PLAINS CO_2 REDUCTION (PCOR) PARTNERSHIP (PHASE III) – REVIEW OF SOURCE ATTRIBUTES

Task 1 – Deliverable D1

(for the period October 1, 2008, through September 30, 2009)

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INTRODUCTION

The Plains CO_2 Reduction (PCOR) Partnership maintains a database of significant regional point sources of carbon dioxide (CO_2). The database is key in the development of CO_2 capture–transportation–sequestration scenarios that have the potential to reduce greenhouse gas emissions in the PCOR Partnership region. To maintain a reasonably current status, the data set undergoes an annual review during which new or missing sources are identified and added, CO_2 emission rates are updated, and facility locations verified. The review that took place between October 1, 2008, and September 30, 2009, addressed all of these areas.

APPROACH

The review began as an effort focused on identifying and incorporating natural gas processing facilities that had previously not been included. Gas processing represents one of the easier sources from which to capture CO_2 in a fairly concentrated form because CO_2 is separated from the raw natural gas stream during acid gas removal activities, although it is then vented. The purity of the CO_2 stream depends upon the constituents present in the raw natural gas as well as the process used to remove the acid gas. However, it is still considered one of the easiest processes from which to obtain relatively pure streams of CO_2. Figure 1 shows the "low-hanging fruit" of CO_2 capture (i.e., the processes from which it is relatively easy to obtain reasonably pure streams of CO_2).

The *Oil and Gas Journal* Worldwide Gas Processing 2008 data set was purchased. This data set included data for 982 gas processing and gas transmission sites that are located within the PCOR Partnership region. The purchased data set did not specifically include CO_2 emissions.

Actual CO_2 emissions values were found for many of the facilities by searching the Environment

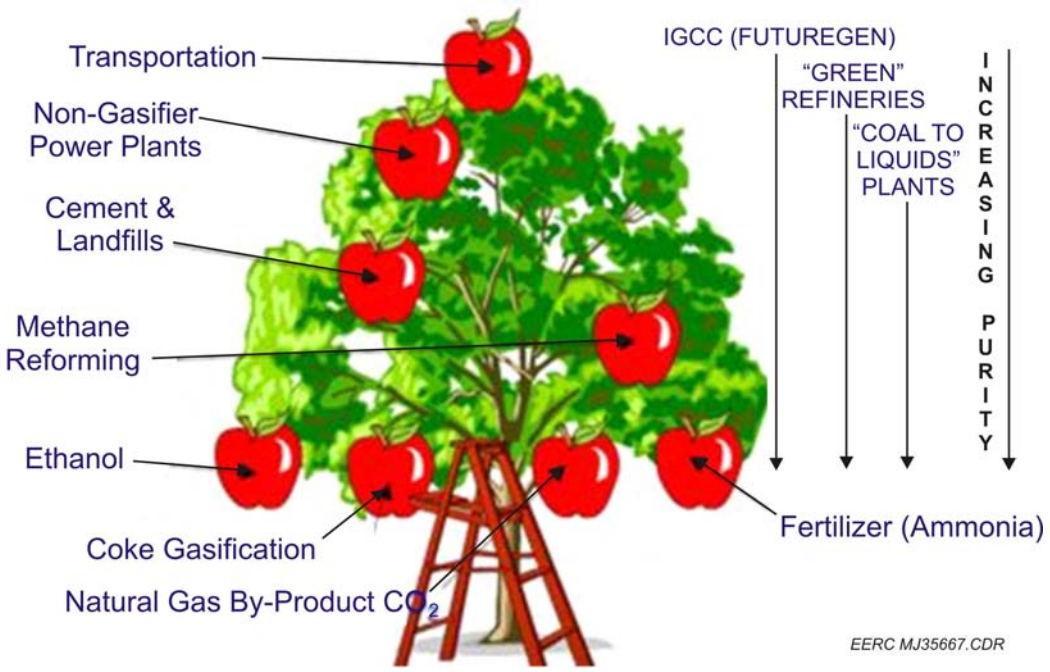

Figure 1. Sources of CO_2 streams; the "low-hanging fruit" (i.e., processes at the bottom) yield the most CO_2 for the least effort (graphic courtesy of Melzer Consulting).

Canada Facility Greenhouse Gas Reporting Search Data Web site (Environment Canada, 2009). For the facilities for which CO_2 emissions could not be determined, the quantity of captured CO_2 was estimated using the following approach. Metz and others (2005) note that about half of raw natural gas production contains CO_2 at concentrations that average at least 4% by volume, so CO_2 content of the raw natural gas throughput at the various facilities was estimated to make up 4 vol% of this stream. To be on par with the data generated by the other U.S. Department of Energy (DOE) Regional Carbon Sequestration Partnerships, an average 75% CO_2 removal rate, and subsequent venting of that CO_2, was assumed (DOE Regional Carbon Sequestration Partnerships Capture and Transportation Working Group, 2008). Equation 1 shows the calculation used to estimate the amount of CO_2 captured and subsequently emitted in short tons/yr.

$$CO_2 \text{ out} = g \times 0.04 \times \frac{10^6 \frac{ft^3}{d}}{\frac{MMft^3}{d}} \times \frac{365\,d}{yr} \times \frac{lbmol}{379\,ft^3} \times \frac{44\,lb}{lbmol} \times \frac{1\,ton}{2000\,lb} \times 0.75 \qquad [1]$$

where g is the natural gas throughput in $MMft^3/d$, and the gas stream is assumed to be at oil and gas industry standard conditions of 60°F and 1 atm. It should be noted that this methodology

does not imply a quality of processed natural gas. It is merely a tool used to estimate CO_2 capture and subsequent emission for an "average" gas-processing facility.

Each of the natural gas processing facilities' locations was verified by visual confirmation using the Google Earth satellite imagery. If the emission from a site was small and the facility did not appear on the satellite photographs to be a processing facility, the site was considered to be a natural gas transmission site rather than a gas processing site, and its label within the database was changed to reflect this.

During the efforts to find actual CO_2 emission values for the various sites, a few other sites were identified that were not contained in the database. When adding each of these sites to the database, the location was verified using Google Earth imagery.

The final significant change to the PCOR Partnership CO_2 emissions database was to define "large stationary sources" as emitting at least 15,000 short tons CO_2/yr. All sites emitting less than 15,000 tons CO_2/yr were eliminated from the searchable database that appears in the PCOR Partnership Decision Support System.

RESULTS

Table 1 shows the number of gas processing facilities that were added to the PCOR Partnership CO_2 source database during the past year's activities. The addition of these facilities and newly discovered sources as well as elimination of all sources smaller than 15,000 tons CO_2/yr resulted in the changes to the PCOR Partnership point source CO_2 emission database that are summarized in Table 2. Currently, there are 927 sources that emit 561.89 million short tons CO_2 annually.

Table 1. Changes in Numbers of Gas Processing Facilities Based on Purchase of the *Oil and Gas Journal* Worldwide Gas Processing 2008 Data Set (all data purchased, including sources emitting less than 15,000 tons CO_2/yr)

	Prior to Data Purchase		Following Data Purchase	
State/Province	Natural Gas Processing	Natural Gas Transmission	Natural Gas Processing	Natural Gas Transmission
Alberta	10	3	903	3
British Columbia	4	1	34	1
Manitoba	0	1	0	1
Minnesota	0	14	0	14
Missouri	0	6	0	6
Montana	2	3	4	3
Nebraska	0	10	1	10
North Dakota	9	9	7	9
Saskatchewan	1	4	25	4
South Dakota	0	3	0	3
Wisconsin	0	3	0	3
Wyoming	6	28	8	28

Table 2. Summary of CO_2 Point Sources Found Within the PCOR Partnership Region as of September 30, 2009

Broad Category	Number of Point Sources	Emissions, millions of short tons, yr	Percentage of Total Number of Sources	Percentage of Emissions
Agricultural and Agriculture-Related Processing	55	5.65	5.9	1.0
Electricity Generation	185	372.75	20.0	66.3
Chemical and Fuel Production	37	19.37	4.0	3.4
Ethanol Manufacture	92	26.48	9.9	4.7
Cement/Clinker Production	23	16.56	2.5	2.9
Industrial	33	15.21	3.6	2.7
Small-Scale Heat and Power	42	2.90	4.5	0.5
Manufacturing	95	10.85	10.2	1.9
Petroleum- and Natural Gas-Related	272	68.24	29.3	12.1
Paper and Wood Products	78	22.86	8.4	4.1
Waste Processing	15	1.03	1.6	0.2
Total	927	561.89	100.0	100.0

REFERENCES

Environment Canada Facility GHG Reporting Search Data Web site, www.ec.gc.ca/pdb/ghg/onlineData/dataSearch_e.cfm (accessed August 2009).

Metz, B., Davidson, O., de Coninck, H., Loos, M., and Meyer, L., eds., 2005, IPCC special report on carbon dioxide capture and storage: New York, Cambridge University Press, 431 p.

U.S. Department of Energy Regional Carbon Sequestration Partnerships Capture and Transportation Working Group, 2008, CO_2 point source emission estimation methodologies summary: U.S. Department of Energy National Energy Technology Laboratory, 35 p.

LIST OF ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
CO_2	carbon dioxide
d	day
DOE	U.S. Department of Energy
ft^3	cubic feet
g	natural gas throughput
IGCC	integrated gasification combined cycle

lb	pound
lbmol	pound mole
$MMft^3$	million cubic feet
PCOR Partnership	Plains CO_2 Reduction Partnership
ton	short ton
yr	year