The Importance of CCS in a Low-Carbon Energy Future

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Outline of My Talk

- Why CCS?
- The Good News
- The Not-So-Good News
- A Path Forward
Why the interest in carbon capture and storage?
The Climate Change Policy Driver

- 1992 U.N. Framework Convention on Climate Change called for “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”

- 194 country signatories (as of May 2011)
Stabilization Requires Large Emission Reductions, Soon

Serious impacts projected for >2°C rise in average global temperature

Required change in global CO$_2$, equiv emissions from 2000 to 2050

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Source: IPCC, 2007

CO$_2$ from energy use is the dominant greenhouse gas; Large CO$_2$ reductions are needed
Trend in World Energy Use

~85% of world energy is from fossil fuels

Source: BP, 2011
Global CO$_2$ Emissions and Atmospheric Concentrations are Increasing

Continued increases are projected in the absence of policy interventions

Source: ORNL, 2011

Source: NOAA, 2011
More extreme events are expected as atmospheric concentration rises.
Motivation for Carbon Capture and Storage (CCS)

- Fossil fuels will continue to be used for many decades—alternatives are not able to substitute quickly.
- CCS is the **ONLY** way to get large CO$_2$ reductions from fossil fuel use—a potential bridging strategy to a sustainable energy future.
- CCS also is needed to decarbonize the transportation sector (via low-carbon electricity and hydrogen from fossil fuels).
- Models show CCS is a key component of cost-effective strategies; without CCS, the global cost of achieving a low-carbon energy future will be **much higher**.
CCS Reduces Overall Cost

Difference in cost with and without CCS for three stabilization goals (equiv. CO$_2$ conc. in the atmosphere), assuming different levels geologic storage availability.

Source: PNNL, 2008
In many cases the use of CCS on gas-fired power plants is an important part of least-cost strategies for CO$_2$ reductions.

CCS also applies to biomass systems and industrial processes.

Source: NAS, 2010
The Good News
CCS Technology

- Is real
- It works
- It is effective
- It is commercially available
Industrial Applications of CO$_2$ Capture

Gas-fired power plant

Coal-fired power plant

H$_2$ production plant

(Source: Flour Daniel)
(Source: IEA GHG)
(Source: Chevron-Texaco)

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Captured CO$_2$ Stored in a Deep Saline Formation

Sleipner Project
(Norway)

Source: Statoil

E.S. Rubin, Carnegie Mellon
Captured CO$_2$ Stored in a Depleted Gas Formation

In Salah /Krechba (Algeria)

Source: BP
Captured CO$_2$ Stored with Enhanced Oil Recovery (EOR)

Sources: IEAGHG; NRDC; USDOE

E.S. Rubin, Carnegie Mellon
CCS at a Coal-Fired Power Plant
(Pilot plant with storage in a deep saline formation)

Source: AEP, 2009

20 MW pilot plant at AEP’s Mountaineer Power Plant
(West Virginia)

E.S. Rubin, Carnegie Mellon
The Not-So-Good News
Current CCS Technology

• Is expensive
• Not yet proven at full-scale power plants
• Remaining legal and regulatory issues
• Uncertain public acceptance in some places
• Need for training and expertise worldwide
• Few if any incentives to deploy CCS
Key Barriers to CCS Deployment

- Policy
- Policy
- Policy

Without a policy requirement or incentive, there is little or no reason to deploy CCS
Strong Interactions Between Policy and Other Key Factors

These interactions depend strongly on local and national settings
A path forward
Large-Scale Demonstrations can start to gain experience needed to reduce costs

Planned demonstration projects in the U.S. (as of May 2011)

Historical “experience curves” show large reductions in cost with cumulative worldwide capacity

Source: USDOE, 2011
R&D Programs are Developing Lower-Cost Technologies

Source: USDOE, 2010
Must also Meet Developing Country Needs for

- Access to information
- Technical training
- Capacity building
- Planning/analysis tools
- Legal/regulatory assistance
- Financial assistance
IECM: A Tool for Analyzing CCS Options for Power Plants

- A desktop/laptop computer model developed for USDOE/NETL; free and publicly available at: www.iecm-online.com

- Provides systematic estimates of performance, emissions, costs and uncertainties for preliminary design of:
  - PC, IGCC and NGCC plants
  - All flue/fuel gas treatment systems
  - All CO₂ capture and storage options

- Over 1300 users in 56 countries
The World Bank and Other Organizations Play a Key Role

- The World Bank CCS Trust Fund is a unique and important program for enabling CCS in developing countries worldwide.

- These country programs provide critical building blocks for further CCS activities and projects.

- Financing for full-scale CCS projects remains the most critical challenge... not only for the Bank and developing countries, but for all countries.

- This workshop is an important step forward in meeting that challenge.
Thank You

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