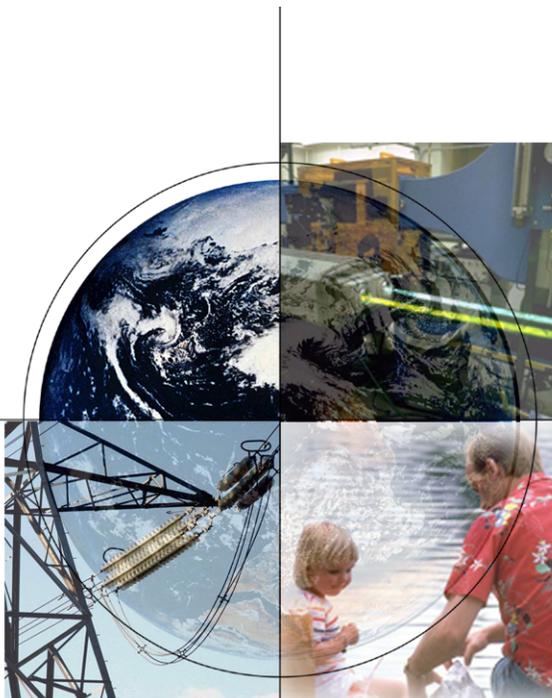


CO₂ POINT SOURCE EMISSION ESTIMATION METHODOLOGIES SUMMARY



*Regional Carbon Sequestration
Partnership's Annual Meeting*

*Melanie Jensen
Plains CO₂ Reduction Partnership*

*Presenting on behalf of the Capture and
Transportation Working Group*

December 12 & 13, 2007

U.S. DOE Carbon Capture and Sequestration Program

National Energy Technology Laboratory



CO₂ Methodologies Document Approach

- **CO₂ Methodologies Document outlines approaches used to achieve the following:**
 - **Source Identification:** Identify significant CO₂ emission sources within each Partnership region.
 - **CO₂ Emission Estimates:** Assess availability of CO₂ emission data or apply an estimate of the CO₂ emissions based upon scientific and engineering principles.
- **CO₂ emission estimation methodology and equations for major CO₂ point sources organized by industry types outlined in the Carbon Sequestration Atlas.**



CO₂ Point Sources by Industry Type

- Major CO₂ point sources fall under one of nine industry types.
- Industry types identified and outlined by the Carbon Sequestration Atlas.
- **Industry Types:**
 - Electric-Generating Plants
 - Ethanol Plants
 - Agricultural Processing Facilities
 - Natural Gas Processing Facilities
 - Industrial Facilities
 - Iron and Steel Facilities
 - Cement and Lime Plants
 - Refineries/Chemical Facilities
 - Fertilizer Production.

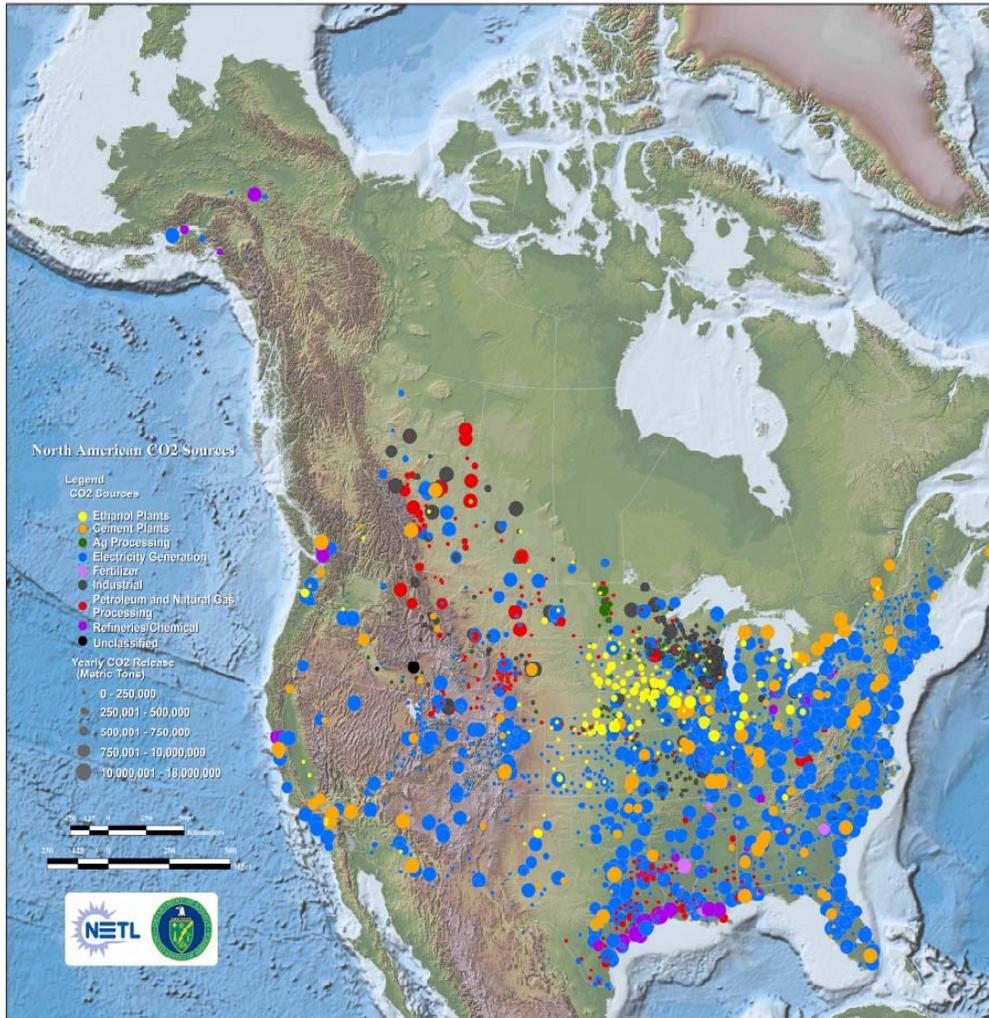


CO₂ Point Sources by Industry Type

Industry type	CO ₂ Point Sources Included
Electric-Generating Plants	<ul style="list-style-type: none"> • Coal, Oil, and Natural Gas fired power plants
Ethanol Plants	<ul style="list-style-type: none"> • Ethanol Plants regardless of feedstock type
Agricultural Processing Facilities	<ul style="list-style-type: none"> • Sugar Production
Natural Gas Processing Facilities	<ul style="list-style-type: none"> • Natural Gas Processing Facilities
Industrial Facilities	<ul style="list-style-type: none"> • Aluminum Production Facilities • Paper and Pulp Facilities • Soda Ash Production Facilities • Glass Manufacturing Facilities • Automobile Manufacturing Facilities • Compressor Stations • Iron Ore Processing Facilities
Iron and Steel Facilities	<ul style="list-style-type: none"> • Iron and Steel Producing Facilities
Cement and Lime Plants	<ul style="list-style-type: none"> • Lime Production Facilities • Cement Plants
Refineries/Chemical Facilities	<ul style="list-style-type: none"> • Petroleum Refinery Processing • Ethylene Production Facilities • Ethylene Oxide Production • Hydrogen Production Facilities
Fertilizer Production	<ul style="list-style-type: none"> • Ammonia Production



Carbon Sequestration Atlas of the U.S. and Canada

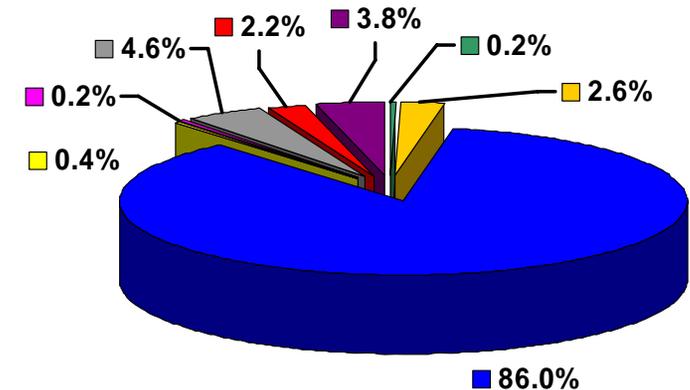


CO₂ Sources Documented in NatCarb

	CO ₂ Emission (Million Tons)	Number of Facilities
CO ₂ Sources	3,809	> 4,365

Phase I Requirement: Regional Carbon Sequestration Partnerships conduct greenhouse gas (GHG) emission inventories and point source surveys within their respective partnership boundary areas.

Percentage of CO₂ Stationary Source Emissions by Industry Type



■ Agricultural Processing Facilities	■ Cement and Lime Plants
■ Electric-Generating Plants	■ Ethanol Plants
■ Fertilizer Production	■ Industrial Facilities
■ Natural Gas Processing Facilities	■ Refineries/Chemical Facilities



CO₂ Estimation Methodology

- **CO₂ emission estimates for a given point source based on:**
 - Most readily available data.
 - Most representative data.
- **First data choice by all Partnerships: Databases**
 - Contain reliable and accurate data obtained from direct emissions measurements via continuous emissions monitoring (CEM) systems.
 - Types: EPA eGRID, NATCARB, Transfer Technology Network.
- **Second data choice by all Partnerships: CO₂ Emission Factors**
 - Emission factors coupled with facility fuel use data or facility production data.
 - Data obtained from various databases, websites, and publications.
- **Point source spatial location obtained from databases (eGRID) and websites and verified with mapping tools (Google Earth, TerraServer).**



Document Layout Example: Electric-Generating Units

- Emission estimation approach outlined for each industry type.
- Approach broken down by the databases (if available) or emissions factors (with equations) employed.
- Majority of electric-generating facility data available from eGRID.

Electric-Generating Units Databases

Methodology	Description
Database	<p>Where available, actual emissions data were obtained from various databases. The most current data were used, even if not all sources had the same vintage data. These include:</p> <ul style="list-style-type: none"> • EPA Clean Air Markets Division Facility Emissions Data (accessed 2005 via NATCARB) [where the average of the most recent four years of data were selected and aggregated to the plant level and the lowest values were dropped to reduce the impacts of startup and maintenance.]¹ • EPA eGRID database (2002)² • EPA Acid Rain Program Emission Report for the 2005 year (2006)³ • Commission for Environmental Cooperation Website (US Plants)⁴ • Commission for Environmental Cooperation Website (Canadian Plants)⁵ • Website for Canadian Sources⁶ • U.S. EPA, Acid Rain Program Emission Report for Year of 2005 Greenhouse Gas Inventory Sector Analysis, 2006.¹² • New plant data from EIA Table ES3; New and Planned U.S. Electric Generating Units by Operating Company, Plant and Month, 2007 – 2008.¹⁸



*All superscripted values in the following tables are defined by footnotes in the CO₂ Methodologies Document.



eGRID Database

- EPA Emissions & Generation Resource Integrated Database (eGRID).
- Comprehensive inventory of environmental attributes of electric power systems.
- Based on available plant-specific data for all U.S. electricity generating plants that provide power to the electric grid and report data to the U.S. government
- Air emissions data for nitrogen oxides, sulfur dioxide, carbon dioxide, and mercury.

The eGRID logo, featuring the word "eGRID" in a bold, blue, sans-serif font. The background of the slide is a faded image of an industrial facility, likely a power plant or refinery, with tall towers and structures under a clear sky.

eGRID

Document Layout Example: Electric-Generating Units Cont.

Electric-Generating Units Emission Factors

Emissions Factors	<p>Data were analyzed based on the IPCC (2006) greenhouse gases methodology using fuel consumption, a fuel-specific carbon coefficient, and the fuel related-fraction of carbon oxidized, similar to the following equation:⁵⁶</p> $M_{CO_2} = \frac{3.664F_t C_{\%} D_F}{2000} \text{ (if liquid or gaseous fuel)}$ $M_{CO_2} = 3.664C_{\%} F_t \text{ (if solid fuel)}$ <p>CO₂ emissions were calculated via combustion based on fuel type and usage data provided by the Transfer Technology Network (TTN) database:¹⁰</p> $M_{CO_2} = \frac{3.664F_t C_{\%} D_F}{2000} \text{ (if liquid or gaseous fuel)}$ $M_{CO_2} = 3.664C_{\%} F_t \text{ (if solid fuel)}$
	<p>For new plants without CO₂ data, annual emissions were estimated by calculating megawatt hours from the plant capacity and 50% annual production for natural gas combined cycle or 20% for natural gas simple cycle. 1100 lb of CO₂ per MWh was approximated based on examination of natural gas plants in the eGRID data to estimate emissions at new plants.²</p> $M_{CO_2} = \frac{1100P}{2000}$

- Emission estimates via emission factors described in detail for each industry type.
- Legend provides definitions for equation variables.

Legend:

$C_{\%}$ = Carbon in the Fuel (weight fraction)

D_F = Fuel Density (lb/gallon = liquid; lb/million scf = gas)

F_t = Fuel Usage Rate (depends on fuel type) (gallons/year = liquid; million scf/year = gas; tons/year = solid)

M_{CO_2} = Total CO₂ emissions (tons/year)

P = Annual plant generation (MWh)



CO₂ Estimation Methodology Document

Conclusions

- Summarizes calculations, emissions factors, and databases employed by the Regional Carbon Sequestration Partnerships with respect to CO₂ point source emissions estimation methods.
- Estimation Method Hierarchy:
 - 1) **Databases:** reliable data obtained from direct emissions measurements.
 - 2) **Emission Factors:** coupled with production or fuel use data.
- Available data varies by industry type and point source. The most readily available and accurate data always selected first.
- The document will supplement Appendix A of the second version of the Carbon Sequestration Atlas.

