The Status and Future of Carbon Capture and Storage

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Outline of Talk

• Why the interest in CCS?
• A brief history of the technology
• Current status: globally & US
  – Large-scale projects
  – Small-scale projects + R&D
• Future outlook: policy, policy, policy
• Closing thoughts to consider
Why the Interest in CCS?

- CCS is the ONLY way to get large CO\textsubscript{2} reductions from fossil fuel use—a potential bridging strategy
- CCS also can help decarbonize the transportation sector via low-carbon electricity and hydrogen from fossil fuels
- Energy models show that without CCS, the cost of mitigating climate change will be much higher:
  - IPCC scenarios for 2 deg C: without CCS, mitigation cost increases an avg of 140%; vs. 7% no nuke, 6% limited wind and solar; 64% limited bioenergy.

A Brief History

- Integrates 3 major components: capture, transport and storage
- Capture widely used in industrial processes; for coal it requires removal of CO\textsubscript{2} from either flue gas (post-comb) or fuel gas. Done at small scale since 1970s.
- Pipeline transport: 4000 miles, transporting 67 Mt/yr
- Geological storage: Sleipner since 1990s; US now 10 Mt stored; Gorgon = biggest underway (~3-4 Mt/y)
Status of CCS Technology

• Globally: 22 projects operating or u/c
  – Xx power plants; yy industrial processes; zz storage only
  – 55 projects total: 27 in Americas, 11 in China, 9 in Europe, 2 in Gulf, 6 in rest of world

• U.S.: 6 large demo projects planned or u/c
  – 4 power plants (1 PC, 3 IGCC), 2 industrial processes

Key Barriers to CCS Deployment

• Policy
• Policy
• Policy

Without a policy requirement or strong incentive to reduce CO₂ emissions significantly, there is no reason to deploy CCS widely
Climate Policy will be a Key Determinant of Future Coal Markets

- **Scenario 1**: Business as usual with no new controls on carbon emissions
- **Scenario 2**: A pathway to stringent (80%) CO2

Policy options that can foster CCS and technology innovation

<table>
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<tr>
<th>Direct Gov’t Funding of Knowledge Generation</th>
<th>Direct or Indirect Support for Commercialization and Production</th>
<th>Knowledge Diffusion and Learning</th>
<th>Economy-wide, Sector-wide, or Technology-Specific Rgs and Standards</th>
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<td>• R&amp;D contracts with private firms (fully funded or cost-shared)</td>
<td>• R&amp;D tax credits</td>
<td>• Education and training</td>
<td>• Emissions tax</td>
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<td>• Intramural R&amp;D in government laboratories</td>
<td>• Patents</td>
<td>• Codification and diffusion of technical knowledge (e.g., via interpretation and validation of R&amp;D results; screening; support for databases)</td>
<td>• Cap-and-trade program</td>
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<td>• R&amp;D contracts with consortia or collaborations</td>
<td>• Production subsidies or tax credit for firms bringing new technologies to market</td>
<td>• Technical standards</td>
<td>• Performance standards (for emission rates, efficiency, or other measures of performance)</td>
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<td>• Tax credits, rebates, or payments for purchasers/users of new technologies</td>
<td>• Technology/Industry extension program</td>
<td>• Fuels tax</td>
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<td>• Gov’t procurement of new or advanced technologies</td>
<td>• Publicity, persuasion and consumer information</td>
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<td>• Demonstration projects</td>
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<td>• Loan guarantees</td>
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<td>• Monetary prizes</td>
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Source: NRC, 2010

E.S. Rubin, Carnegie Mellon
What is the Outlook for CCS Costs?

• Sustained R&D is essential to achieve lower costs; but...
• Learning from experience with full-scale projects is equally critical.
• Strong policy drivers that create markets for CCS are needed to spur innovations that significantly reduce the cost of capture.

Thank You

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