Toward a Global Geoscience Initiative

Challenges for Solid Earth Science Related to Energy/Climate/Environment/Economy

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Enormous

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Immediate

Challenges for Solid Earth Science Related to Energy/Climate/Environment/Economy

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Strategies for Stabilizing CO₂ Emissions by Mid-Century

Potential Wedge #6 - CO₂ Capture and Storage (CCS) from coal baseload power generation

Potential Wedge #9 - Use Nuclear to replace coal baseload power

Potential Wedge #5 - Use Gas to replace coal baseload power

To contribute to stabilization of atmospheric greenhouse gas, each wedge must operate at a scale of ~ 1 GT C/y
Coal/Nuclear/CCS Scenario

Source: EPRI, The Power to Reduce CO$_2$ Emissions, 2007
If CO₂ Sequestration is going to contribute to stabilization of atmospheric greenhouse gas, it must operate at a scale of ~ 1 GT C/y
If CO₂ Sequestration is going to contribute to stabilization of atmospheric greenhouse gas, it must operate at a scale of ~ 1 GT C/y
Mass of CO$_2$ in CCS $\approx$ Oil Production
Why Not Just Do It?

- 1996 to present
- 1 Mt CO₂ injection/yr
- Seismic monitoring

X 3500!
Capacity and Cost?

AEP Mountaineer Project: New Haven, WV

NY Times Sept. 21, 2009

Current Plans to Inject 100 ktons/y for 2-5 years
AEP Mountaineer Project: New Haven, WV

AEP Mountaineer CO$_2$ Emissions $\sim$7 Mton/year limited to $\sim$ 35 kton/year per injection zone - 200 injection zones required!

183 Coal burning plants in Ohio River Valley (emitting 700 Megatons of CO$_2$/year)

Lucier and Zoback (2008)
Cost

- Energy penalty: 10 to 30%
- Cost
  - $50 to $100/tonne CO₂ for the nᵗʰ plant
  - Significantly more for the 1ˢᵗ plants ($150 to $250/tonne CO₂)
  - Cost of electricity generation: 50 to 100% increase
- Uncertain reliability
Revisiting Overly Optimistic World Wide Capacity Estimates

<table>
<thead>
<tr>
<th>Reservoir Type</th>
<th>Lower Estimate of Global Storage Capacity (GtCO₂)</th>
<th>Upper Estimate of Global Storage Capacity (GtCO₂)</th>
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<tbody>
<tr>
<td>Oil and gas fields</td>
<td>675</td>
<td>900</td>
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<tr>
<td>Coal seams (ECBM)</td>
<td>3–15</td>
<td>200</td>
</tr>
<tr>
<td>Saline aquifers</td>
<td>1000</td>
<td>~ 10,000</td>
</tr>
</tbody>
</table>

IPCC, 2005
50 New Nuclear Power Plants by 2030?

Licensing Will be a Formidable Task that Will Take Effort and Time
Waste Disposal After Yucca Mountain?
Surface Waste Storage and Other Natural Hazards

Catastrophic Risk in the United States: Earthquake, Hurricane, Tornado, and Hail

Flood Risk (as of March 14, 2023)
Fuel Switching to Reduce CO$_2$ Emissions

Natural Gas Produces Half the CO$_2$ per BTU

Current Gas Power Electrical Generation Capacity 400 GW

Current Average Utilization $\sim$20%

To Meet CO$_2$ Reduction Targets for 2020, Need to Increase Utilization of Existing Plants to $\sim$40%

(Could Also Replace Oldest and Least Efficient Coal Plants with Combined-Cycle Gas Plants)
Unconventional Gas Resources

2009 Estimates of Gas Resources Over 2000 TCF
~100 Years at Current Consumption
Global Potential for Shale Gas

World Total: 32,560 tcf

roughly 300 years of supply
Inexpensive (and stable) Gas Prices

(from America’s Energy Future)
Many Challenges Remain

Optimize the Resource

Minimize Environmental Impact

Photo: USGS
Toward a Global Geoscience Initiative

Enormous, Important and Immediate

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