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_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 <u>much</u> 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

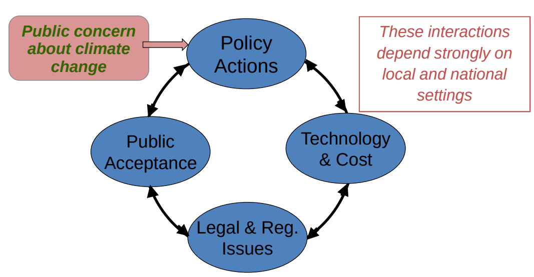
- Integrates 3 major components: capture, transport and storage
- Capture widely used in industrial processes; for coal it requires removal of CO2 from either flue gas (post-comb) or fuel gas. Done at small scale since 1970s.
- Pipeline transport: 4000 miles, transporting 67 Mt/yr
- Geological storage: Sliepner 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



Strong Interactions Between Policy and Other Key Factors

Without a policy requirement or strong incentive to reduce CO_2 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

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

Source: NRC, 2010

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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