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On the Long-Term Average Cost of CO2 Transport and Storage

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March 2008

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(9/2003)

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ABSTRACT: This short paper extracts data from previously published research of ours to describe how the cost of pipeline-based CO_2 transport and geologic storage varies across site-specific circumstances likely to be encountered by a significant number of anthropogenic CO_2 point sources. This paper disaggregates a \$15/tonCO_2 cost for transporting and storing CO_2, which has been characterized in our work as a long-term average price.

KEY WORDS: carbon dioxide capture and storage; CO_2 pipeline transport; CO_2 storage in deep geologic formations; cost; carbon management; climate change.

SUGGESTED CITATION: JJ Dooley, RT Dahowski, CL Davidson. "On the Long-Term Average Cost of CO_2 Transport and Storage." Joint Global Change Research Institute. Pacific Northwest National Laboratory. February 2008. PNNL-17389.

The U.S. Environmental Protection Agency (EPA) is currently using a cost of $15/ton of CO_2 (tCO_2)[1] to represent the cost of transport and storage of CO_2 once it has been captured from a large anthropogenic CO_2 point source such as a power plant. This is being used within EPA's macroeconomic modeling of the cost of complying with various proposed CO_2 emissions policies. This $15/tCO_2$ cost is based upon previously published research of ours and we have been asked to shed some light on the relative contribution of the cost of CO_2 transport and the cost of CO_2 storage (including measurement, monitoring and verification) to this overall $15/tCO_2$ figure.[2]

This $15/tonCO_2$ cost for storing CO_2 is characterized in our work as a long-term average price that seems to describe the site-specific circumstances likely to be encountered by a significant number of anthropogenic CO_2 point sources. However, this represents neither the exact cost for a given power plant, nor the cost likely to be encountered by all anthropogenic CO_2 sources. Despite the general statement that a significant fraction of CCS projects in the U.S. will fall in the $15/tCO_2$ range, the cost of deploying CCS systems will vary significantly from project to project, depending upon a host of source- and site-specific conditions.

Key contributors to the variability in estimated CO_2 transport and storage costs include:

- The type and individual characteristics of the anthropogenic CO_2 point source from which CO_2 is being captured and in particular the expected CO_2 flow rate (given the economies/diseconomies of scale associated with transport and storage);

- Transport distance and terrain that a CO_2 pipeline must traverse between the source and selected storage reservoir;

- Characteristics of the selected storage reservoir (e.g., reservoir type, depth, permeability, net thickness, pressure, etc.)

It is the specific combination of these factors for each individual source/reservoir pair that will determine the transport and storage costs and contribution of each to the total estimated combined cost. Because of the degree of variability of these parameters from one potential project to the next, the cost of deploying CCS systems will likely continue to span a wide range. Still, this $15/tonCO_2$ cost assumption is a useful, robust and appropriately conservative proxy for transport and storage costs likely to be encountered across a significant fraction of potential future commercial CCS deployment scenarios, which EPA can apply in its modeling without having to model tens of thousands of potential site-specific cases.

The following chart illustrates the actual modeled cost split for 6 sample points on this part of the CO_2 transport and storage cost curve, where the totals approximate $15/tCO_2$. These specific points were selected to represent the typical variation in component costs across the numerous source-reservoir pairings in this region of the cost curve.[3] The accompanying table highlights

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[1] All financial data presented in this paper are in 2005 U.S. dollars. "tCO_2" refers to metric tons of carbon dioxide.

[2] RT Dahowski, JJ Dooley, CL Davidson, S Bachu and N Gupta. *Building the Cost Curves for CO_2 Storage: North America.* Technical Report 2005/3. International Energy Agency Greenhouse Gas R&D Programme.

[3] As described in detail in Dahowski et. al. 2005, each of these six source-sink cost parings were extracted from a larger integrated analysis of the cost of employing CCS across the United States and Canada which employed an overall cost-minimizing optimization process that specifically took into account reservoir filling and the competition for storage space among sources as each large CO_2 point source sought out its

some of the key characteristics of the source-reservoir pairs which contribute to the transport and storage costs. As the figure shows, the fraction of each project's per-ton transport and injection cost attributed to either component varies significantly. For this reason, while we believe that this $15/tCO_2$ assumption is valid and useful for EPA's modeling purposes, it would be difficult and misleading to try to quote a "representative" cost proportion for either transport or storage for CCS in the U.S.
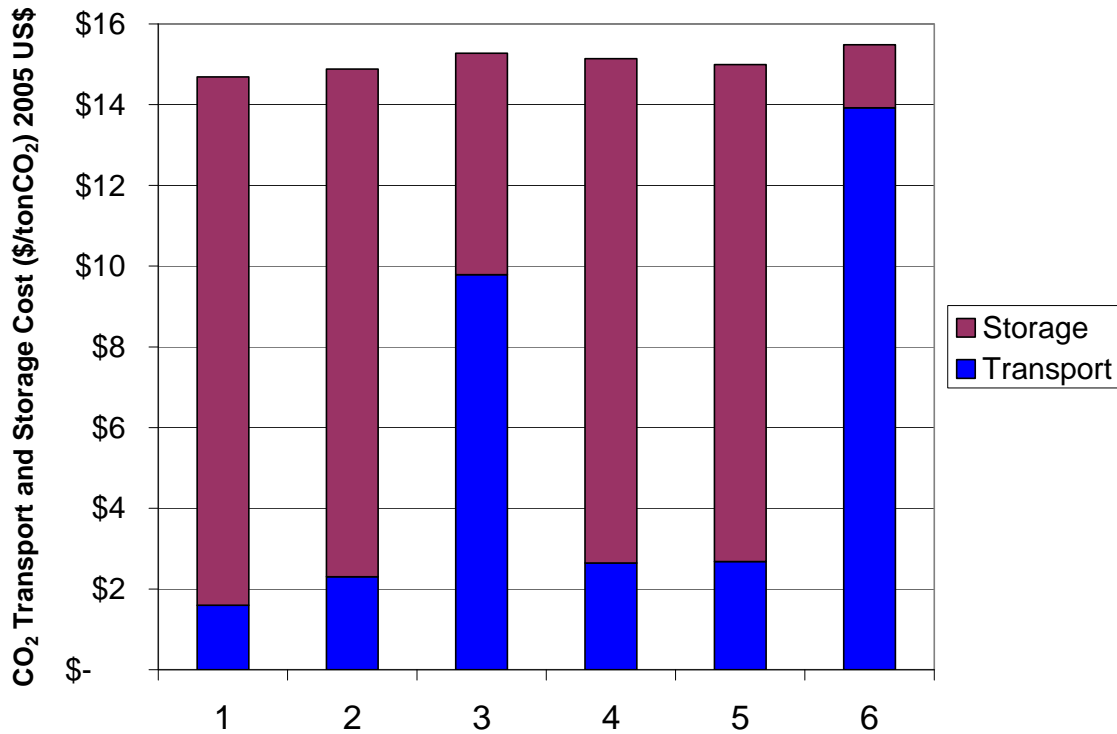
Case	
1	Oil refinery in Mississippi in the immediate vicinity of a depleted gas basin
2	Small gas-fired power plant in Louisiana in the immediate vicinity of depleted gas basin
3	Gas-fired power plant in New Mexico 60 miles away from unmineable coal seam
4	Coal-fired power plant in Iowa 85 miles from a deep saline formation
5	Coal-fired power plant in Wisconsin 50 miles from a deep saline formation
6	Smaller cement kilns in Kansas in the immediate vicinity of a depleted oil field

Figure: Representative variation in transport and storage costs for projects with net transport/storage cost of about $15/tCO_2$, as illustrated by 6 sample points from the cost curve.

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lowest cost storage option. The net result is that many large CO_2 point sources with higher cost of capture (e.g., coal-fired power plants) might not be able to access their preferred storage option and must rely on 2nd, 3rd or other best options as cheaper sources of CO_2 (e.g., a natural gas processing facility) out compete them for the storage space in the first best storage option. The impact of this on the U.S. electric power sector is addressed more fully in: Wise MA, JJ Dooley, RT Dahowski, and CL Davidson (2007). "Modeling the impacts of climate policy on the deployment of carbon dioxide capture and geologic storage across electric power regions in the United States." International Journal of Greenhouse Gas Control. Volume 1, Issue 2, April 2007, Pages 261-270.