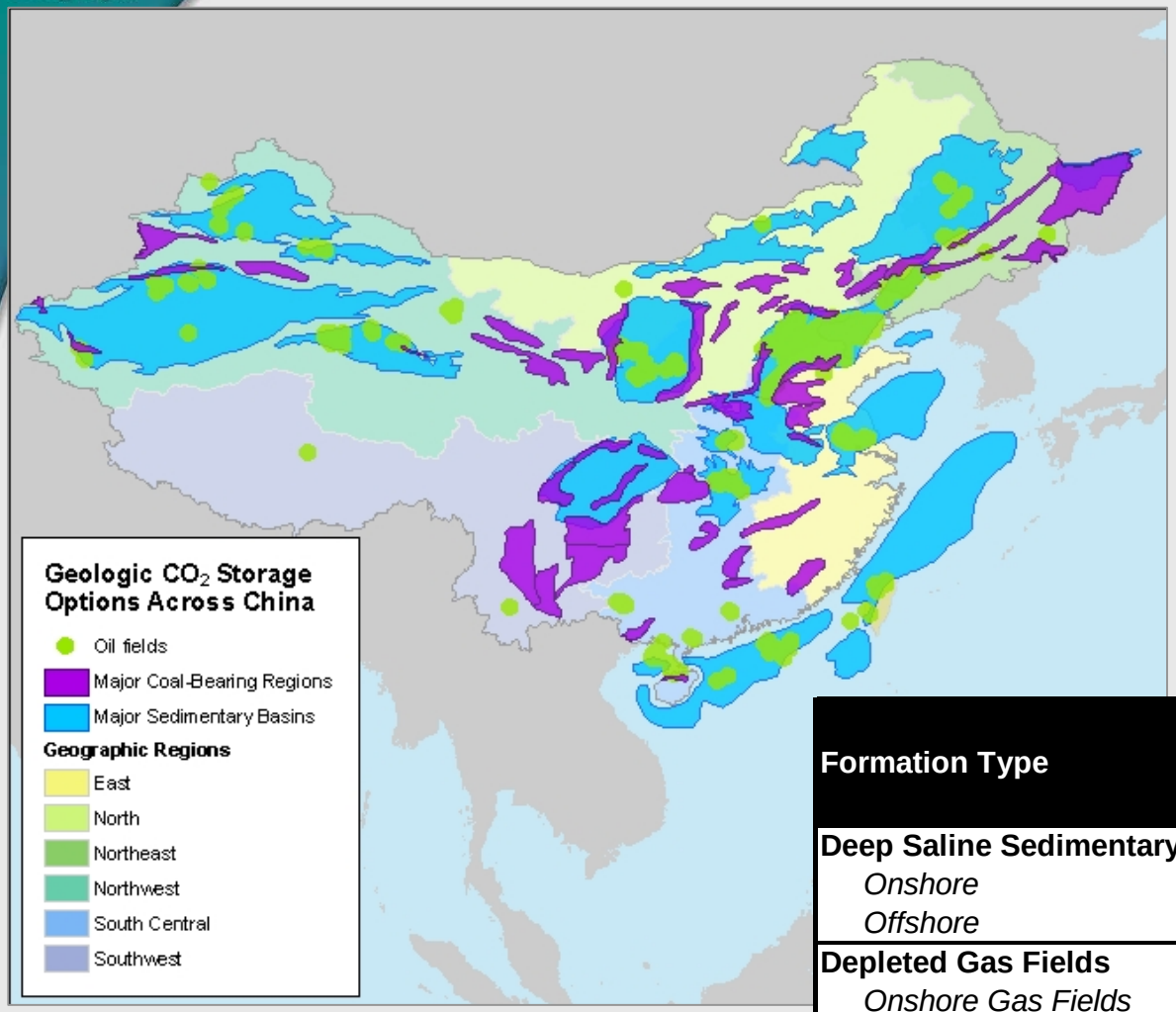
Understanding Regional Heterogeneities



- Nearly 250 CO_2 sources (100+ $ktCO_2$/yr each)
- Total estimated CO_2 emissions from these sources: 800 $MtCO_2$/yr
- Roughly 20% of China's CO_2 is emitted in this region



Geologic CO_2 Storage Capacity

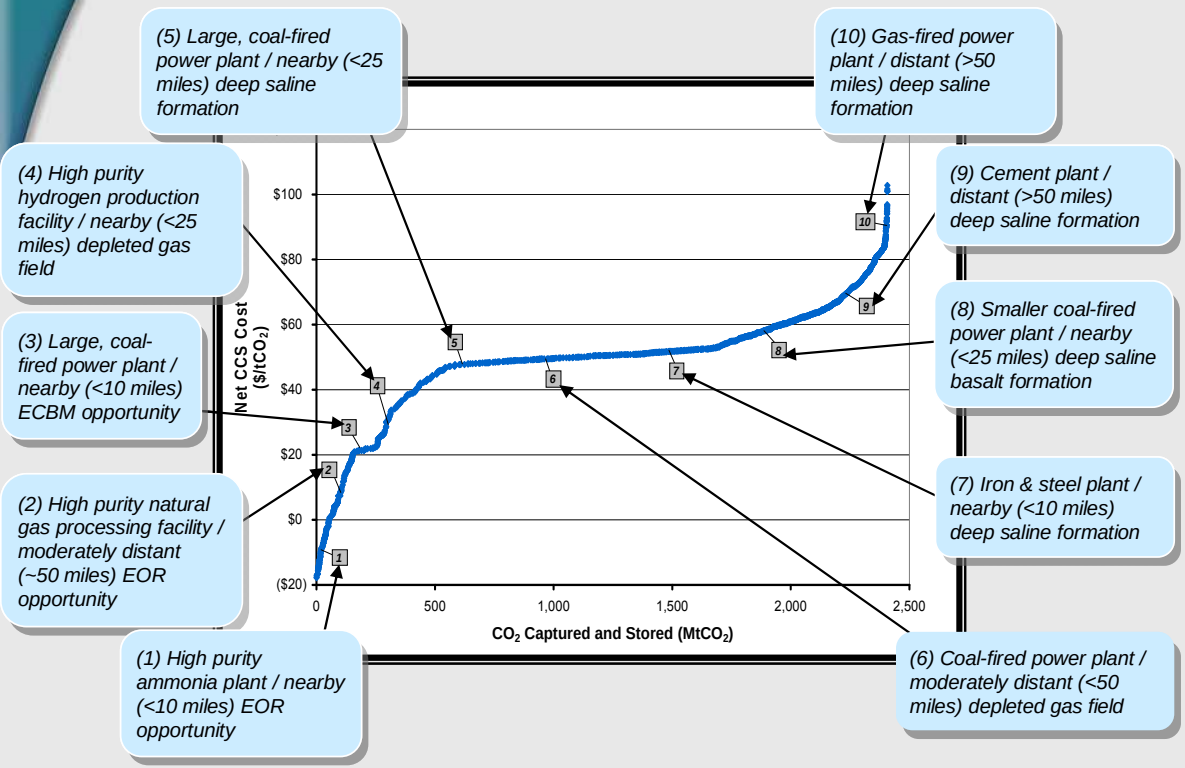


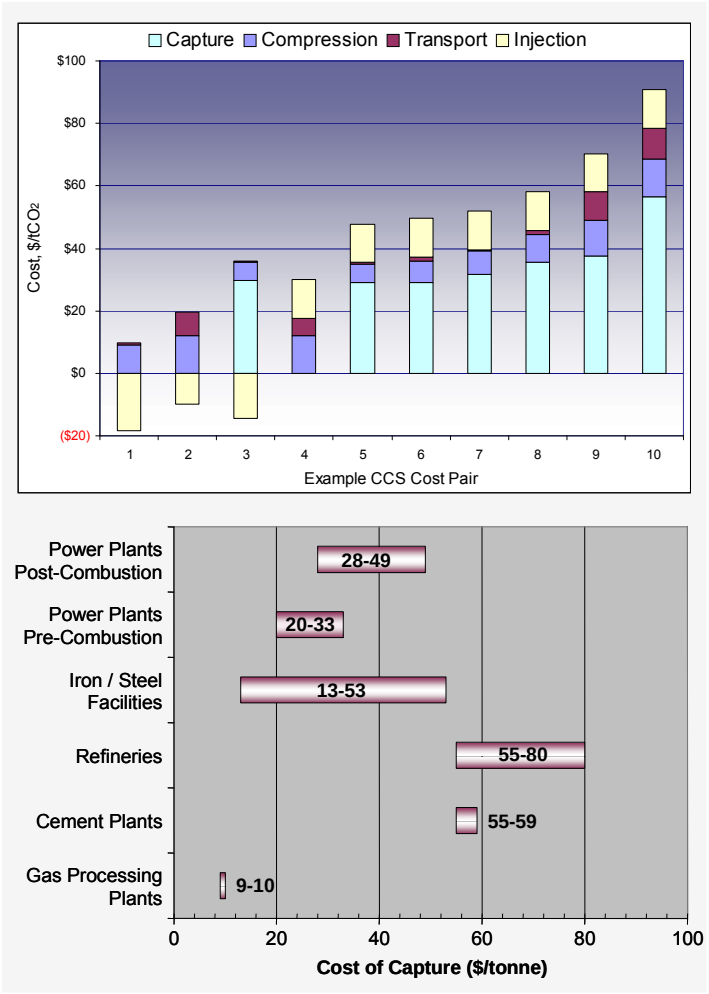
- Preliminary results indicate as much as 2,300,000 $MtCO_2$ storage capacity in onshore basins
- Predominantly in deep saline formations

Formation Type	Number of Formations Analyzed	Estimated CO_2 Storage Capacity ($MtCO_2$)
Deep Saline Sedimentary Basins	**27**	**3,067,000**
Onshore	*17*	*2,290,000*
Offshore	*10*	*778,000*
Depleted Gas Fields	**35**	**4,100**
Onshore Gas Fields	*29*	*3,600*
Offshore Gas Fields	*6*	*500*
Coal Basins	**68**	**12,000**
Depleted Oil and EOR Fields	**59**	**4,800**
TOTAL	**189**	**3,087,900**

The Value of Cost Curves

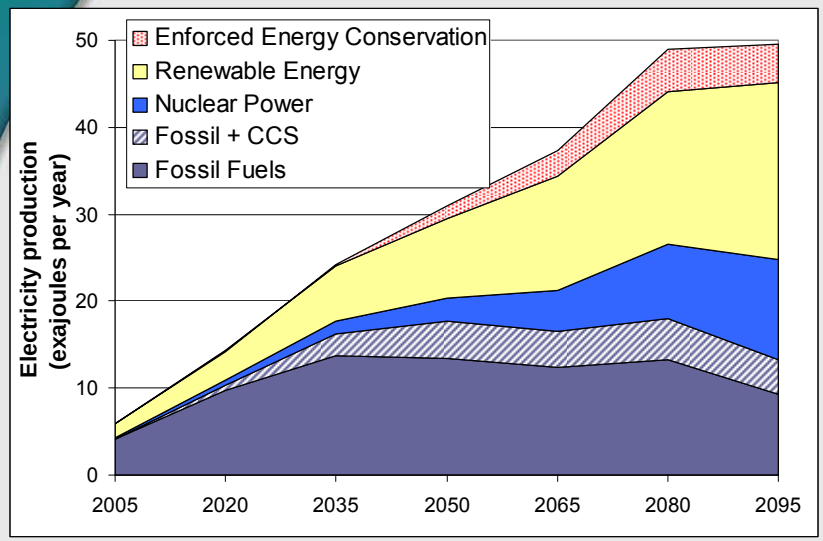
The Net Cost of Employing CCS within the United States - Current Sources and Technology





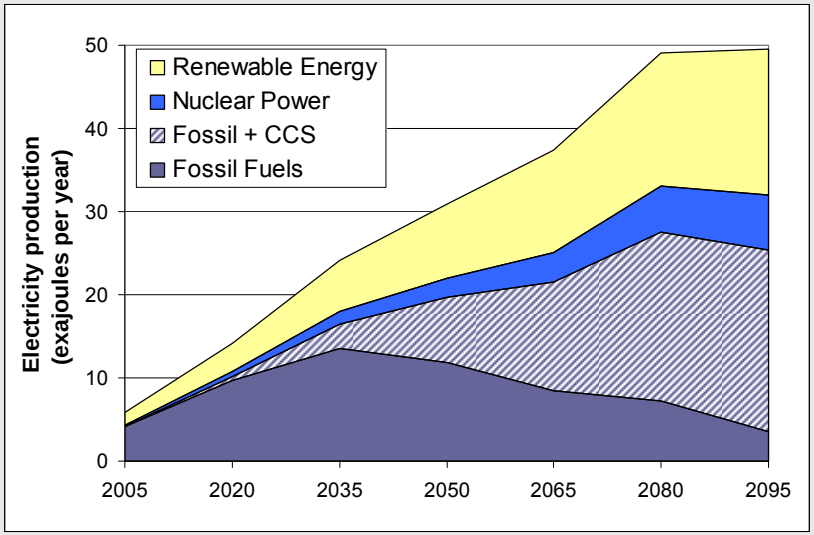
The Value of Improving Estimates of the CO_2 Storage Resource in China

CCS Deployment in China is Limited

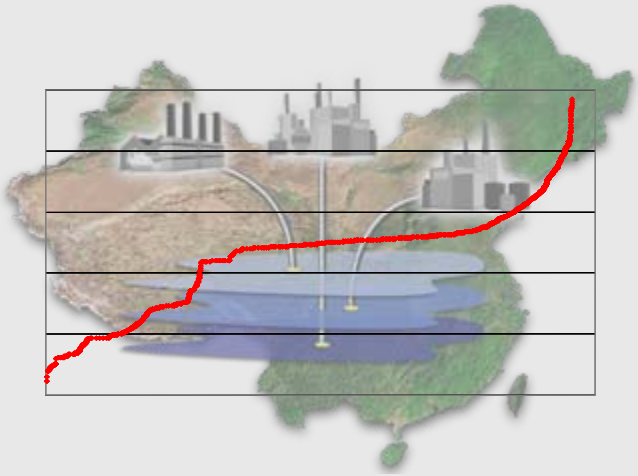


- The use of fossil fuels is severely curtailed in carbon-constrained world
- Nuclear power and biomass must be pushed beyond cost-effective limits to meet energy demand
- These combine to result in high energy prices

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
- $100s of billions to a $1 trillion in economic benefits

Cost Curve Development: Next Steps

- Finalize CO_2 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 CO_2 transport and storage