The Southwest Regional Partnership on Carbon Sequestration:

Employing the Integrated Assessment Model for Systems Insight

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The Southwest Regional Partnership on Carbon Sequestration

• A collection of experts in economics, geology, engineering, public policy and public outreach.

• One task is to develop a high-level methodological framework to address physical, economic and policy requirements.

• The Integrated Assessment Team developed a dynamic simulation computer model to characterize the screening criteria:
  – underground geologic storage of carbon dioxide (CO$_2$)
  – the relative size of the CO$_2$ flow from the source to the sink
  – economics associated with this system
Carbon Dioxide Emissions from Electricity Generation for Select States

(EPA, 2005; Data for 2000)
Electricity Generation Mix for Select States

(Note: Oil-based and other fuels represented 2% or less of the total installed MW)
(EPA, 2005; Data for 2000)
Carbon Dioxide Emissions by Fuel Type

(Note: Oil-based and other fuels represented 1% or less of the total CO2 emissions)  
(EPA, 2005; Data for 2000)
Model Interface

SOUTHWEST REGIONAL PARTNERSHIP ON CARBON SEQUESTRATION: TEST CASE MODEL

Prototype Version 1.0
July 2005

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Schematic of the CO₂ pathway in the Integrated Assessment Model

Source → Capture → Transportation → Storage → Metering

- Power Plants
- GTI Modeling
- Pipelines
- Natural Gas, Oil Formations
- Ongoing
Test Case: Northern New Mexico and Southern Colorado

Region

20 km radial distance from power plant (CO2 Source)

CO2 Sink(s)

CO/NM Border

Albuquerque
Mass Balance Sector of the Model: CO₂

• **Sources of CO₂:**
  – Select power plants in NM
  – Emissions & Generation Resource Integrated Database (EGRID)

• **Capture and Transport:**
  – 90% capture of the CO₂
    » GTI used the IECM-CS Model (Carnegie Mellon)
  – Williams (Princeton) & Ogden (UC Davis) publications for pipeline and associated infrastructure information

• **Sinks:**
  – Sink characterization team developed a shortlist of 7 sinks in Southern CO and Northern NM
  – Oil and Natural Gas Pools
Cost Sector of the Model

- **Capture Costs:**
  - GTI used the IECM-CS Model developed by Carnegie Mellon University for DOE

- **Transportation Costs:**
  - Pipeline and Disposal Well costs from Williams & Ogden publications

- **Disposal Costs:**
  - Disposal Well and associated costs from Williams & Ogden publications
Regulatory and Verification Sector of the Model

• Measurement, Monitoring, and Verification (MMV):
  – Ongoing information/data collection
  – Initial and subsequent costs for MMV

• Begin to focus on potential sites:
  – Suitable technologies for the application/cost (sequestration, MMV)
  – Spatial aspects (location of CO₂ source, and sink)
  – Temporal aspects (how long could the sinks last)
Model Interface: Prototype Results Screen

Summary Screen: Four Power Plants in New Mexico (Animas, Raton, Four Corners, San Juan).

- **$ / tonne CO2**
  - Animas: 106.85
  - Raton: 313.85
  - Four Corners: 37.56
  - San Juan: 37.00

- **km to sink**
  - Animas: 56.12
  - Raton: 281.01
  - Four Corners: 33.10
  - San Juan: 17.78

- **Lifetime of Sink (Years)**
  - Animas: 7,973
  - Raton: 4,302
  - Four Corners: 0.8
  - San Juan: 0.9

- **Million Metric Tonnes CO2/yr**
  - Animas: 0.10
  - Raton: 0.02
  - Four Corners: 13.58
  - San Juan: 11.61
## Test Case: Years of Capacity (Smallest and Largest Source to Sink Combinations)

<table>
<thead>
<tr>
<th>Power Plant (MW)</th>
<th>Smallest Sink (Years of Sink Capacity)</th>
<th>Largest Sink (Years of Sink Capacity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animas (50)</td>
<td>107</td>
<td>7,973</td>
</tr>
<tr>
<td>Raton (13)</td>
<td>439</td>
<td>32,829</td>
</tr>
<tr>
<td>Four Corners (2270)</td>
<td>&lt; 1</td>
<td>56</td>
</tr>
<tr>
<td>San Juan (1779)</td>
<td>&lt; 1</td>
<td>65</td>
</tr>
</tbody>
</table>
Percent of CO₂ Captured Scenarios: Test Case CO₂ and Cost Sensitivities

(GTI, 2005)
Percent of CO₂ Captured Scenarios: Test Case CO₂ and Cost Sensitivities

(GTI, 2005)
Integrated Assessment: Regional Energy Model and Test Case Work

- Electricity Generation
- Total Energy Demand by Fuel Type:
  - Coal
  - Natural Gas
- Total Carbon Emissions
- Carbon Sources, Sinks
- Sequestration Technologies
- Carbon Sequestered, Costs

Blue = Working Framework
Red = Test Case
Future Expandability of the Integrated Assessment Model Framework

- ‘String of Pearls’ concept
  - Model calculates the distance to transport CO₂ from the source to the closest sink
  - Then calculates the distance from the first sink to the next closest sink, and so on until a network of sinks are used
  - The model could address additional metrics (e.g. largest sink volume, lowest overall cost, etc.) for additional systems insight

(km, picture and orientation not to scale)
Issues to Address

- **Carbon Model Issues**
  - Ongoing development for additional user options
  - Time scale, projections, costs, granularity

- **Regional Allocation**
  - Economic data on political boundary basis, sources and sinks are geographic
  - Regulatory issues by political boundary

- **Sources of Carbon**
  - Utility vs. Non-Utility

- **Future Modeling Efforts**
  - Focus on demonstration test cases, MMV and additional sequestration options
Conclusions

• The CO₂ capture costs represent the majority of the total (capture + transportation + storage) systems cost

• Project scenarios between CO₂ sources and sinks should account for $/tonne cost, sink longevity, safety, and potential public/policy issues when planning

• The regulatory framework may drive carbon sequestration projects (utility vs. non-utility, MMV, state-to-state electricity trade)
The Southwest Regional Partnership on Carbon Sequestration:

*Employing the Integrated Assessment Model for Systems Insight*

Thank You.