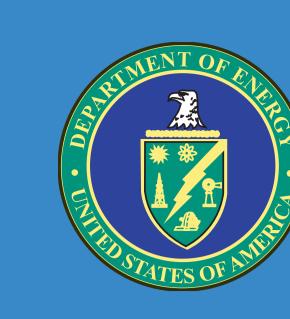




Estimating the Cost to Capture, Compress, and Transport CO₂ from Stationary Sources in the PCOR Partnership Region





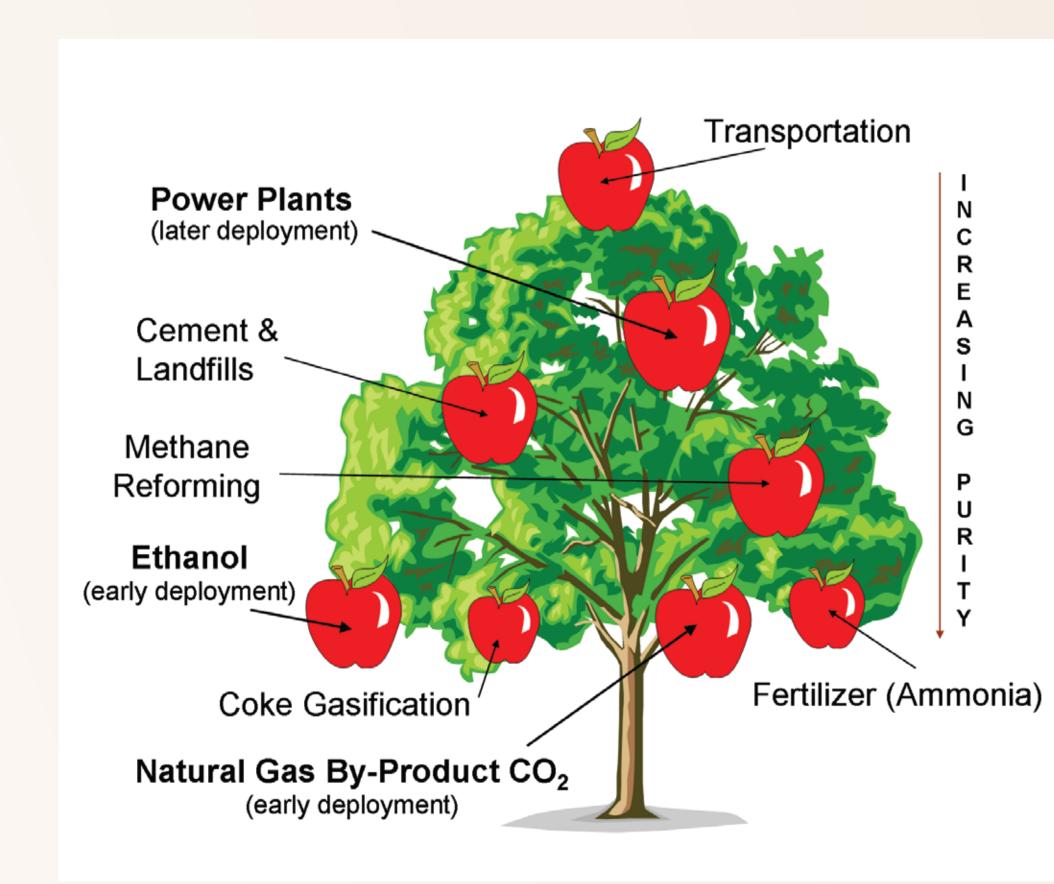
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Gas-Processing Facilities • 64,500-180,000 180,000-390,000 90,000-900,000 900,000-950,000 **Electricity-Generating Stations** Larger than 100 MW • 55,000-2,250,000 0 2,250,000-7,750,000 **7,750,000–11,000,000** 11,000,000-18,500,000 • 18,000-70,000 70,000-215,000 9 215,000-385,000 9 385,000-605,000 605,000-1,500,000

Types of Sources

The earliest deployment of carbon capture and storage (CCS) in the Plains CO_2 Reduction (PCOR) Partnership region will most likely involve the "lowest-hanging fruit," i.e., take place at gas-processing facilities and ethanol plants where capture will be the easiest. These plants produce a reasonably pure, wet CO_2 stream that requires only dehydration and compression prior to transport. After capture at ethanol plants and gas-processing plants, the power plants may be the next capture targets because they are the largest CO_2 emitters and, therefore, have the greatest impact on regional CO_2 emission.

Sources of CO_2 streams; the "low-hanging fruit" (i.e., processes at the bottom) yield the most CO_2 for the least effort (graphic based on Melzer Consulting graphic).



Approach

- Capture, dehydration, and compression costs were estimated using the Carnegie Mellon Integrated Environmental Control Model (IECM).
- Although not designed to model dehydration and compression of a CO₂ stream from an ethanol or gas-processing plant, the outputs were manipulated to separate the costs associated with drying and compression from the rest of the capture costs.
- The model was used "as is" for the power plants, although only 100-MW and larger plants were evaluated. This is because the economics and power requirements of capturing CO₂ at electricity-generating units larger than 100 MW would render electricity generation at those facilities no longer feasible.
- It was assumed that the most cost-effective approach to transporting the CO₂ would be via pipeline and that a pipeline network would eventually be constructed. To estimate the cost of such a network in the PCOR Partnership region, the Massachusetts Institute of Technology (MIT) pipeline routing model was used to estimate routes (i.e., distances) and diameters.

Water and Solids Management
Cooling System Once-Through

1. Diagram 2. Flue Gas 3. Capital Cost O&N Cost 5. Total Cost 6. Cost Fac

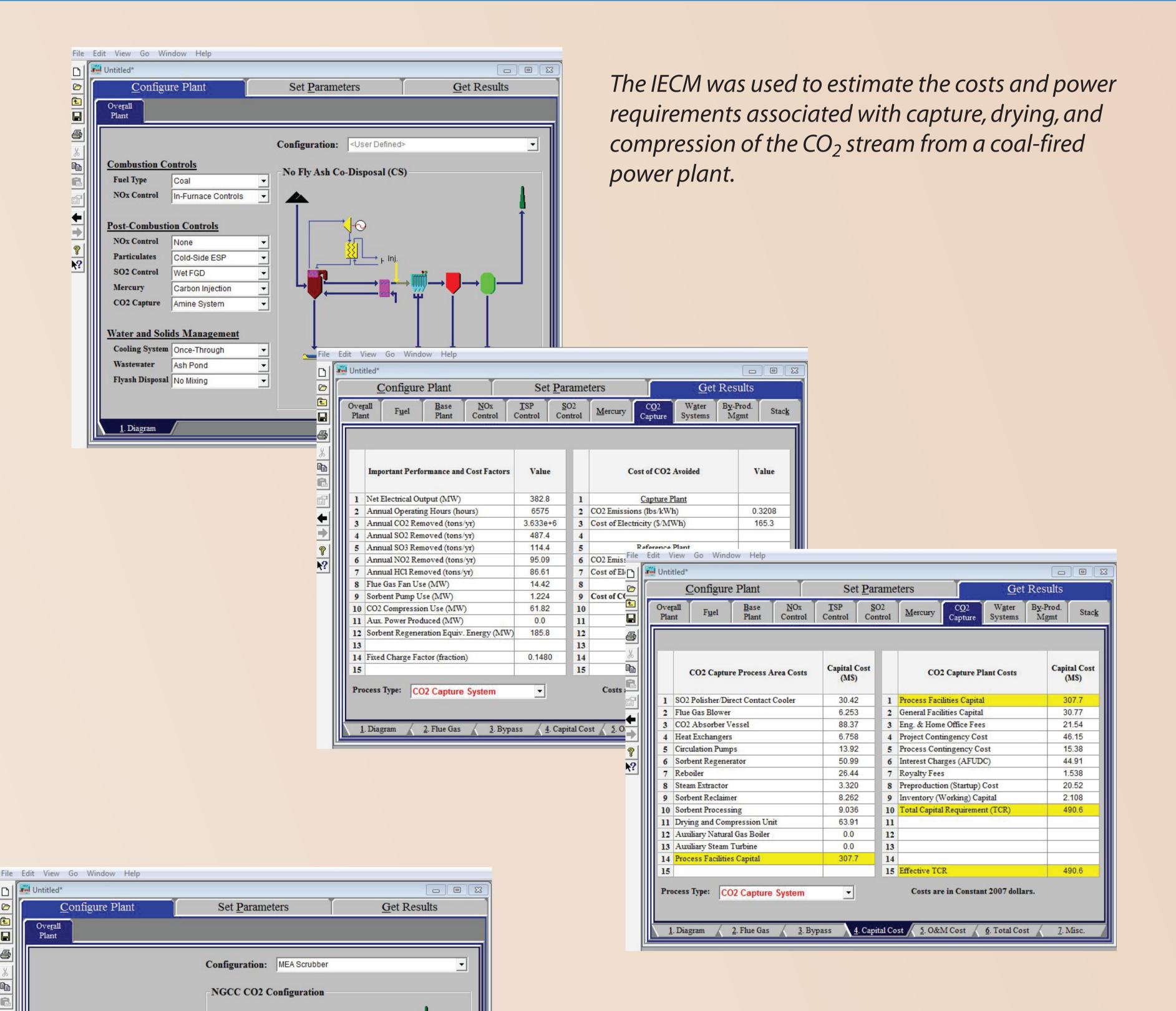
The IECM results were manipulated to

estimate the cost of drying and com-

and gas-processing plants.

pression of the CO_2 stream at ethanol

• The cost and energy estimates did NOT include injection costs at the geologic sink or any monetary value assigned to the CO₂.



Capture and Compression Estimations

Version 5.22 (released January 28, 2008) of the IECM was used to estimate the capture and compression costs and power requirements at power plants. The IECM is a desktop computer modeling program that was developed at Carnegie Mellon University with funding from the National Energy Technology Laboratory.

- The model was configured as a natural gas combined-cycle turbine to estimate the cost of drying and compression. Changing the number of turbines and the CO₂ scrubber bypass produced the appropriate emission level for the plant being modeled.
- To estimate the cost of capture using an amine system, drying, and compression of CO₂ from a power plant, the model was configured to match the various regional power plants being studied. Only units producing at least 100-MW power were modeled.

Pipeline Transportation Estimations

The MIT pipeline transportation model was developed by the MIT Carbon Capture and Sequestration Program for the Carbon Management Geographical Information System project under a Department of Energy contract. The MIT model calculates pipeline diameter for a given mass of CO₂ and a least cost path connecting a CO₂ source to a given geologic sink. Cost estimates were made with the following assumptions:

- The cost of booster stations was not included in the pipeline cost.
- A cost of \$70,000/in. diameter/mi was used for estimation of construction costs. These were amortized at 10% for ten periods to obtain annualized capital costs.
- O&M costs were estimated to be \$5000/mi, irrespective of pipeline diameter.

Results

Sources

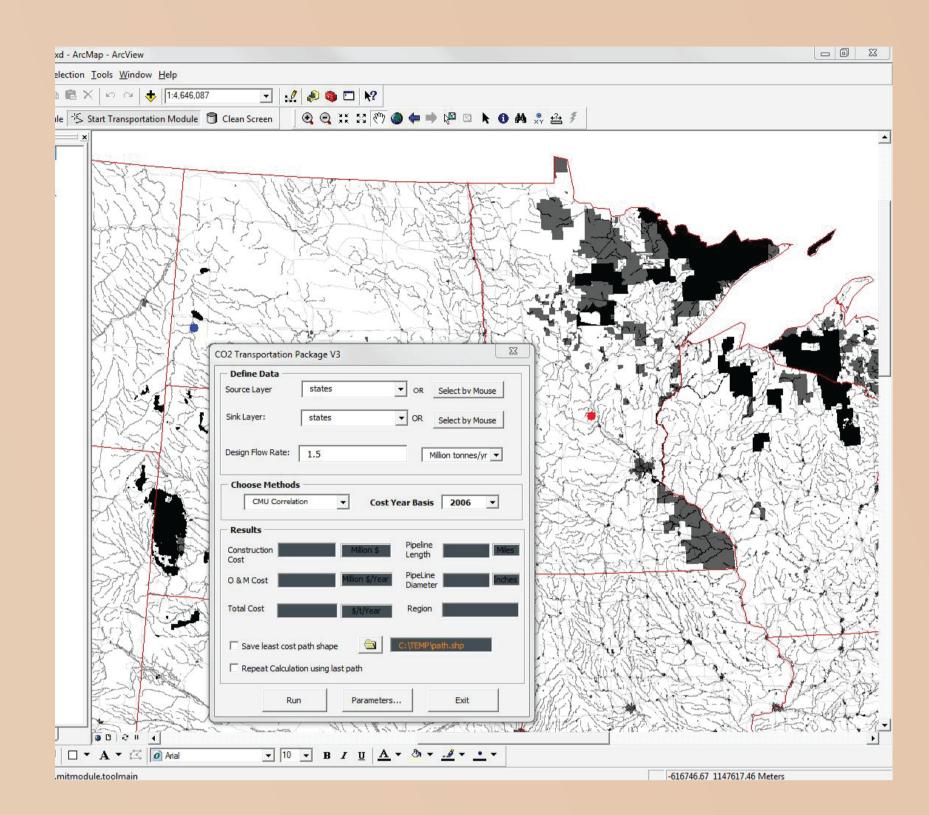
	Ethanol Plants	Gas-Processing Plants	Power Plants with 90% Capture
Number of Sources Emitting >15,000 tons/yr	92	99	132 individual units located at 74 power stations
CO ₂ Emission, million tons	15.6	21.1	314.92
Compression/Dehydration Cost, \$/ton	10	12	
Capture/Compression/Dehydration Cost, \$/ton avoided			78
% Reduction in Regional CO ₂ Emission from Capture of 90% of the Sources' CO ₂	3	4	54

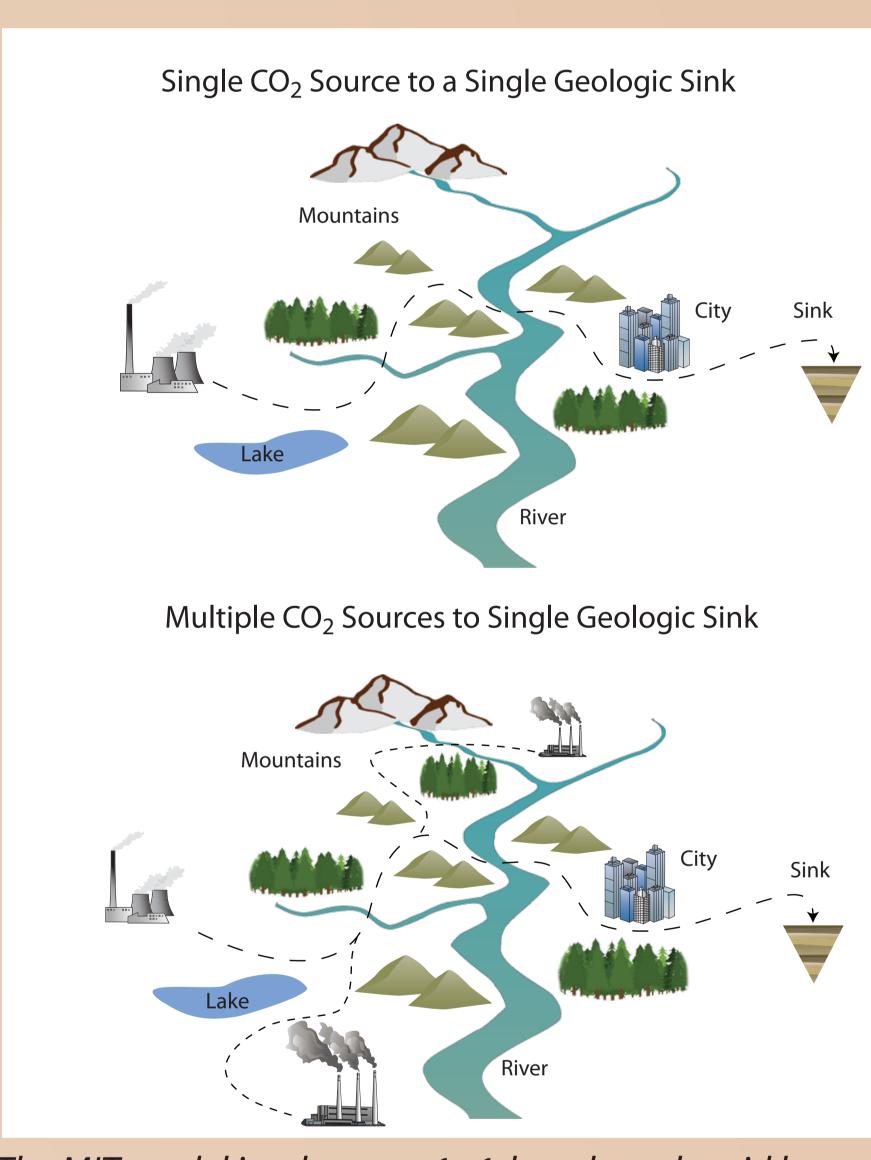
A regional CO_2 emissions reduction of 61% could be achieved if the CO_2 from all of these sources could be captured. This would cost an estimated \$71/ton avoided.

Pipeline

Pipeline Diameter,	Total Length in Region,	
in.	mi	
4	691	
6	1292	
8	508	
12	1466	
16	902	
20	1766	
24	1444	
30	1565	
36	178	

Total annual cost (i.e., annualized capital cost plus O&M costs) for the pipeline network was estimated to be \$2.34B. If the CO_2 from the ethanol plants, the gas-processing plants, and 90% of the CO_2 from the power plants were captured, the cost would be \$6.65/ton, or less than 10% of the total cost to capture, compress, and transport the CO_2 .





The MIT model implements 1×1 -km obstacle grid layers in which local terrain, crossings, protected areas, and populated places are assigned relative cost factors that are used to determine the least cost route between CO_2 source(s) and a geologic sink.

Conclusions

- The approach taken during this study can be used in any state or region to provide stakeholders with crucial information needed to make decisions regarding implementation of CCS.
- The estimated capture, compression, and pipeline costs illustrate that additional research for cost-effective capture and compression technologies and judicious siting of pipeline networks are needed so that CCS can be implemented with minimal financial hardship on a region's utilities, industries, and consumers.