

Brookings Institute Forum: US China Clean Energy Cooperation
Washington, DC
Sept. 17th, 2010

Session 3: US-China Cooperation on Clean Coal



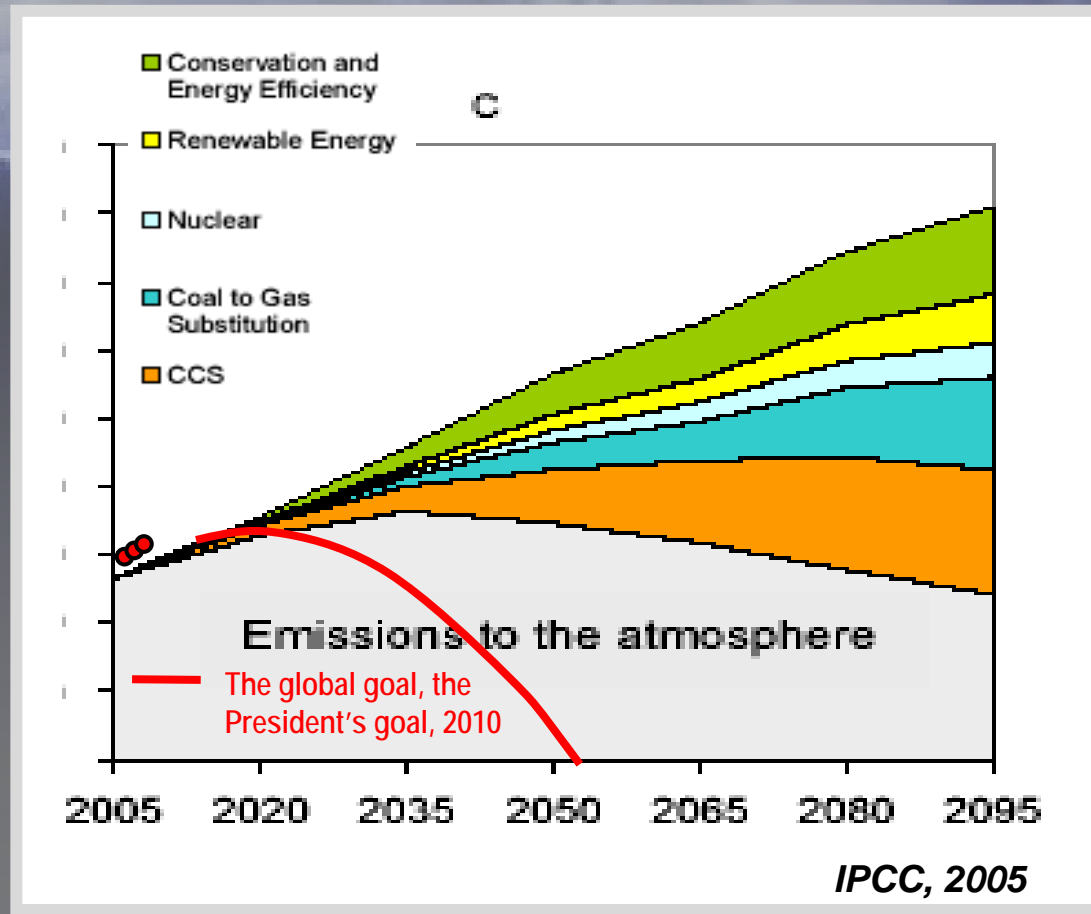
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We have until 2020 to create energy technologies to reach our energy rich, low-carbon goals



Demand growth is never met with emissions reductions alone

Tremendous growth in demand

Current demand ~350-370 EJ per year

By 2050, another 100-500 EJ needed

Significant growth in developing countries

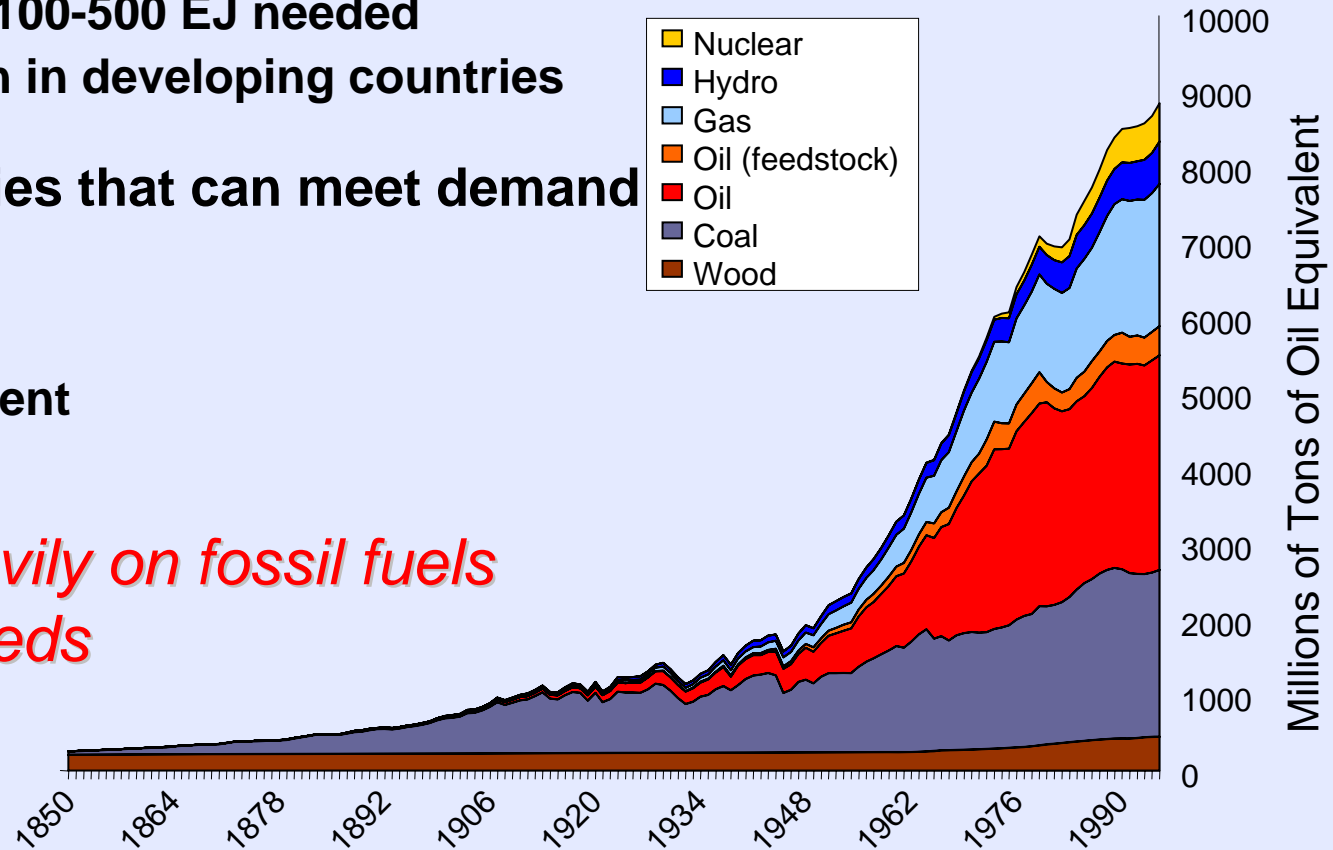
Limits to technologies that can meet demand

Intermittency

Power density

Lack of development

*We must rely heavily on fossil fuels
for our energy needs*

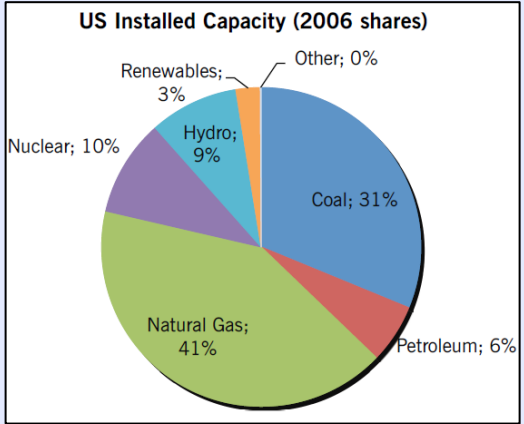
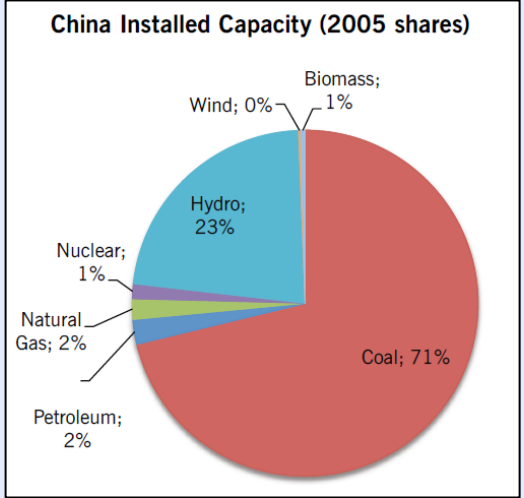
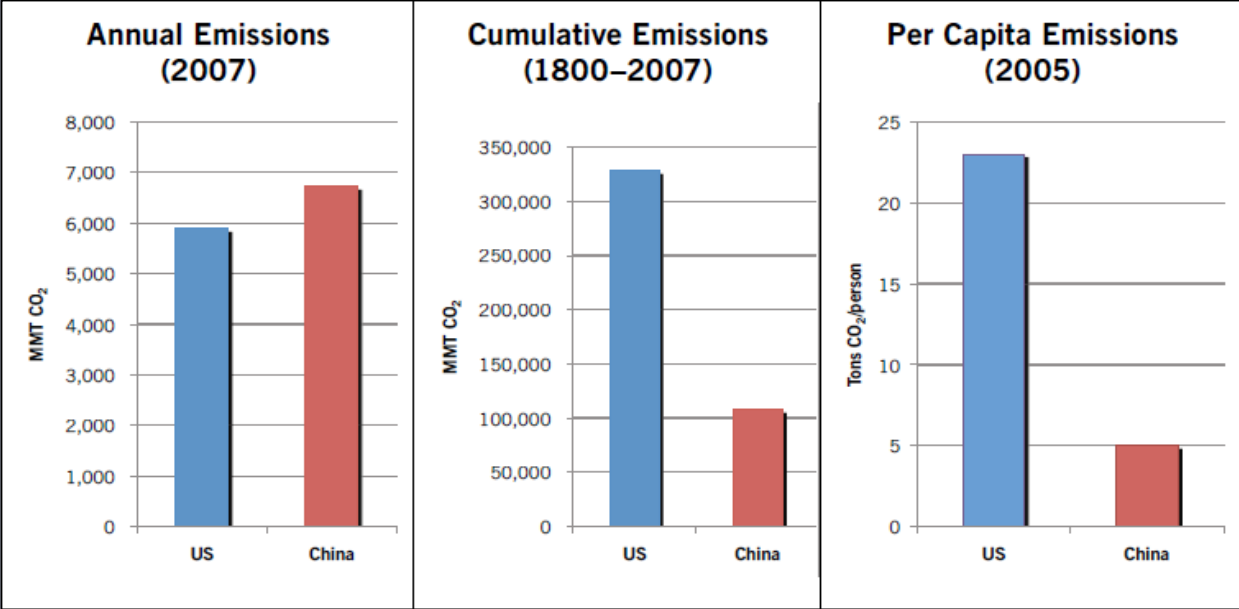


Holdren, 2008

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This is a shared obligation and a shared opportunity, in particular with the US and China

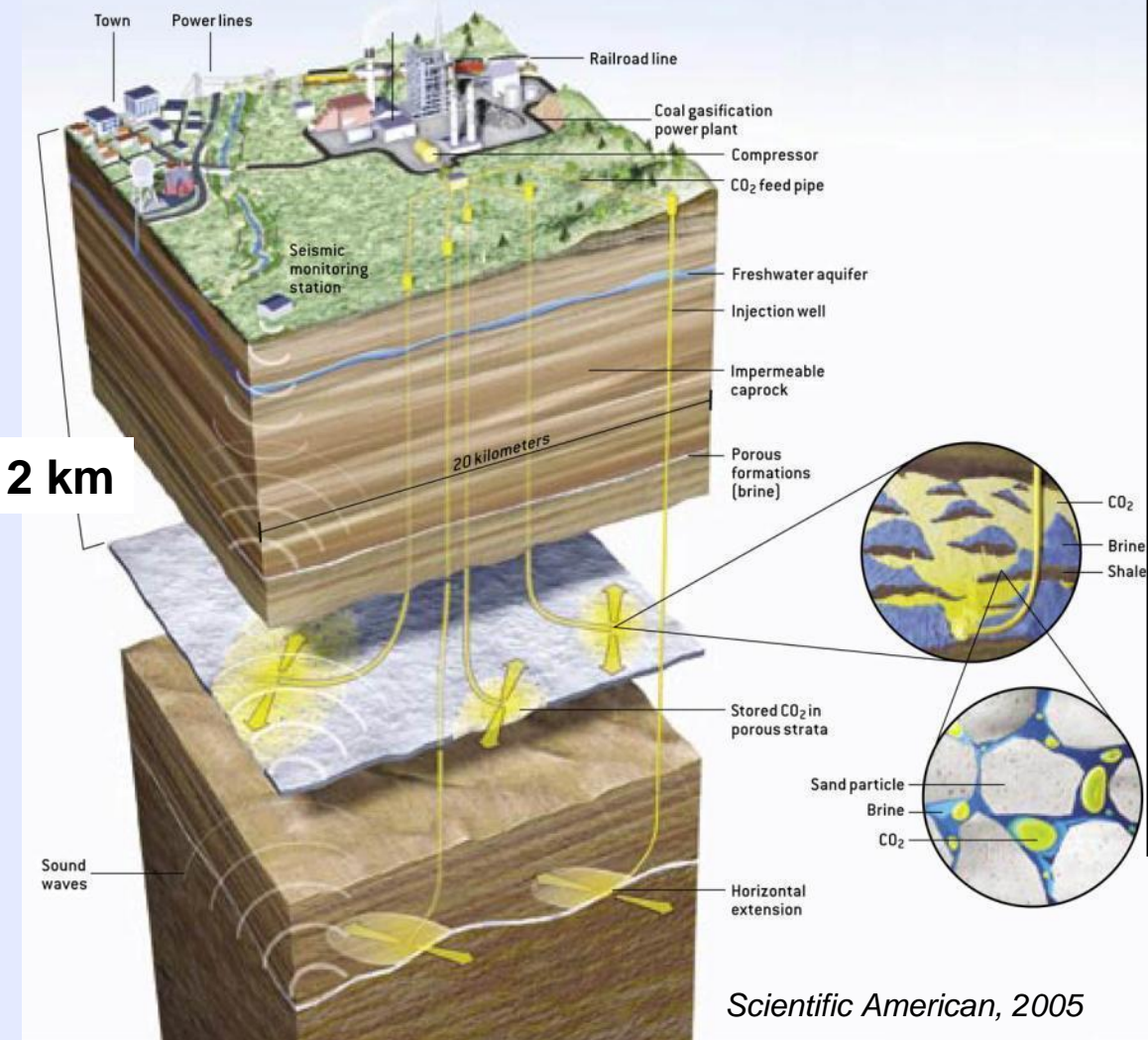


Chu and Thornton, 2009

“..both countries will need not only bold leadership and a new set of national policies, but also a path-breaking cooperative agenda that can be sustained over the long run [over the next 5-10 years].”



Geological carbon sequestration is the deep injection of CO₂ to avoid atmospheric release

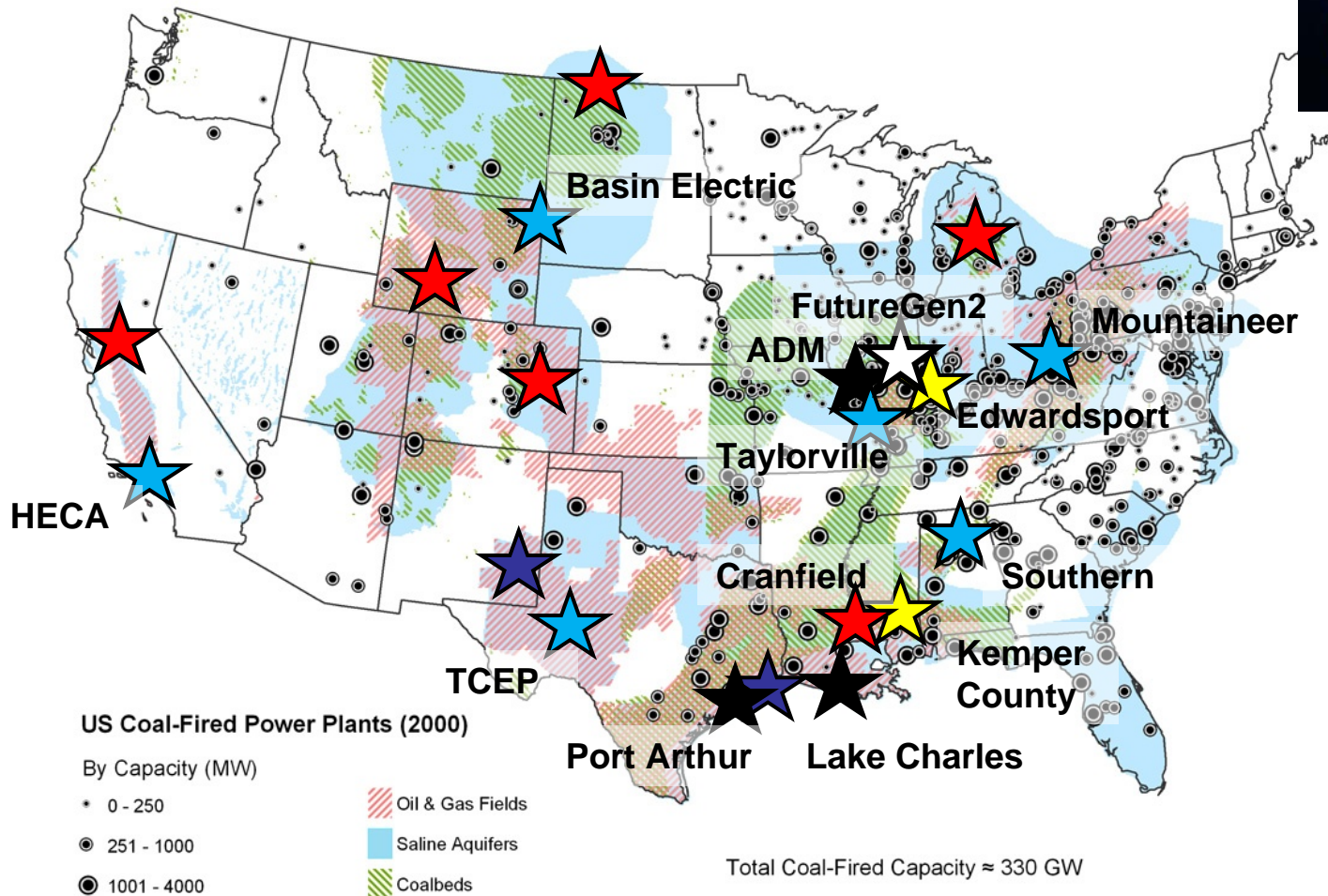


CO₂ can be stored in deep geological formations as a pore-filling fluid:

- **Saline Formations:** *largest capacity (>1600-3200 Gt, N. America; 2200 China)*

- **Depleted Oil & Gas** *potential for enhanced oil and natural gas recovery*

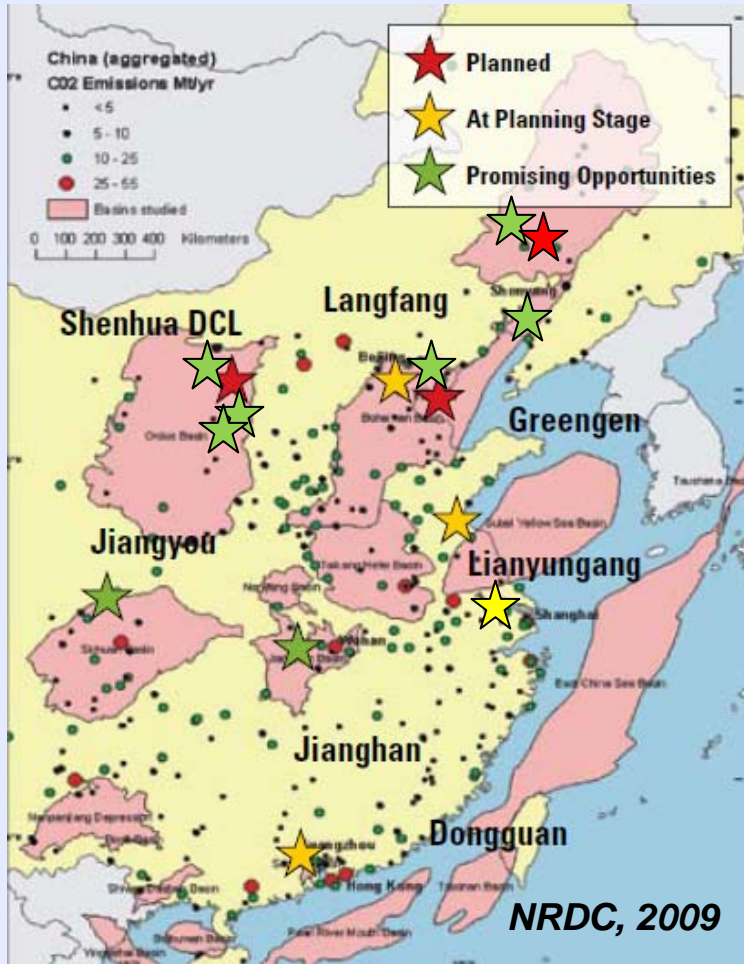
The DOE and industry have embarked on a set of large-scale CCUS demonstrations: many sites and technologies



- ★ Large commercial projects
- ★ Clean Coal Power Initiative
- ★ Industrial sequestration
- ★ Regional Partnerships large projects
- ★ Prior field experiments

Gasification, post-combustion capture, polygeneration, biomass co-firing, and oxyfiring demonstrations in many different geological settings

Many CO₂ streams (130Mt total) exist that could serve as early development as CCS projects



Estimated costs of GCS: \$5-10/t CO₂

New 100,000 t CO₂/y PCC project in Shanghai is active: will scale up to 160,000 t this month; planned 2M t/y project



GreenGen project designed to demonstrate low-C gasification power plant w/ Chinese technology

Integrated IGCC + CCS outside Tianjin

- Project led by Huaneng and TPRI; also Petrochina
- TPRI gasifier
- CO2-EOR; future saline formation possible
- Research platform for technology testing
- Ultra-low sulfur & water



250 MW IGCC: 2011

500 MW IGCC+1Mt/y CCS: 2013

750 MW IGCC+2Mt/y CCS: 2015

***Phase 1 IGCC project 40% built;
partnership w/ Duke Energy***

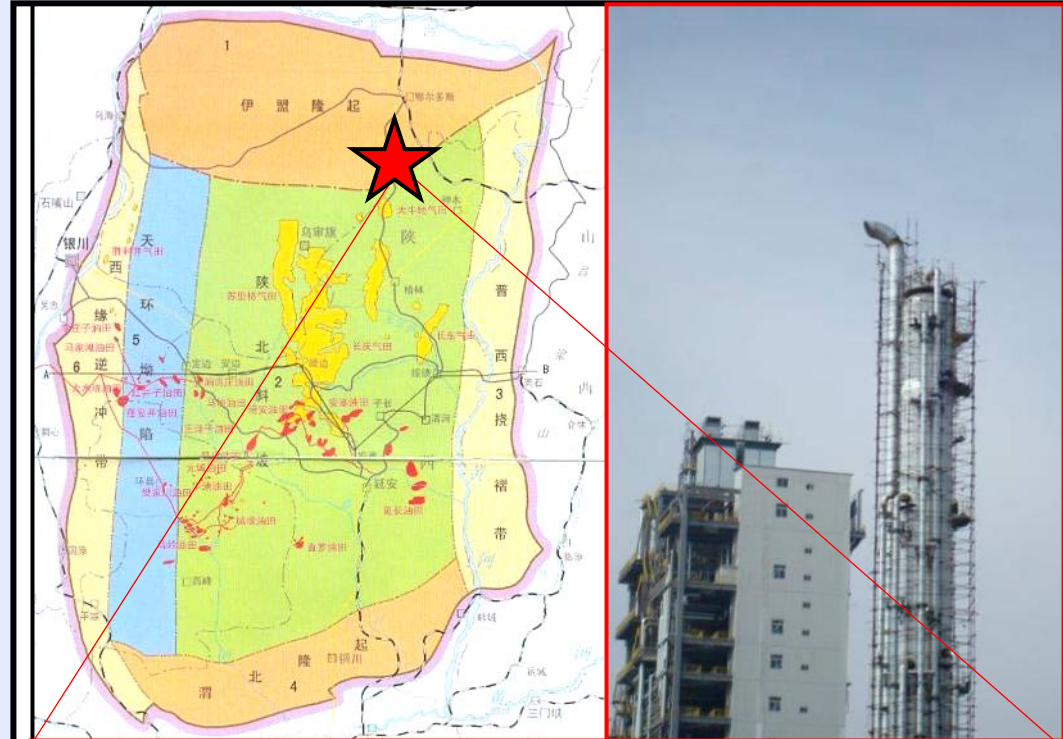


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West Virginia Univ., DOE/FE, and LLNL in US-China collaboration with Shenhua on large GCS project

- **US-China Annex II collaboration**
 - Signed in 2003
 - Resigned Sept. 2009
- **Shenhua direct coal liquefaction plant (Ordos basin, Inner Mong.)**
 - First of a kind plant
 - ~3 million tons CO₂/year for sequestration
 - Pre-feasibility report completed
 - 100,000 t pilot in planning
- **Real-world perspective on local needs, concerns for CCS commercialization in China**



This could become a world-class flagship CCS project

Shenhua DCL plant is on target to be China's first large CCS project



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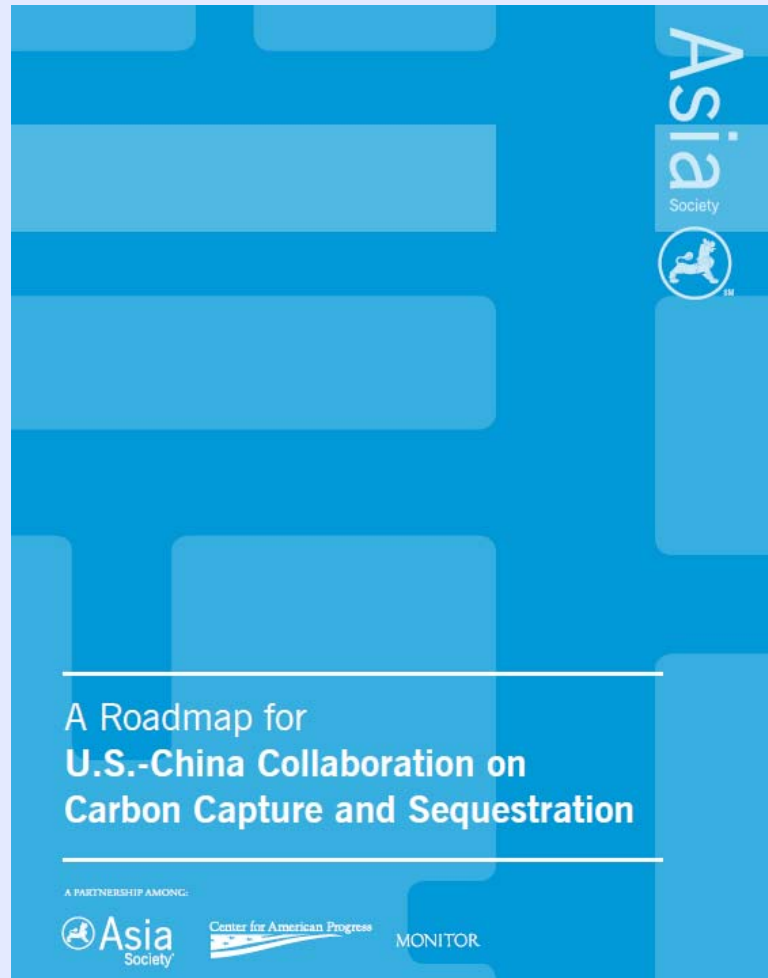
A strong and sustained US-China partnership will help both countries achieve their goals and needs



Businesses: exchange knowledge, IP, and practices, joint ventures
Governments: create incentives, opportunities; remove roadblocks
Both: provide financing, people

A Roadmap for US-China Collaborations on CCS

Task Force: CAP, Asia Society, Monitor, and LLNL

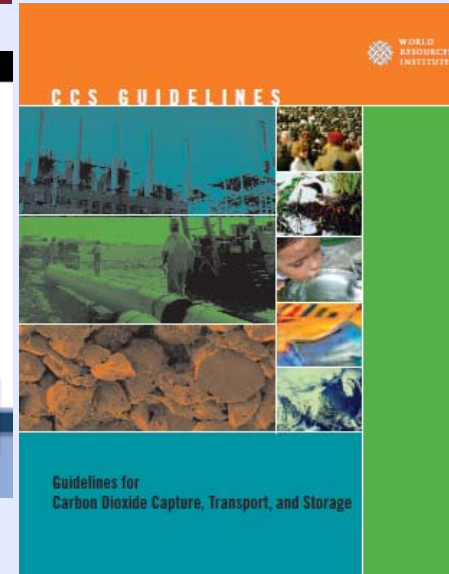
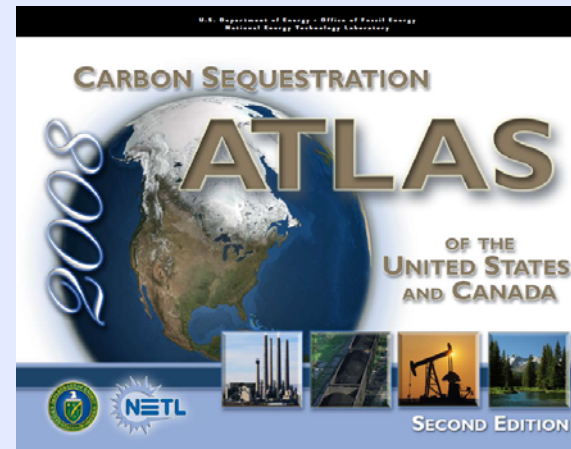
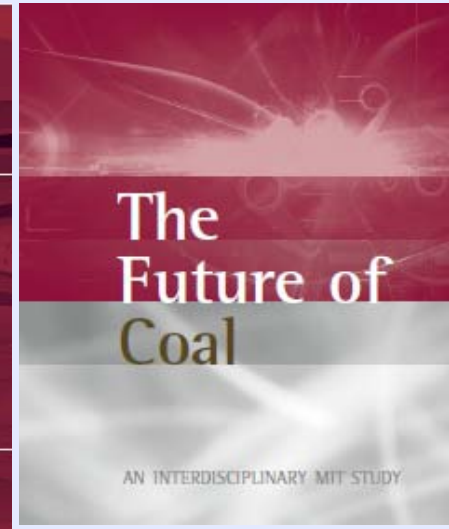
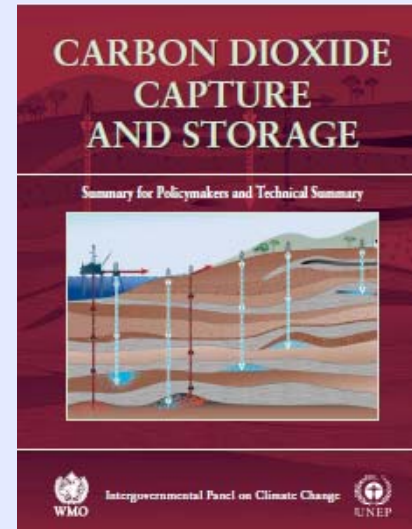


English: http://www.asiasociety.org/files/pdf/AS_CCS_TaskForceReport.pdf

Chinese: http://www.asiasociety.org/files/pdf/AS_CCS_TaskForceReport_Chinese.pdf

There are tremendous available resources, applicable learnings, works in progress

- **IPCC Special Report**
 - 2004 snapshot
 - High level of technical detail
- **CO₂ Monography (SPE)**
- **MIT Report: Future of Coal**
- **IOGCC draft guidelines (2007)**
- **NAS study (2009)**
- **WRI CCS draft guidelines**
- **Many 100's DOE documents**
 - N. America CO₂ Atlases
 - Technology Roadmaps
 - Regional Partnerships
 - FutureGen selection criteria
 - Task Force report



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