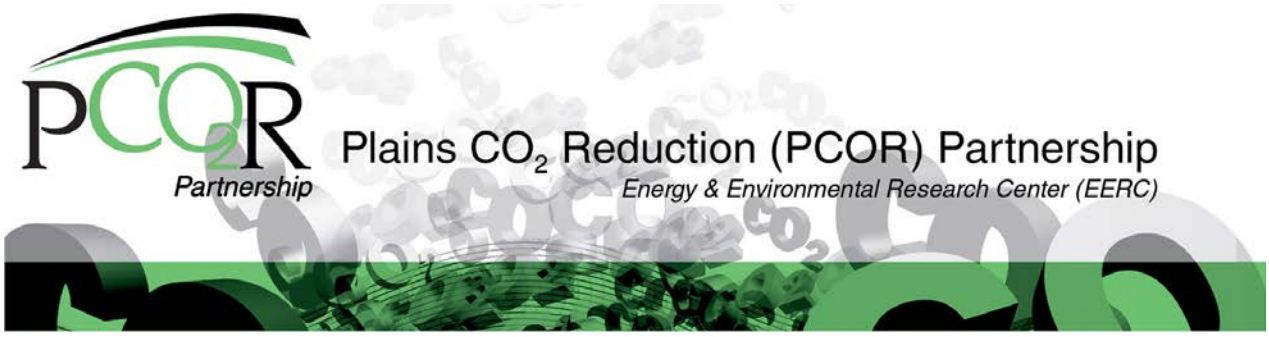

REVIEW OF SOURCE ATTRIBUTES

Plains CO_2 Reduction Partnership Phase III
Task 1 – Deliverable D1

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NOMENCLATURE AND ABBREVIATIONS

CH_4	methane
CO_2	carbon dioxide
CO_2eq	carbon dioxide equivalent
DOE	U.S. Department of Energy
DSS	Decision Support System
EPA	U.S. Environmental Protection Agency
HFC	hydrofluorocarbon
HFC-23	fluoroform
N_2O	nitrous oxide
NATCARB	National Carbon Sequestration Database and Geographic Information System
NO_x	nitrogen oxides
PCOR	Plains CO_2 Reduction
PFC	perfluorocarbon
PFC-116	hexafluoroethane
PFC-14	tetrafluoromethane
RCSP	Regional Carbon Sequestration Partnerships
SF_6	sulfur hexafluoride
SO_2	sulfur dioxide

REVIEW OF SOURCE ATTRIBUTES

EXECUTIVE SUMMARY

The Plains CO_2 Reduction (PCOR) Partnership, led by the Energy & Environmental Research Center at the University of North Dakota, maintains a database of regional sources of carbon dioxide (CO_2) emissions and evaluates it on an annual basis. The database is an important part of assessing potential CO_2 capture–transportation–storage scenarios that could reduce greenhouse gas emissions in the PCOR Partnership region. The emission measurements compiled in this database are typically acquired through online databases of the U.S. Environmental Protection Agency and Environment Canada. The updated database shows that there are 402 significant (greater than 100,000 tonnes) CO_2 emission sources that emit 469 million tonnes on an annual basis.

REVIEW OF SOURCE ATTRIBUTES

INTRODUCTION

The Plains CO_2 Reduction (PCOR) Partnership, led by the Energy & Environmental Research Center at the University of North Dakota, maintains a database of significant regional point sources of carbon dioxide (CO_2). The database is a key in the development of CO_2 capture–transportation–storage 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 are verified. This report summarizes the data review that took place between October 1, 2016, and September 20, 2017.

APPROACH

Actual emission measurements were obtained from three data sets in order to update the PCOR Partnership's CO_2 emission database:

- The Environment Canada Reported Facility Greenhouse Gas Data (Environment Canada, 2017), an online greenhouse gas search engine, provides the annual emissions of CO_2, CH_4 (methane), N_2O (nitrous oxide), SF_6 (sulfur hexafluoride), PFCs (perfluorocarbons), HFCs (hydrofluorocarbons), and other greenhouse gases for point sources from all sectors. The Canadian point sources in the PCOR Partnership database were updated using 2015 data (the most current data). The search engine can be accessed at www.ec.gc.ca/ges-ghg/donnees-data/index.cfm?lang=En.

- The U.S. Environmental Protection Agency (EPA) Air Markets Program Data online emission search engine (U.S. Environmental Protection Agency, 2017a) provides CO_2, SO_2 (sulfur dioxide), and NO_x (nitrogen oxides) emission data for electric utilities and larger industrial heat/power plants. When possible, the PCOR Partnership database was updated using facility data from 2016 so as to incorporate the most current data. This search engine can be accessed at ampd.epa.gov/ampd/.

- EPA's Greenhouse Gas Reporting Program Data for Calendar Year 2015 (U.S. Environmental Protection Agency, 2017b) is a searchable site that contains CO_2, N_2O, CH_4, PFC-14 (tetrafluoromethane), PFC-116 (hexafluoroethane), and HFC-23 (fluoroform) emission data reported from large facilities in nine industry groups: power plants, landfills, metal manufacturing, mineral production, petroleum refineries, pulp and

paper manufacturing, chemical manufacturing, government and commercial facilities, and other industrial facilities. The Greenhouse Gas Reporting Program Data can be accessed at ghgdata.epa.gov/ghgp/main.do.

The EPA searchable database presents a challenge in that it is difficult to determine the total CO_2 emissions as opposed to the total CO_2 equivalent (CO_2eq) emissions for some of the source types. One example of this is sugar-processing facilities with their inherent lime production. This is not true for all source types.

The threshold for inclusion of the sources into the PCOR Partnership data is 100,000 tonnes/yr. The threshold was chosen for several reasons:

- 100,000 tonnes/yr is generally thought to be the minimum emission level that would be useful to a commercial end user.

- The cost to capture and transport CO_2 from a system producing a smaller CO_2 stream than this would likely be prohibitively expensive.

- The other Regional Carbon Sequestration Partnerships (RCSPs) have generally reported their CO_2 data for sources that produce at least 100,000 tonnes CO_2/yr. This threshold puts the PCOR Partnership data set on the same basis as the other RCSP data sets within NATCARB (National Carbon Sequestration Database and Geographic Information System).

RESULTS

As of September 20, 2017, the updated PCOR Partnership database contains 402 sources that produce an estimated 469 million tonnes of CO_2 annually. The breakdown of the CO_2 emissions by broad source category is presented in Table 1. The breakdown of the CO_2eq emissions by broad source category is given in Table 2, while Table 3 shows the types and CO_2eq of the other greenhouse gases emitted by the CO_2 sources tracked in the PCOR Partnership data set.

Figure 1 shows the locations of 15 new facilities that were found to be missing from the data set and were, therefore, added to it. Seven sources present in last year's data update did not produce the minimum quantity of CO_2 to be included in this data set.

When available, the CO_2eq emissions due to CH_4, N_2O, HFCs, PFCs, and/or SF_6 are incorporated into the PCOR Partnership database. This information was found for as many as 303 (depending on the greenhouse gas) of the 402 sources and is summarized in Table 3. Roughly 75% of the large CO_2 point sources in the PCOR Partnership region emit other greenhouse gases in addition to CO_2.

The process of moving this latest data set to the PCOR Partnership Decision Support System (DSS) is currently under way. When the process is complete, the updated emission data will be reflected via the online geographic information systems on the PCOR Partnership DSS and the U.S. Department of Energy's national portal.

Table 1. Summary of CO_2 from Point Sources Found Within the PCOR Partnership Region as of September 20, 2017

Category	Count	Total CO_2, tonnes	% of Sources	% of Emissions
Electricity Generation	127	304,682,744	31.6	64.9
Petroleum- and Natural Gas-Related	95	87,868,023	23.6	18.7
Cement/Clinker Production	22	17,761,069	5.5	3.8
Chemical and Fuel Production	25	16,243,843	6.2	3.5
Ethanol Manufacture	48	14,480,908	11.9	3.1
Paper and Wood Products	16	9,852,512	4.0	2.1
Industrial	21	7,093,986	5.2	1.5
Agricultural and Agriculture-Related Processing	21	6,566,465	5.2	1.4
Manufacturing	8	1,871,615	2.0	0.4
Waste Processing	13	1,888,450	3.2	0.4
Small-Scale Heat and Power	6	1,109,287	1.5	0.2
Total	**402**	**469,418,902**	**100.0**	**100.0**

Table 2. Summary of CO_2-Equivalent Emissions from Point Sources Found Within the PCOR Partnership Region as of September 20, 2017

Category	Count	Total CO_2eq, tonnes	% of Sources	% of Emissions
Electricity Generation	127	305,307,554	31.6	62.9
Petroleum- and Natural Gas-Related	95	91,132,546	23.6	18.8
Cement/Clinker Production	22	20,128,453	5.5	4.1
Chemical and Fuel Production	25	17,861,042	6.2	3.7
Ethanol Manufacture	48	14,706,481	11.9	3.0
Paper and Wood Products	16	14,472,522	4.0	3.0
Industrial	21	7,256,562	5.2	1.5
Agricultural and Agriculture-Related Processing	21	7,139,680	5.2	1.5
Waste Processing	13	3,733,640	3.2	0.8
Manufacturing	8	2,272,601	2.0	0.5
Small-Scale Heat and Power	6	1,145,110	1.5	0.2
Total	**402**	**485,156,189**	**100.0**	**100.0**

Table 3. Summary of Non-CO_2 Greenhouse Gases Emitted by Sources in the PCOR Partnership Region

Greenhouse Gas	CO_2 Equivalent Value	Number of Sources	Quantity, tonnes CO_2eq
CH_4	21	303	5,529,236
N_2O	310	293	2,590,683
SF_6	23,900	5	5303
HFC	140 to 11,700	5	12,219
PFC	6500 to 9200	3	377,543

Figure 1. Location of the new facilities identified during this database update.

REFERENCES

Environment Canada, 2017, Environment Canada reported facility greenhouse gas data: www.ec.gc.ca/ges-ghg/donnees-data/index.cfm?lang=En (accessed September 2017).

U.S. Environmental Protection Agency, 2017a, U.S. Environmental Protection Agency air markets program data for calendar year 2016: ampd.epa.gov/ampd/ (accessed September 2017).

U.S. Environmental Protection Agency, 2017b, U.S. Environmental Protection Agency greenhouse gas reporting program data for calendar year 2015: ghgdata.epa.gov/ ghgp/main.do (accessed September 2017).