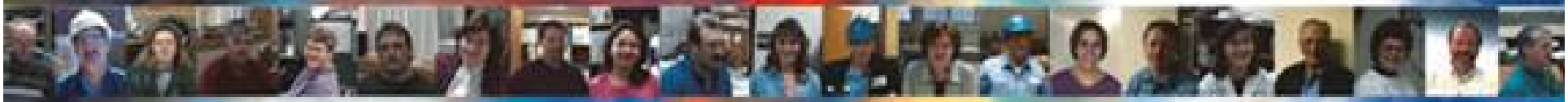
PCO2R Partnership

EERC
Energy & Environmental Research Center

EERC Technology – Putting Research into Practice

Regional Carbon Sequestration Partnerships Annual Program Review Meeting

John Harju and Ed Steadman

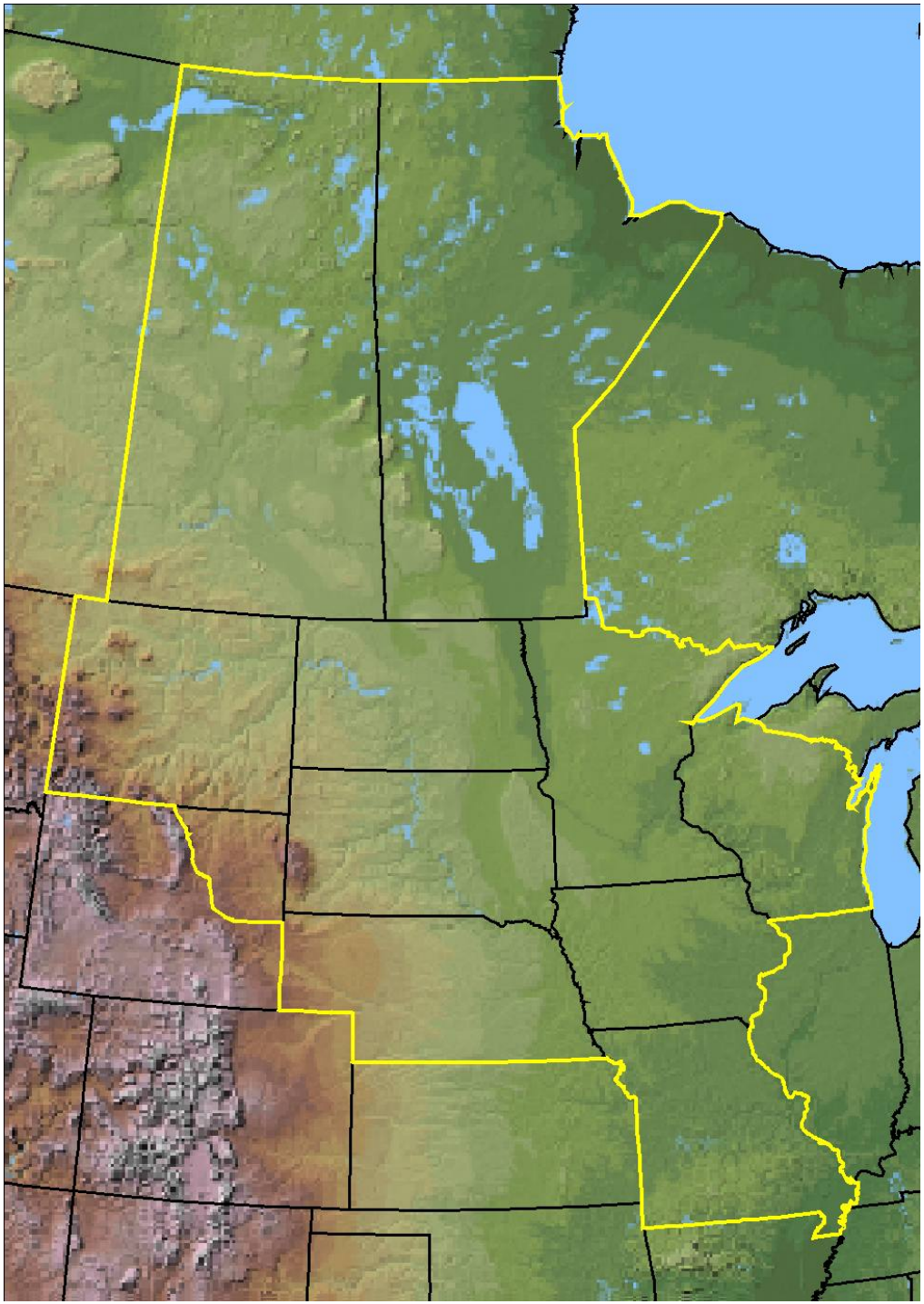


Pittsburgh, PA
November 16–17, 2004

University of North Dakota

"We are moving into a ***carbon-managed*** world, not a ***carbon-constrained*** world."
— *R. Patrick*

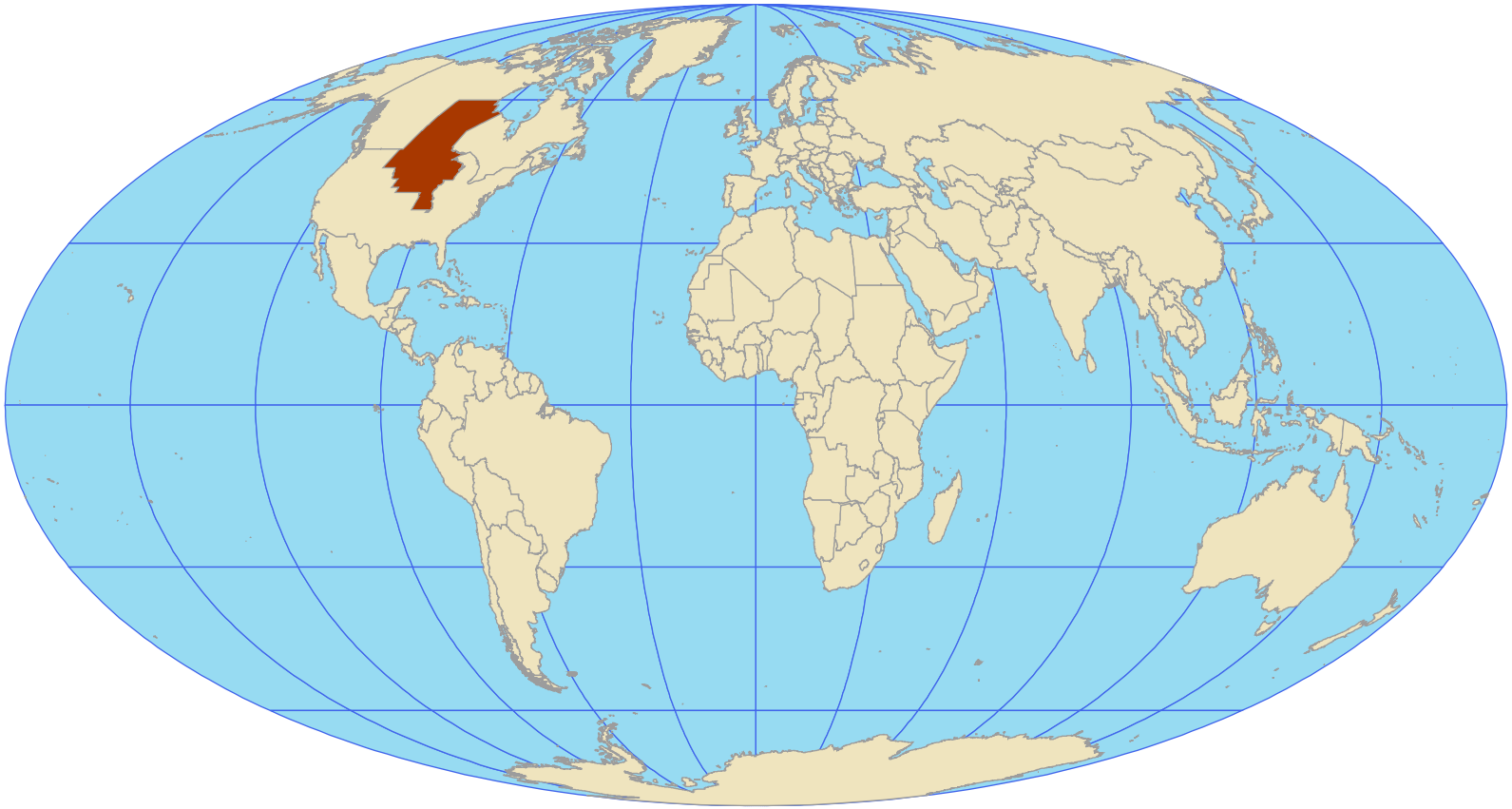
Rick Patrick, Vice President, Planning, Environment, and Regulatory Affairs, SaskPower. Personal communication (2004).



PCOR Partnership

EERC Energy & Environmental Research Center

PCOR Partnership – A Global Perspective

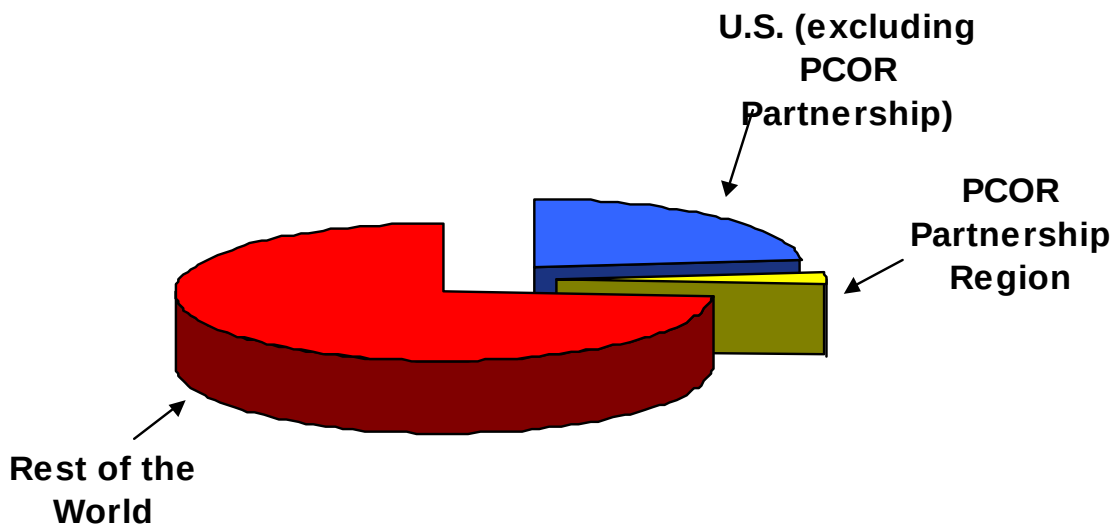


PCOR Partnership

EERC
Energy & Environmental Research Center

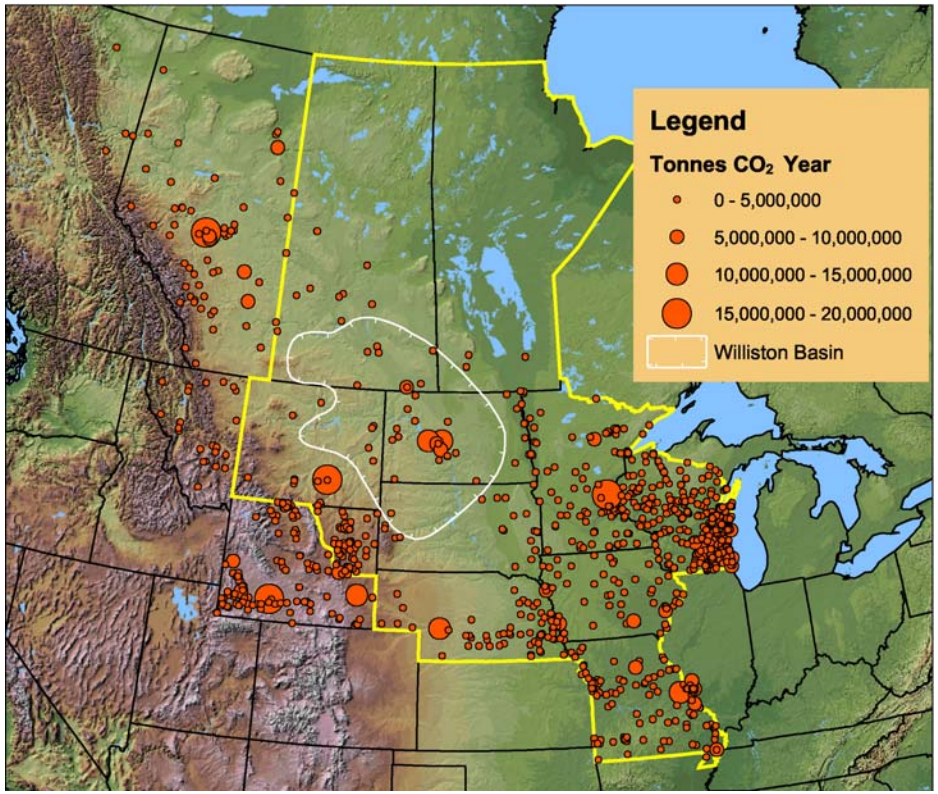
PCOR Partnership CO_2 Emissions

1999 Global CO_2 Emissions
(in MMTCE)



Plains CO_2 Reduction (PCOR) Partnership

- Phase I
  - Gauge public understanding
  - Develop database for:
    - Sources
    - Sinks
    - Separation and transportation options
    - Regulatory and permitting requirements
    - Environmental benefits and risks
  - Identify opportunities and conduct public outreach campaign
  - Develop action plan for Phase II (Technology Evaluations)



PCO2R Partnership

EERC Energy & Environmental Research Center

Plains CO_2 Reduction Partnership – Partners

ptrc Petroleum Technology Research Centre

BASIN ELECTRIC POWER COOPERATIVE
A Touchstone Energy® Cooperative

NDSU
NORTH DAKOTA STATE UNIVERSITY

Manitoba Hydro

LIGNITE Energy COUNCIL

Ducks Unlimited Canada
CANADA'S CONSERVATION COMPANY

WESTERN GOVERNORS' ASSOCIATION

North Dakota Department of Health

HESS

GREAT RIVER ENERGY
A Touchstone Energy® Cooperative

Great Plains SYNFUELS
Dakota Gasification Company

SaskPower

MONTANA-DAKOTA UTILITIES CO.
A Division of MDU Resources Group, Inc.

NORTH DAKOTA NATURAL RESOURCES TRUST

Prairie Public Television

OTTER TAIL POWER COMPANY

N. D. I. C. Oil & Gas Div.

TESORO

Fischer Oil and Gas, Inc.

EERC
Energy & Environmental Research Center

NETL

Kiewit

USGS
science for a changing world

BECHTEL Corporation

CEED
Center for Energy and Economic Development

INTERSTATE OIL AND GAS COMPACT COMMISSION
DEDICATED TO THE CONSERVATION OF OIL AND GAS
1935

North Dakota Petroleum Council

Minnesota Pollution Control Agency

PTTC
TECHNOLOGY CONNECTIONS

UNIVERSITY OF REGINA

Eagle Operating Inc.

CCX

Environment Canada

Great Northern Power Development

Nexant

Chicago Climate Exchange

Montana Department of ENVIRONMENTAL QUALITY

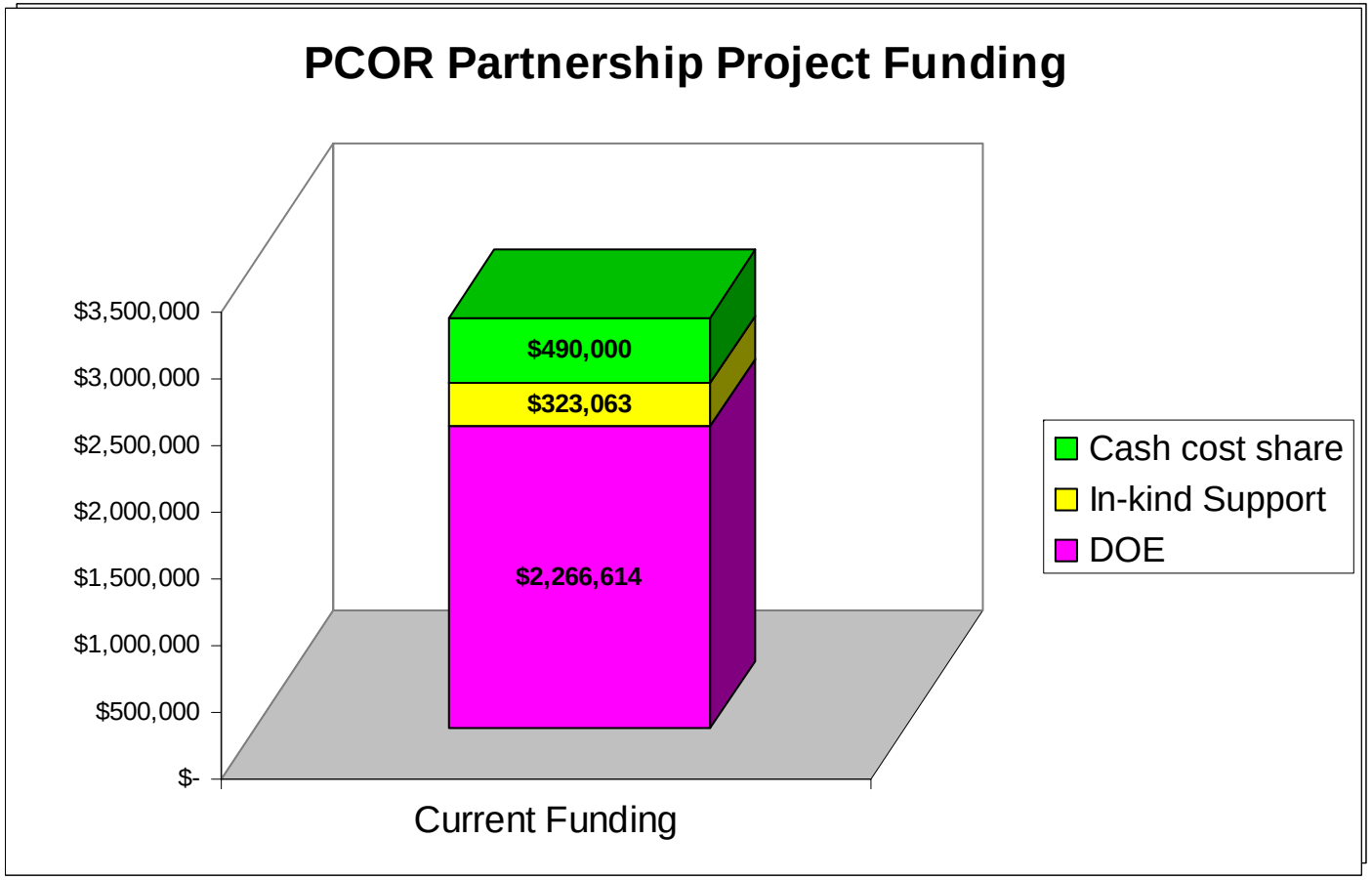
Saskatchewan Industry and Resources

PUBLIC SERVICE COMMISSION MONTANA

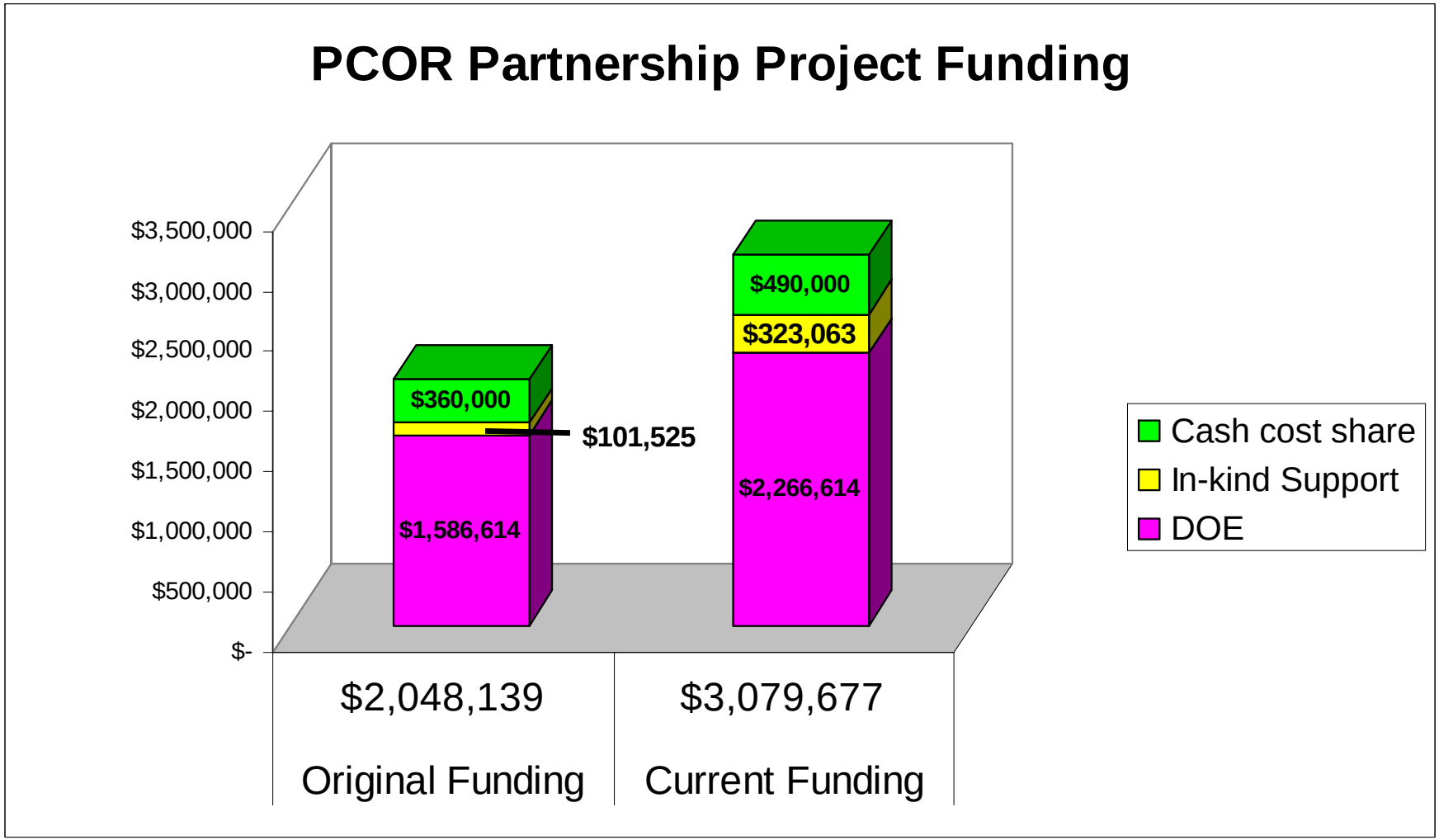
Minnkota Power COOPERATIVE, INC.
MPC
Your Touchstone Energy® Partner

Xcel Energy

PCOR Partnership Project Funding



PCOR Partnership Project Funding



Technology Deployment

PCOR Partnership

EERC Energy & Environmental Research Center

Technology Deployment Issues

- Ecosystem impact and risk assessment
- MM&V
- Safety, regulatory, and permitting requirements

PCO2R Partnership

EERC Energy & Environmental Research Center

Ecosystem Impact and Risk Assessment

Local Risks

CO_2 Leakage to Atmosphere or Shallow Subsurface

- Biological impact on plants, insects, and animals, including asphyxiation or suffocation

CO_2 Dissolved in Subsurface Fluids

- Mobilization of metals or other contaminants
- Contamination of potable water
- Interference with deep-subsurface ecosystems

Displacement

- Ground heave
- Induced seismicity
- Contamination of drinking water by displaced brines or reservoir fluids
- Damage to hydrocarbon or mineral resources

Global Risks

Release of CO_2 to the Atmosphere

- Potential impact on climate change

PCOR Partnership

EERC Energy & Environmental Research Center

What We Know Today Concerning Risks

- CO_2 can be safely stored in geologic formations over long periods of time as observed with naturally existing CO_2 reservoirs.
- Environmental and ecological health effects are well understood.
- The largest risks of CO_2 capture and storage have been identified.
- Local hazards are generally more dependent on the nature of the release than the size of the release.
- CO_2 poses no health and safety risk at low concentrations.
- CO_2 is not flammable or explosive, but it does react with water.
- CO_2 is denser than air and has the potential to pool in low-lying areas or poorly ventilated spaces.

PCO2R Partnership

EERC Energy & Environmental Research Center

MM&V

To ensure safe and effective storage of CO_2, close MM&V will be required through all phases of CO_2 sequestration, including capture and separation, transportation, preinjection site screening, injection, postinjection, abandonment, and long-term management.

MM&V serves to:

- Protect worker health and safety.
- Ensure environmental and ecological safety.
- Verify safe and effective storage.
- Track plume migration.
- Provide early warning for failure.
- Confirm model predictions.
- **Provide Market Assurance!**

PCO2R Partnership

EERC Energy & Environmental Research Center

What MM&V May Include

- Pipeline and injection well integrity, pressures, and flow rates
- Integrity of monitoring wells and abandoned wells
- Leakage from engineered systems (e.g., wells)
- Geological characterization including location of faults and weaknesses in the caprock of the primary storage reservoir
- Groundwater movement and quality
- CO_2 plume migration
- Reservoir pressure
- Ground displacement and induced seismicity
- Effective use of available reservoir storage volume
- Geophysical and geochemical interactions
- Health of shallow subsurface and surface flora and fauna
- CO_2 flux at ground surface
- CO_2 concentrations in topographic features and poorly ventilated areas where CO_2 may pool

PCO2R Partnership

EERC Energy & Environmental Research Center

Current Regulatory Framework

- Most industrial and safety regulations for CO_2 focus on engineering controls and specifications for transportation, storage containers, and pipelines.
- Extensive CO_2 pipeline network in use; regulations in place.
- Surface risks of CO_2 exposure typically handled by state environmental, health, and safety regulatory agencies.
- Only inventory list for Toxic Substance Control Act (TSCA), National Institute for Occupational Safety and Health (NIOSH) confined space hazard classification system and the Federal Emergency Management Agency's (FEMA's) hazardous materials guide treat CO_2 as hazardous substance to the extent that any concentrated, pressurized, or cryogenic gas poses a danger.

PCO2R Partnership

EERC Energy & Environmental Research Center

Current Regulatory Framework, Cont.

- U.S. Environmental Protection Agency (EPA) Underground Injection Control (UIC) Program regulates CO_2 injection for enhanced recovery operations (permitted as Class II injection well); does not specifically address non-enhanced oil recovery (EOR) projects (e.g., storage in deep saline formation).

- Regulatory framework for natural gas storage, nonhazardous or hazardous waste disposal, and acid gas injection may provide additional guidance for regulating CO_2 sequestration operations.

PCO2R Partnership

EERC Energy & Environmental Research Center

PLAINS CO_2 REDUCTION (PCOR) PARTNERSHIP

Practical, Environmentally Sound CO_2 Sequestration

LIST OF PRODUCTS

DEPLOYMENT

Document	Title	Status
Topical Report	Deployment Issues Related to Geologic CO_2 Sequestration in the PCOR Partnership Region	Final draft to partners

Public Outreach

Public Outreach and Education

- Raise awareness of sequestration for the general public
- Provide materials, capabilities, and insights useful to future sequestration activities

PCO2R Partnership

EERC Energy & Environmental Research Center

PCOR Partnership Home - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites Media History Mail Print Edit Discuss

Address http://www.undeerc.org/pcor/ Go Links

University of North Dakota Grand Forks

EERC

The Plains CO_2 Reduction Partnership

PCO2R Partnership

Home | Contact Us | EERC

- PCOR Partnership Profile
- PCOR Partnership Region
- CO_2 Sequestration Info
- For the Classroom
- Become a Member
- Links
- Members Only

The Plains CO_2 Reduction (PCOR) Partnership is assessing the technical and economic feasibility of capturing and storing (sequestering) carbon dioxide (CO_2) emissions from stationary sources in the northern Great Plains and adjacent area. The partnership is composed of more than 30 private and public sector groups from nine states and two Canadian provinces.

The PCOR Partnership, one of seven regional partnerships funded by the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnership Program, is coordinated by the Energy & Environmental Research Center (EERC) at the University of North Dakota in Grand Forks, North Dakota.

Internet

PLAINS CO_2 REDUCTION (PCOR) PARTNERSHIP

Practical, Environmentally Sound CO_2 Sequestration

LIST OF PRODUCTS

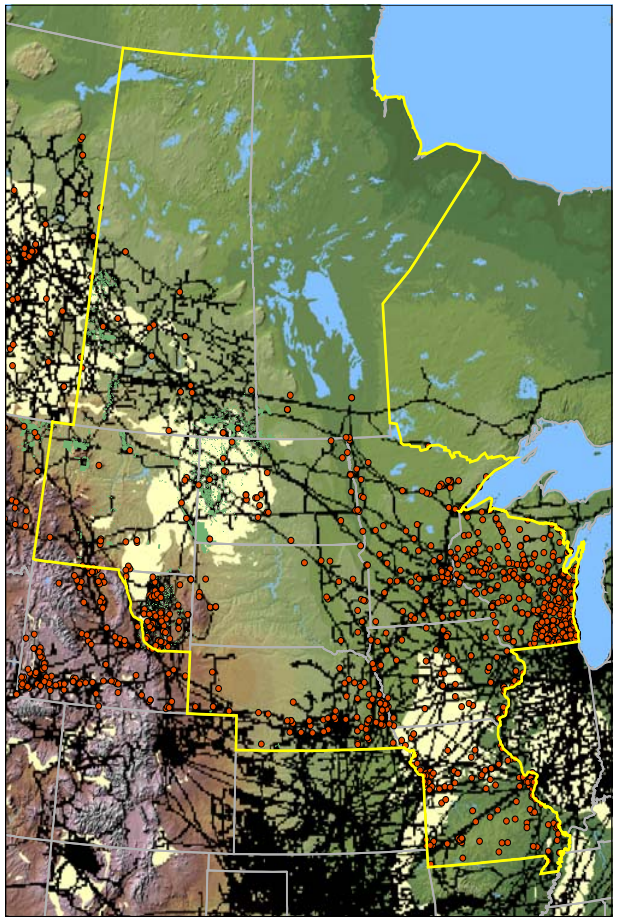
PUBLIC OUTREACH

Document	Title	Status
Fact Sheet	What Is CO_2 Sequestration?	Completed
Fact Sheet	CO_2 Sequestration – Controlling CO_2 Emissions to the Atmosphere Through Capture and Long-Term Storage	Final draft to partners
Fact Sheet	The Weyburn Oil Field – A Model for Value-Added Direct CO_2 Sequestration	Final draft to partners
Video	Carbon Sequestration	Draft in preparation
Focus Group	Public Opinion of CO_2 Sequestration	Draft in preparation
Fact Sheet	Terrestrial Sequestration	Draft in preparation
Fact Sheet	Geological Sequestration	Draft in preparation
Newspaper	Newspaper articles regarding carbon sequestration	Draft in preparation
Web Site	The PCOR Partnership http://www.undeerc.org/pcor/default.asp	Ongoing

Sources, Sinks, and Infrastructure

Shown are the following:

- Pipelines
- Coal regions
- Oil fields
- CO_2 sources
- Political boundaries



PCOR Partnership

EERC Energy & Environmental Research Center

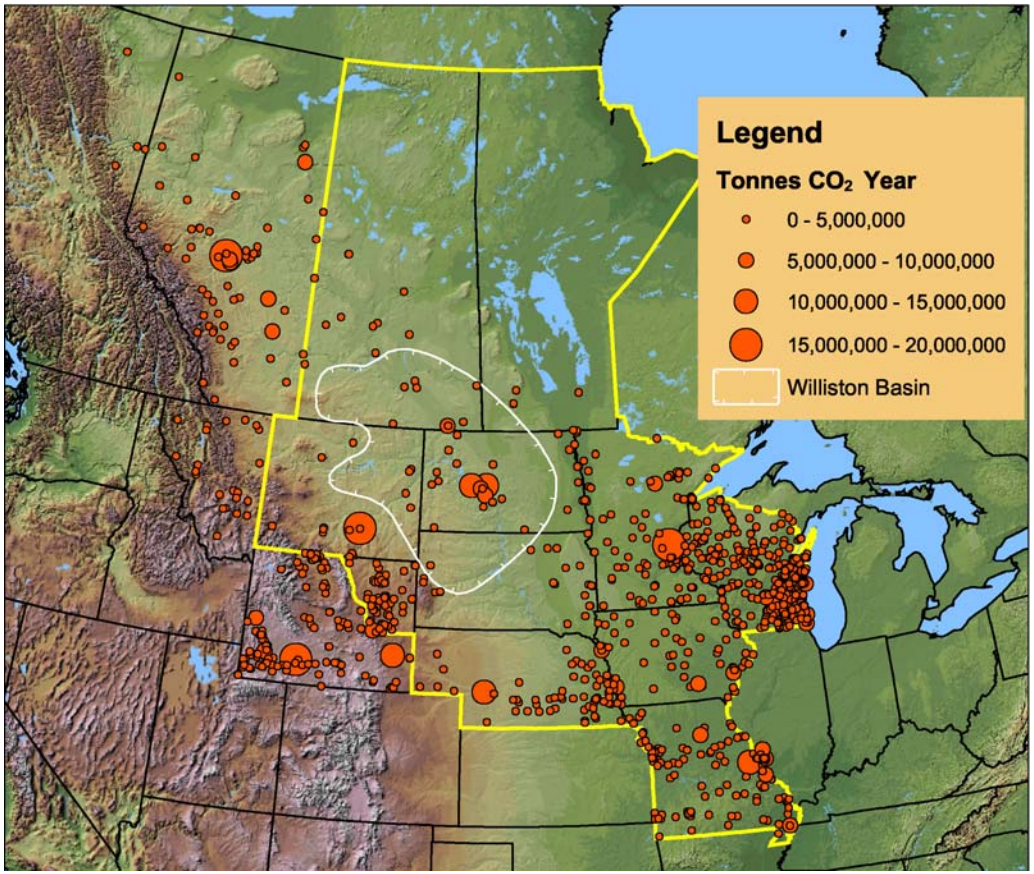
Sources

- Electric utilities
- Ethanol
- Ammonia
- Cement
- Lime production facilities
- Iron ore-processing facilities

PCOR Partnership

EERC Energy & Environmental Research Center

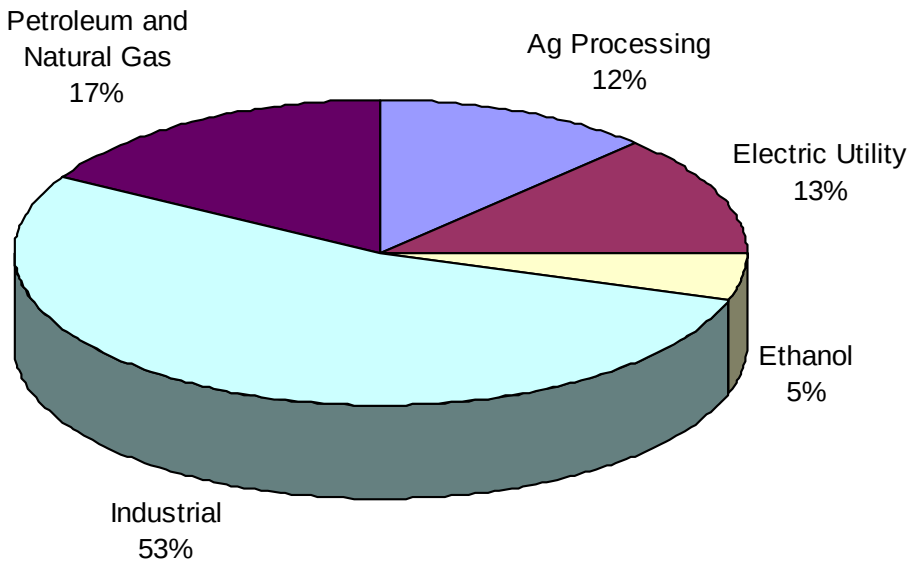
Industrial CO_2 Sources



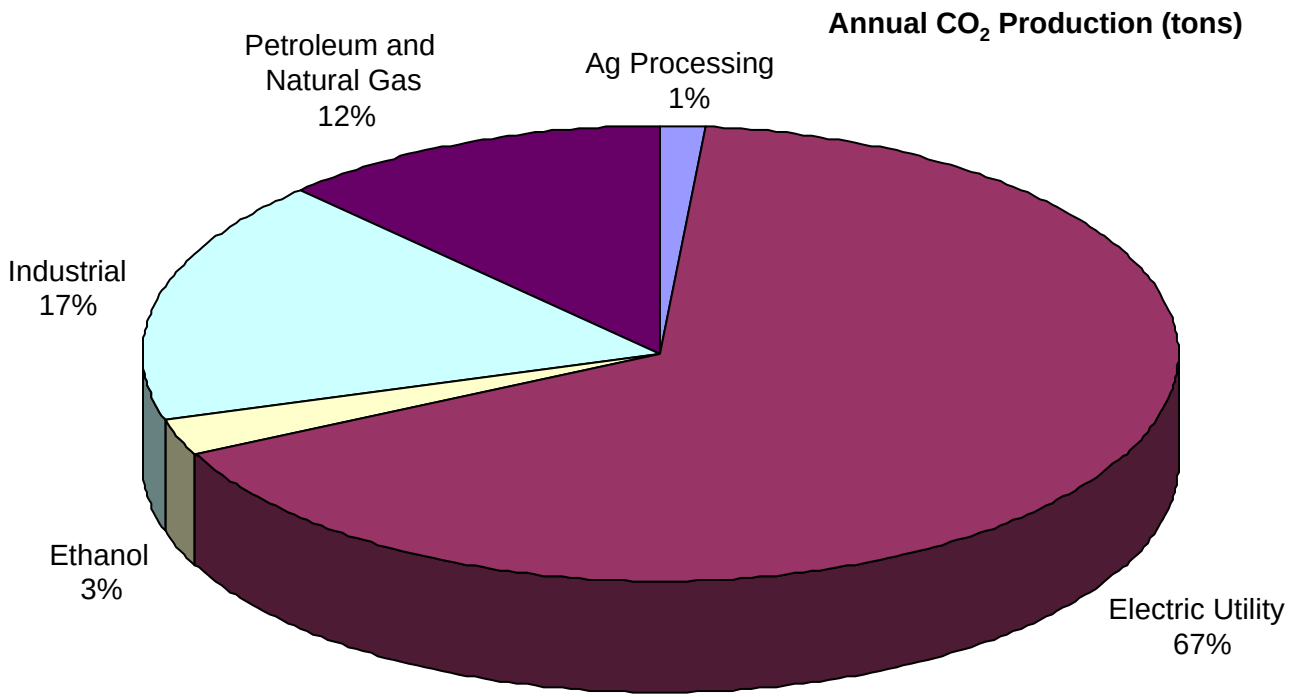
PCOR Partnership

EERC Energy & Environmental Research Center

Stationary CO_2 Source Characterization in the PCOR Partnership Region (#)



Stationary CO_2 Sources in the PCORP Region (Emissions)



PCO2R Partnership

EERC Energy & Environmental Research Center

PLAINS CO_2 REDUCTION (PCOR) PARTNERSHIP

Practical, Environmentally Sound CO_2 Sequestration

LIST OF PRODUCTS

SOURCE CHARACTERIZATION

Document	Title	Status
Topical Report	CO_2 Source Characterization of the PCOR Partnership Region	Draft in preparation

TECHNOLOGY AND INFRASTRUCTURE

Document	Title	Status
Topical Report	Carbon Separation and Capture	Draft in EERC review

Sinks

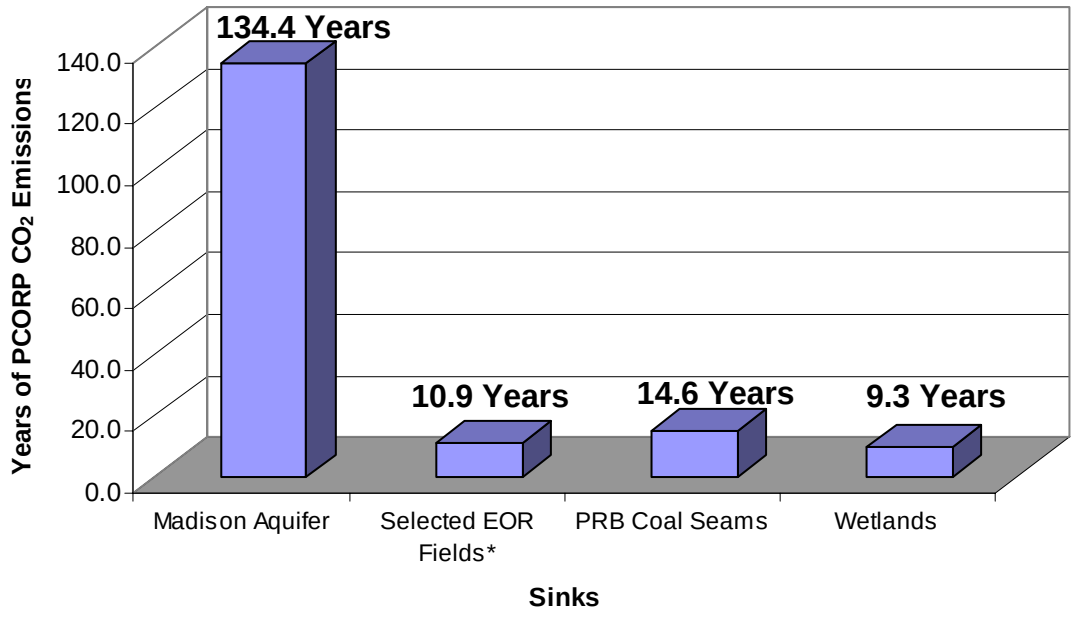
- Geological
  - Brine reservoirs
  - Enhanced oil recovery
  - Depleted oil and gas reservoirs

- Terrestrial

PCOR Partnership

EERC Energy & Environmental Research Center

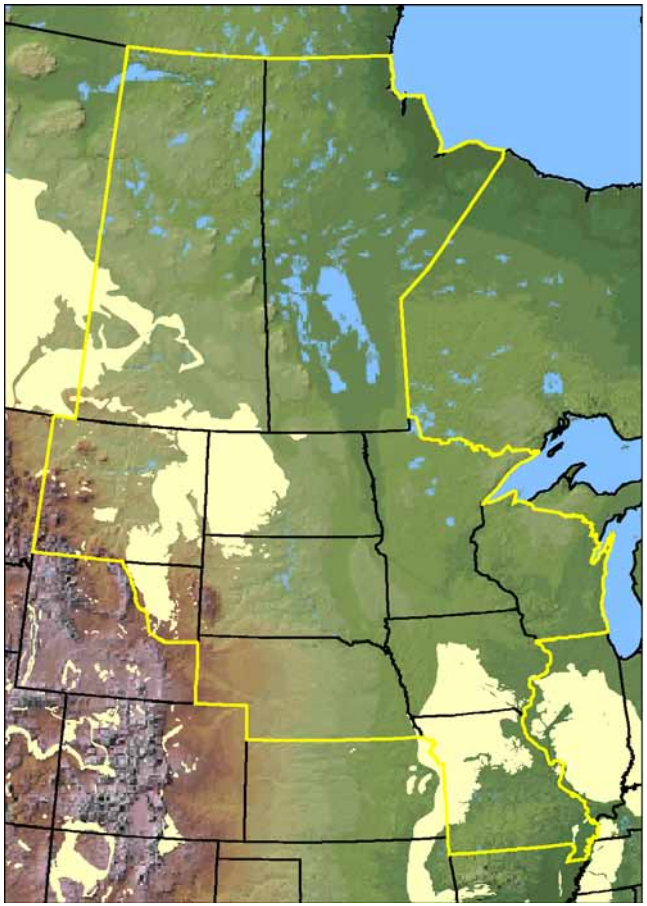
PCOR Partnership Sinks



* in ND, SD, and MT

Geological Sequestration

- Dakota Gasification – Weyburn CO_2 Utilization Project
- Other value-added sequestration options
  - Enhanced oil recovery
  - Enhanced coalbed methane
- Deep saline formations
- Lignite, subbituminous, and bituminous coals
- Depleted oil and gas reservoirs



PCOR Partnership

EERC Energy & Environmental Research Center

Oil Field Data for Reconnaissance Sequestration Estimates

* *Historical information*
* *Reservoir data*
* *Oil characteristics*
* *Gas characteristics*

PCOR Partnership

EERC Energy & Environmental Research Center

Reservoir Data

(average range as reported by various sources)

- ***Areal extent***
- ***Original oil in place***
- ***Average depth to pay***
- ***Average pay thickness***
- ***Average porosity***
- ***Average permeability***
- ***Initial reservoir pressure***
- ***Average initial water saturation***
- ***Formation temperature***
- ***Bubble point***
- ***Drive***

PCO2R Partnership

EERC Energy & Environmental Research Center

EOR CO_2 Demand

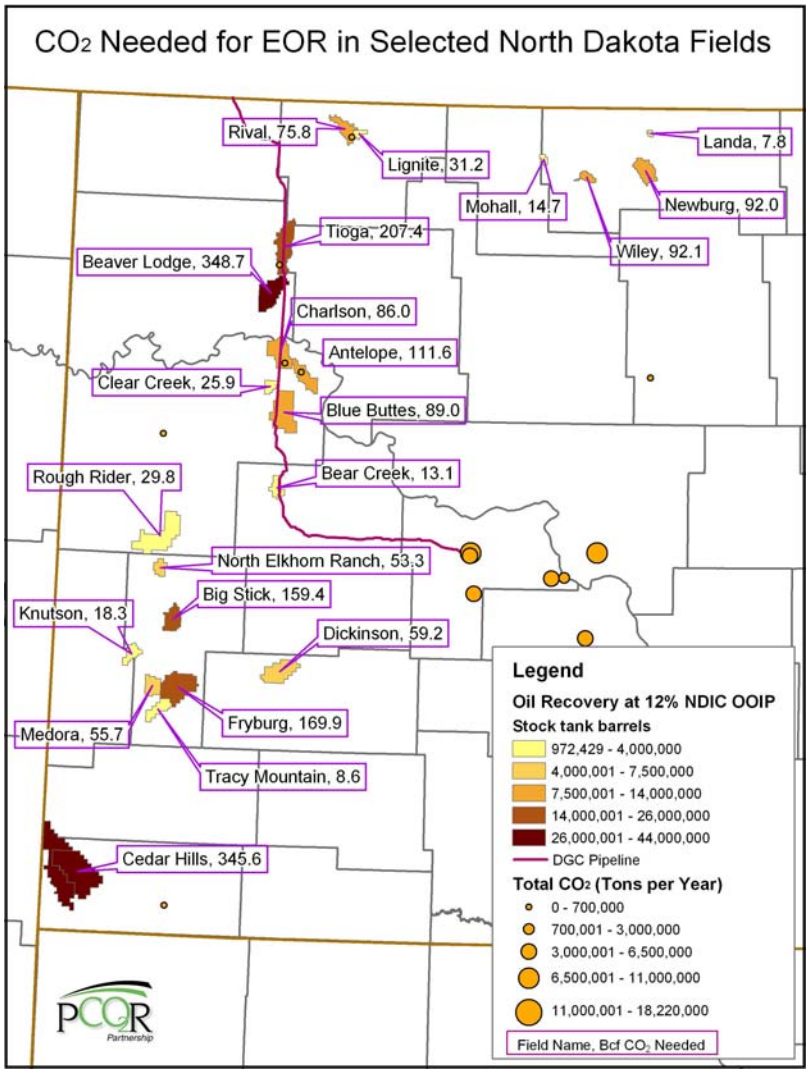
Reconnaissance-level estimation of CO_2 storage capacity from conducting CO_2 EOR projects on selected fields

- Data sources
  - Key partners at state and provincial agencies
- Variable
  - Original oil in place (OOIP)
- Assumptions
  - 12% incremental recovery of OOIP via CO_2 injection
  - Need 8 MCF of CO_2 per barrel of incremental oil
  - 60% retention of total injected CO_2
- Q (cf) = OOIP (bbls) x 0.12 x 8000 (cf/bbl) x 0.60

PCO2R Partnership

EERC Energy & Environmental Research Center

EOR CO_2 Demand



- Estimated 19 MMTCE of CO_2 needed for maximum tertiary EOR operations in 22 selected fields in North Dakota.
- Represents approximately 262 million barrels of incremental oil.
- At $40/bbl = $10.48 billion.

(ND sweet price = $41.30/bbl on11/9/04)

EERC
Energy & Environmental Research Center

Methodology for Non-EOR Oil Field Storage

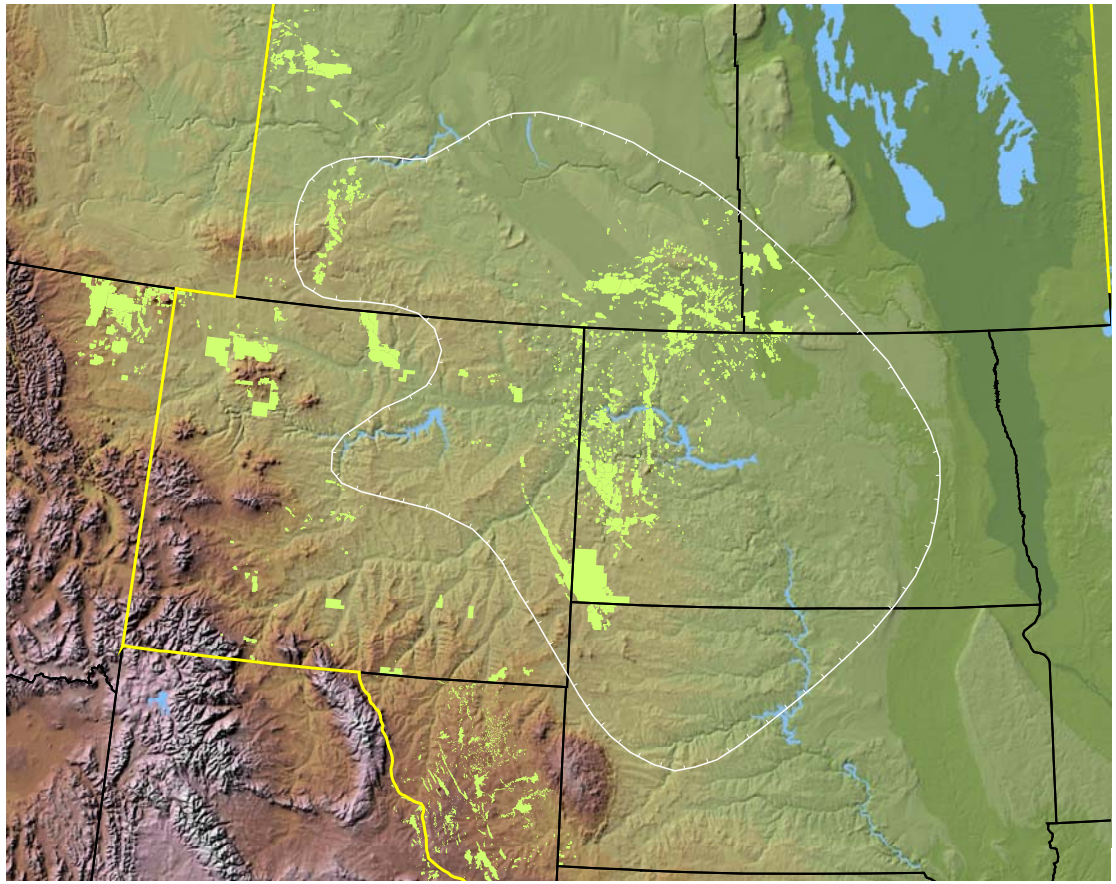
Reconnaissance-level estimation of storage capacity of CO_2 into selected fields.

- Data sources:
  - Key partners at state and provincial agencies.
- Variables and equations adequately considered higher temperatures and pressures present in Williston Basin Reservoirs than commonly used calculators.
- Assumptions:
  - To determine density of CO_2, modifications were necessary because of higher temperatures and pressures present in Williston Basin reservoirs.
  - Assumed 100% pore volume would be filled with CO_2.

PCOR Partnership

EERC Energy & Environmental Research Center

Sequestration Potential of Williston Basin Oil Fields



Estimated CO_2 storage totals for 57 selected fields (of more than 1000)

- **ND (33 fields) = 872 MMTCE**
- **MT (9 fields) = 342 MMTCE**
- **SD (1 field) = 37 MMTCE**
- **SK (8 fields) = 26 MMTCE**
- **MB (6 fields)= 6 MMTCE**

Williston Basin = 1283 MMTCE

(78 yrs of all emissions from all Williston Basin stationary sources)

PCO2R Partnership

EERC Energy & Environmental Research Center

Methodology for Saline Formations

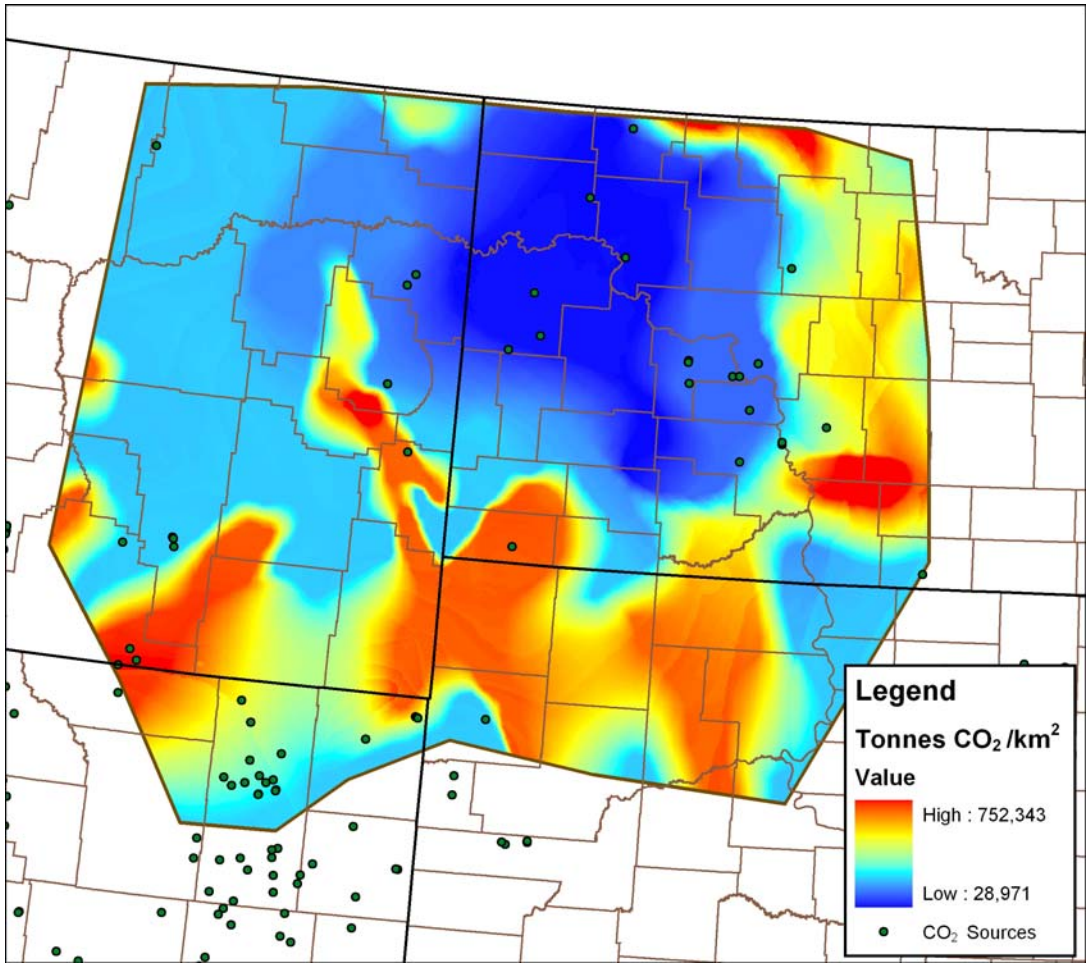
Reconnaissance level estimate of storage capacity for CO_2 dissolved into the waters of the Madison Fm in the Williston Basin and Powder River Basin

- Data sources
  - USGS published papers (Downey), well data from state agencies
- Assumptions
  - Temperature and pressure were calculated using known gradients.
  - Solubility was extrapolated from SPE monograph to suit higher salinities present in Williston Basin.
- Variables and equation based on MIDCARB calculator

PCOR Partnership

EERC Energy & Environmental Research Center

Sequestration Potential of Madison Group (preliminary)



Maximum storage capacity may exceed 13,636,364 MMTCE.

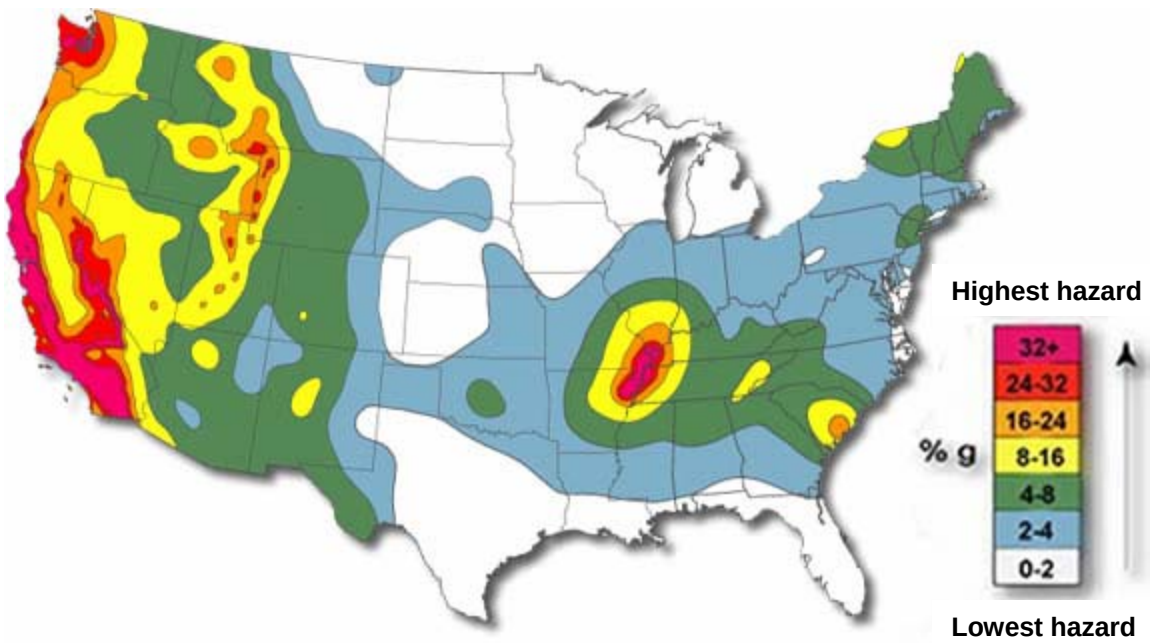
700 years of CO_2 sequestration from all sources that lie above the aquifer.

MMTCE= Millions of Metric Tons of Carbon Equivalent

PCOR Partnership

EERC Energy & Environmental Research Center

Seismic Potential – We Are Very Stable!



PCOR Partnership

EERC Energy & Environmental Research Center

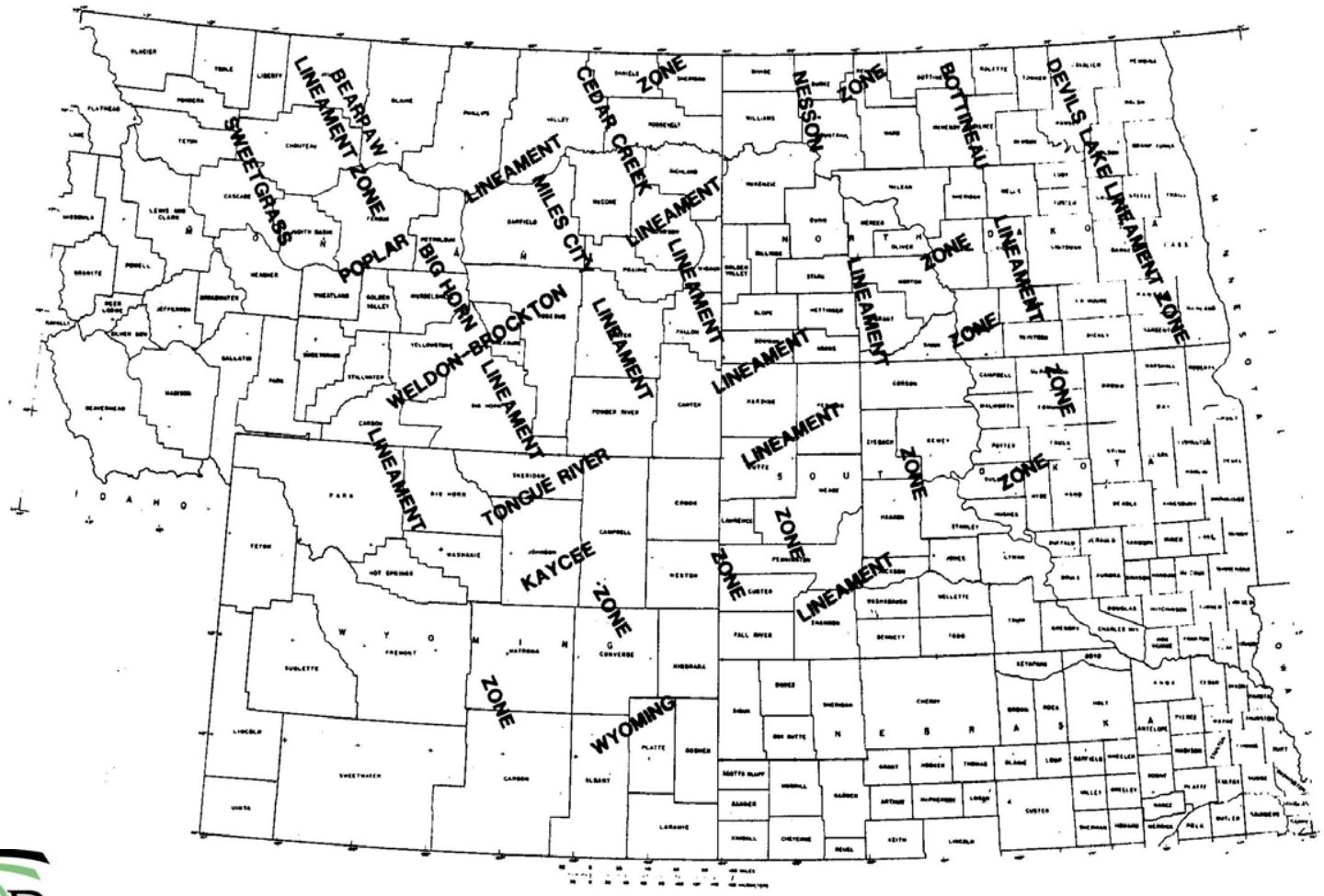
Regional Tectonics and Leakage

- Region is seismically stable
- Basement lineaments
  - Zones of tectonic weakness
  - Higher probability of regional fracturing and faulting
  - May contain conduits for leakage of injected CO_2
  - Most appear to be closed, but evidence suggests some may be open
  - Lineaments appear to exert control over development of basin structure and facies deposition

PCO2R Partnership

EERC Energy & Environmental Research Center

Tectonic Model for Basin



from Brown & Brown; 1987

Comments

- There are certainly local, sealed traps that are good candidates for sequestration in the Williston Basin.
- There is evidence that some linear structures within the Williston Basin may be active or at least open.
- Additional and detailed work is necessary to determine the competency of potential regional reservoirs/sinks for sequestration.

PCOR Partnership

EERC Energy & Environmental Research Center

Methodology for Storage in Coal

Reconnaissance-level estimation of CO_2 storage capacity of the Anderson-Wyodak coal seam in the Wyoming portion of the Powder River Basin

- Data sources
  - State agencies and published analytical data
- Used sorbed phase gas content data to calculate effective CO_2 storage potential for target coal seam
- Equation for total sequestration potential

$CO_2\ SP = (A \times h \times \rho \times SC_{CO2})$

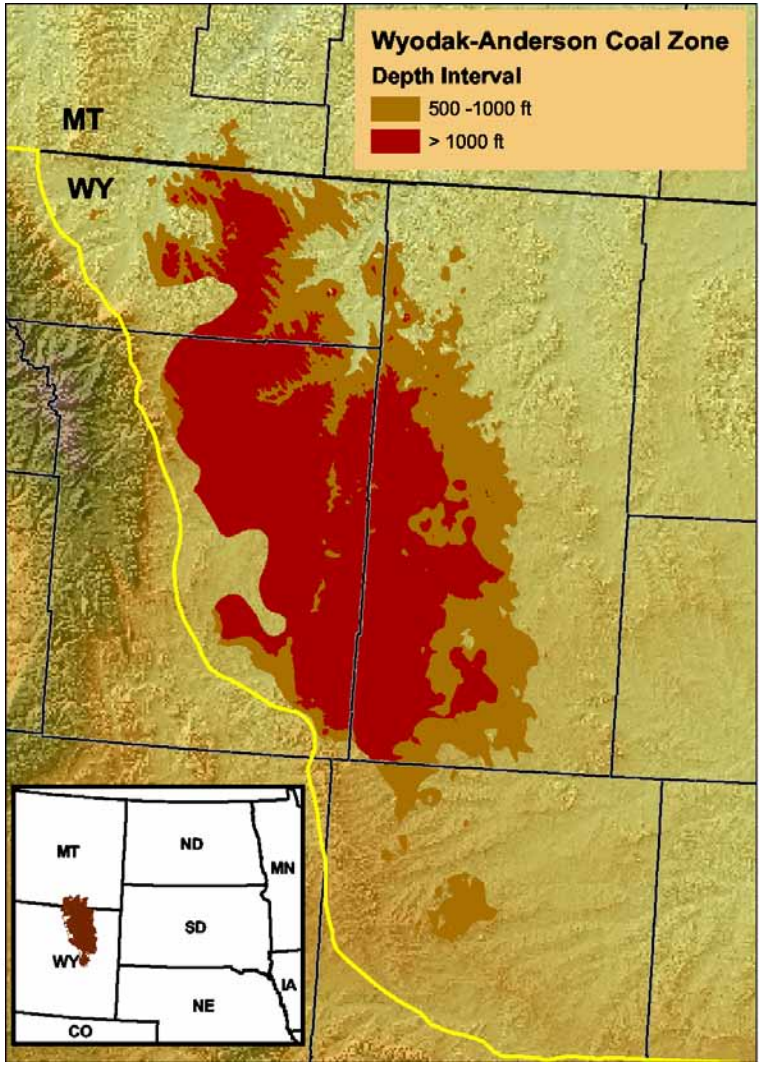
A = area, h = net coal thickness, ρ = CO_2 density

SC_{CO2} = CO_2 storage capacity of coal based on gas content data

PCO2R Partnership

EERC Energy & Environmental Research Center

Storage Potential of Powder River Basin Coal



- Total CO_2 storage capacity of 6.2 billion tonnes (1691 MMTCE) in areas where overburden is >1000 feet
- Sequester all current annual emissions from sources within the Powder River Basin for 156 years

EERC
Energy & Environmental Research Center

Database Content as of October 2004

- Major CO_2 source locations and emission data from all states and provinces in the PCOR Partnership region
- Locations, depth, type, and status of drill holes in North Dakota, Nebraska, South Dakota, Wyoming, eastern Montana, Saskatchewan, and Manitoba
- Oil and gas fields
  - Cumulative production statistics
  - Detailed field reservoir data for North Dakota and Montana

PCO2R Partnership

EERC Energy & Environmental Research Center

Still to Come

- Pool characteristic data for Wyoming, Nebraska, Saskatchewan, and Manitoba
- Refined sequestration potential of selected oil fields for Montana, Wyoming, Nebraska, South Dakota, Saskatchewan, and Manitoba
- Sequestration potential of selected Williston Basin coal beds
- Sequestration potential of Newcastle, Inyan Kara, and Cambro-Ordovician saline formations

PCOR Partnership

EERC Energy & Environmental Research Center

PLAINS CO_2 REDUCTION (PCOR) PARTNERSHIP

Practical, Environmentally Sound CO_2 Sequestration

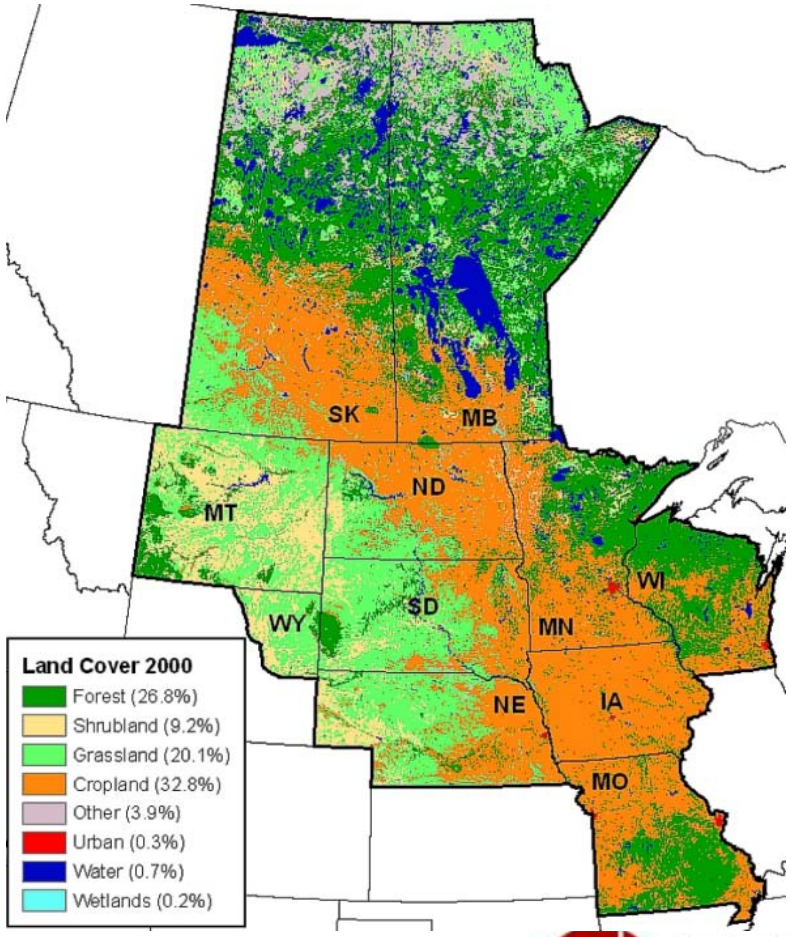
LIST OF PRODUCTS

SINK CHARACTERIZATION-GEOLOGICAL

Document	Title	Status
Topical Report	Geologic CO_2 Sequestration Potential of the Wyodak–Anderson Coal Zone in the Powder River Basin	Final draft to partners
Topical Report	Mission Canyon Formation Outline	Draft in EERC review
Topical Report	Sequestration Potential of the Madison of the Northern Great Plains Aquifer System (Madison Geological Sequestration Unit)	Final draft to partners
Topical Report	The Influence of Tectonics on the Potential Leakage of CO_2 from Deep Geological Sequestration Units in the Williston Basin	Final draft to partners
Topical Report	Overview of Williston Basin Geology as It Relates to CO_2 Sequestration	Final draft to partners
Topical Report	Geologically Sequestered CO_2 Leakage: A Literature Survey	Draft in EERC review
Topical Report	Sequestration Potential of Petroleum Reservoirs in the Williston Basin	Final draft to partners
Topical Report	Additional Formation Outlines for the Williston Basin	Draft in preparation
Topical Report	Sequestration Potential of the Newcastle and Inyan Kara Aquifer Systems	Draft in preparation
Topical Report	Geologic Sequestration Potential of the PCOR Partnership Region	Draft in preparation

Terrestrial Sequestration

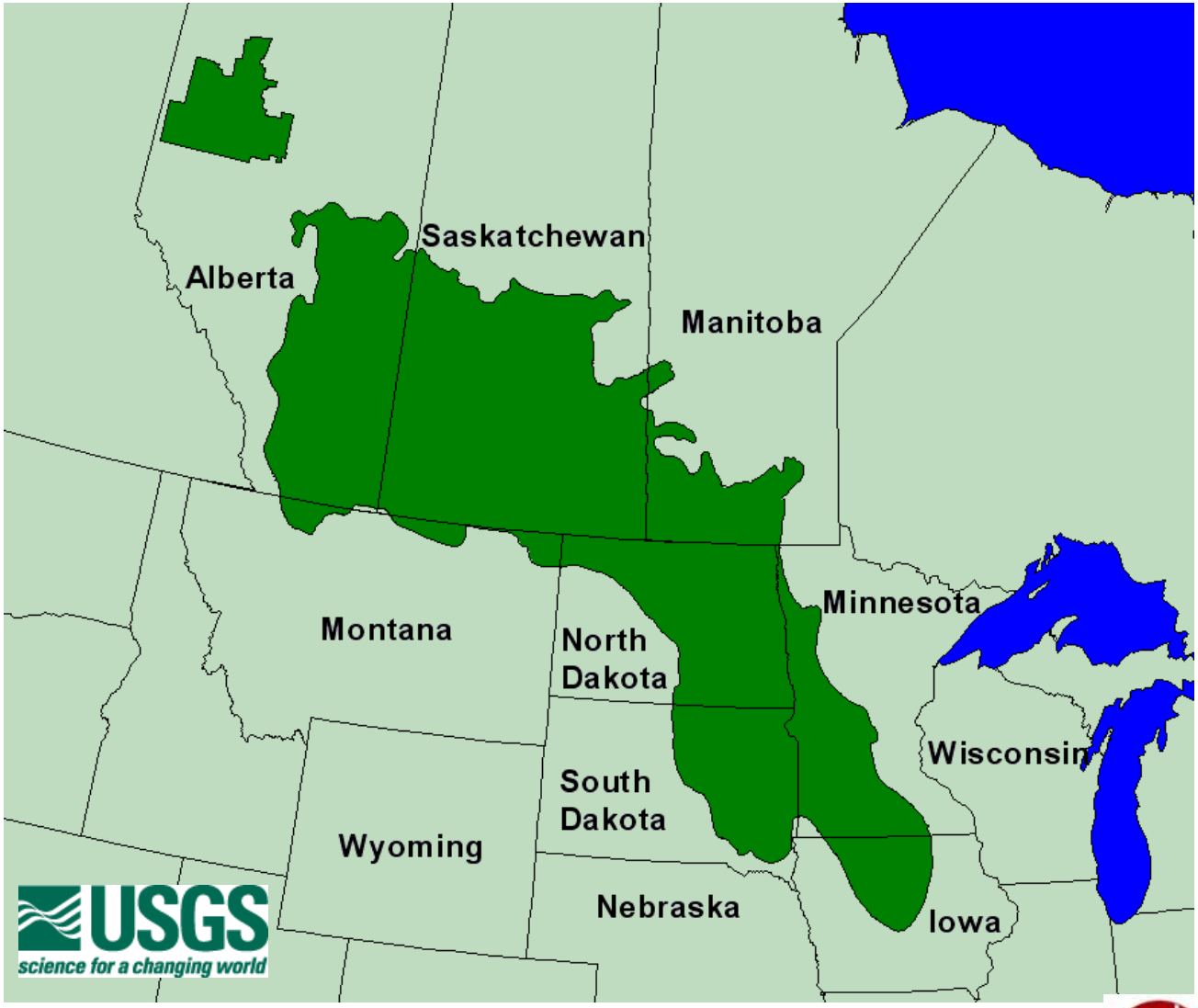
- North Dakota State University – low-moisture land management practices for carbon sequestration
- U.S. Geological Survey – wetland carbon sequestration
- Regional assessment of land uses – an agricultural region



PCOR Partnership

EERC Energy & Environmental Research Center

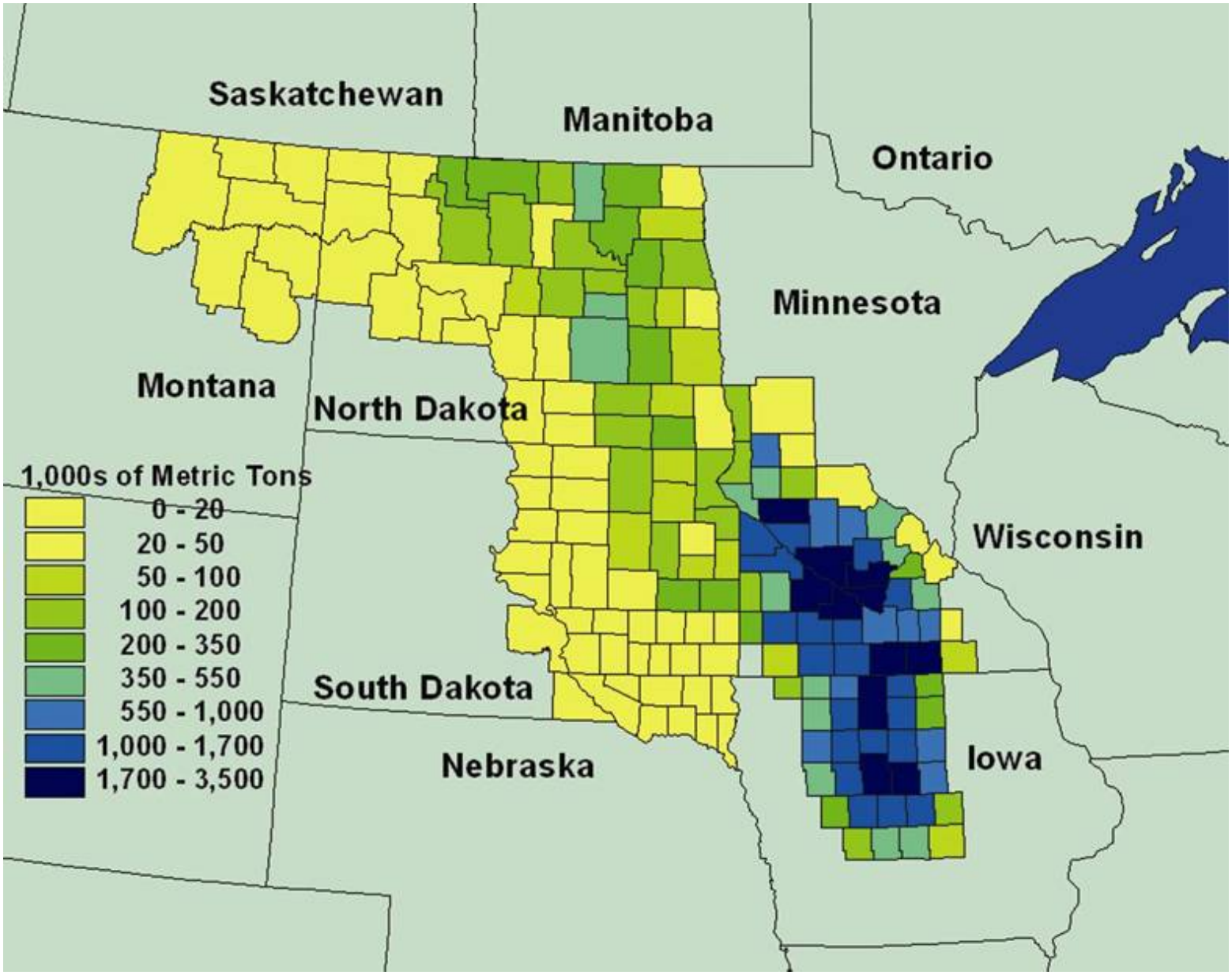
Extent of Glaciated Prairie Pothole Region

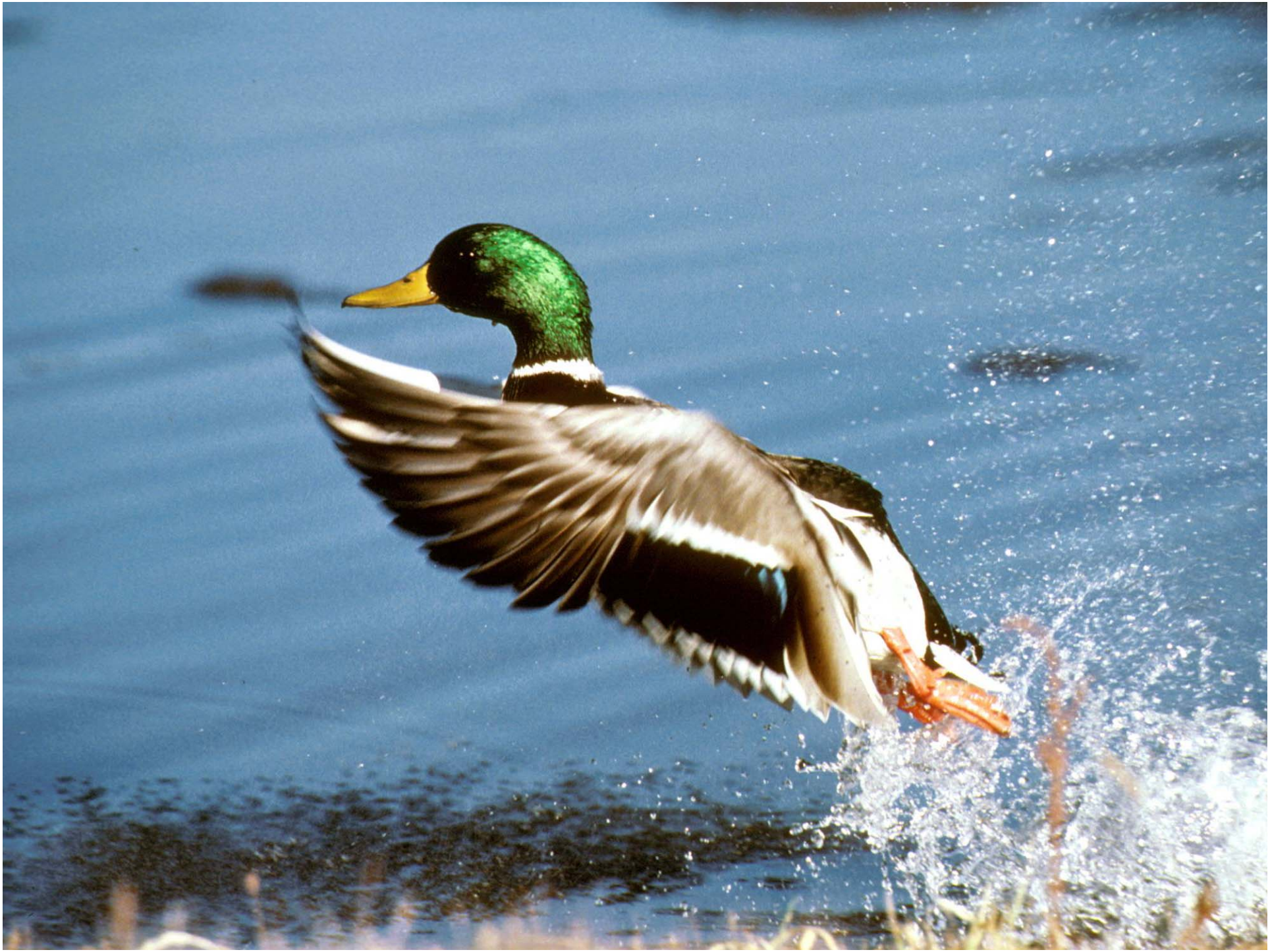


PCQR Partnership

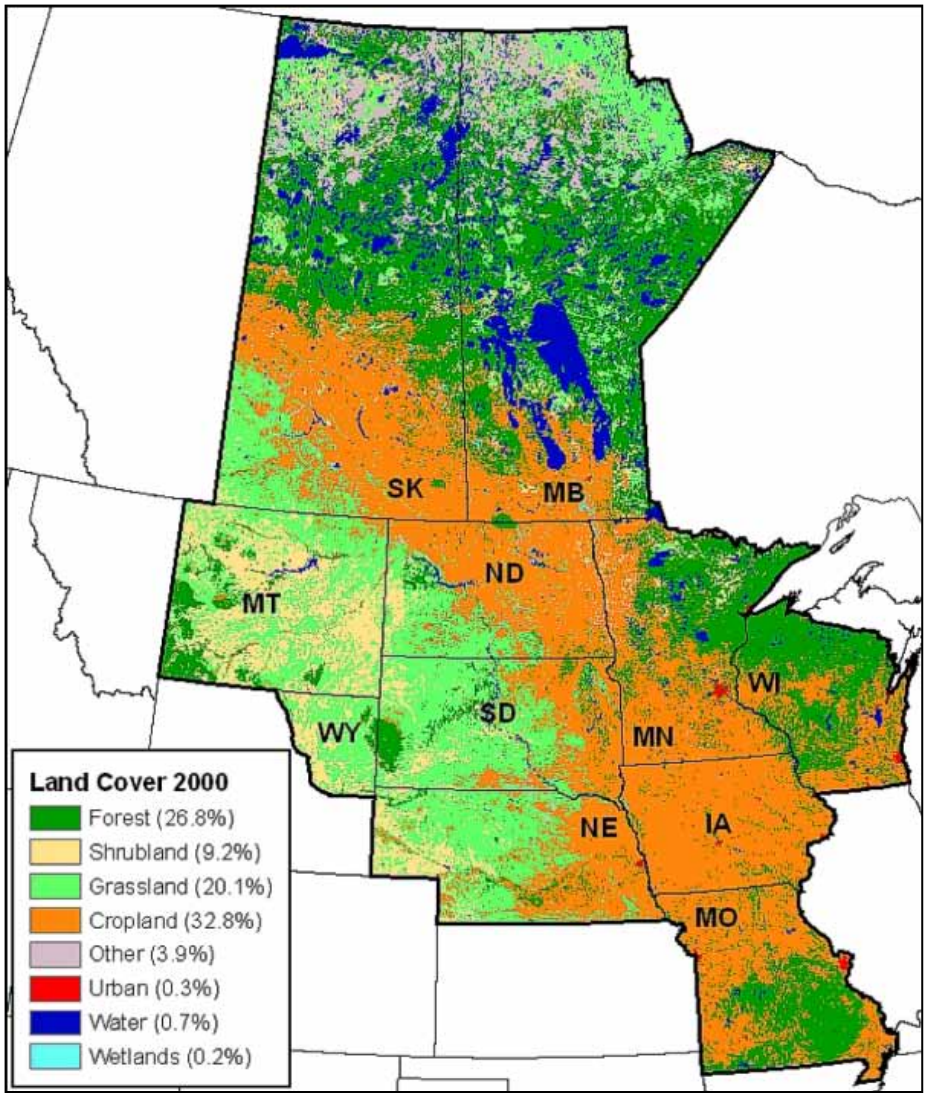
EERC Energy & Environmental Research Center

Wetland Carbon Sequestration Potential





Global Land Cover Data Set



PCOR Partnership

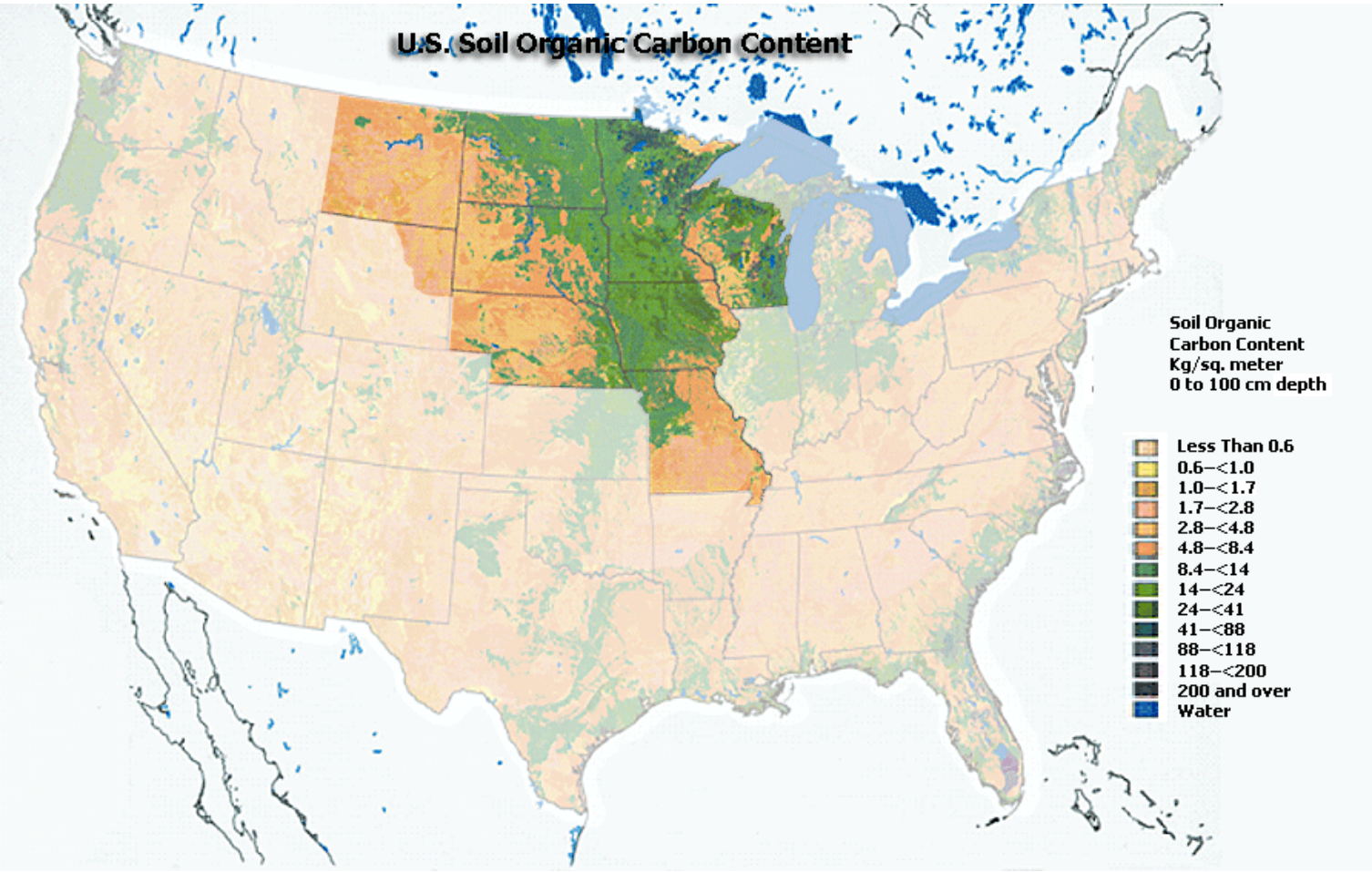
EERC Energy & Environmental Research Center

NDSU Field Plot

PCOR Partnership

EERC
Energy & Environmental Research Center

Estimated Soil Organic Carbon Values



U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), National Soil Survey Center, Lincoln, Nebraska, and EROS Data Center, Sioux Falls, South Dakota, 1996.

PLAINS CO_2 REDUCTION (PCOR) PARTNERSHIP

Practical, Environmentally Sound CO_2 Sequestration

LIST OF PRODUCTS

SINK CHARACTERIZATION – TERRESTRIAL

Document	Title	Status
Fact Sheet	Wetland Carbon Sinks in the Glaciated North American Prairie	Final draft to partners
Topical Report	The Contribution of Soils to Carbon Sequestration	Draft in preparation
Topical Report	Agricultural Practices that Promote Carbon Sequestration (NDSU)	Draft in preparation
Topical Report	Wetland Carbon Sinks in the Glaciated North American Prairie	Draft in preparation

PCOR Partnership Decision Support System

PCOR Partnership Decision Support System

- Web platform
  - Geographic information system (GIS)
  - Database driven
- Interactive data analysis of PCOR Partnership region
  - Review regional characteristics
  - Browse, query, analyze, and download data
  - Inspect wide range of transport and sequestration scenarios
- Linked to NATCARB

PCOR Partnership - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

PCO2R Partnership

Decision Support System

- PCORP GIS
- Indirect Carbon Sequestration
- Advisory Board
- Presentations
- Reports
- List of Products
- DOE: Global Climate Change Initiative Links
- Other Carbon Related Links
  - Sources/Sinks/ Infrastructure Data
  - General/Background Information
  - CO2 Related Projects
- Contact Us
- PCORP Home

The PCOR Partnership Decision Support System (DSS) is a web-based database, GIS, and scenario modeling system. The DSS will allow our research partners to browse, query, analyze, and download data regarding CO2 sequestration in the PCOR region. The focus of this system is to compile an interactive data analysis and modeling interface that will provide for the definition and inspection of a wide range of transport and sequestration scenarios.

Datasets and models will be updated as new information becomes available and provided to team members performing engineering and scientific calculations. In turn, engineering and scientific results will be used to modify the DSS as they become available. This iterative process will result in the most effective and up-to-date database and modeling system possible. The DSS will leverage and integrate the developing knowledge of the character and spatial relationships of sources, sinks and the transportation links between them into an overall scenario assessment methodology. The scenario assessment methodology will include all of the critical elements to the demonstration or commercial implementation of any scenario including environmental risk, technical feasibility and availability, cost and economics, life cycle assessment impacts, and social and political factors.

ArcIMS Viewer - Microsoft Internet Explorer

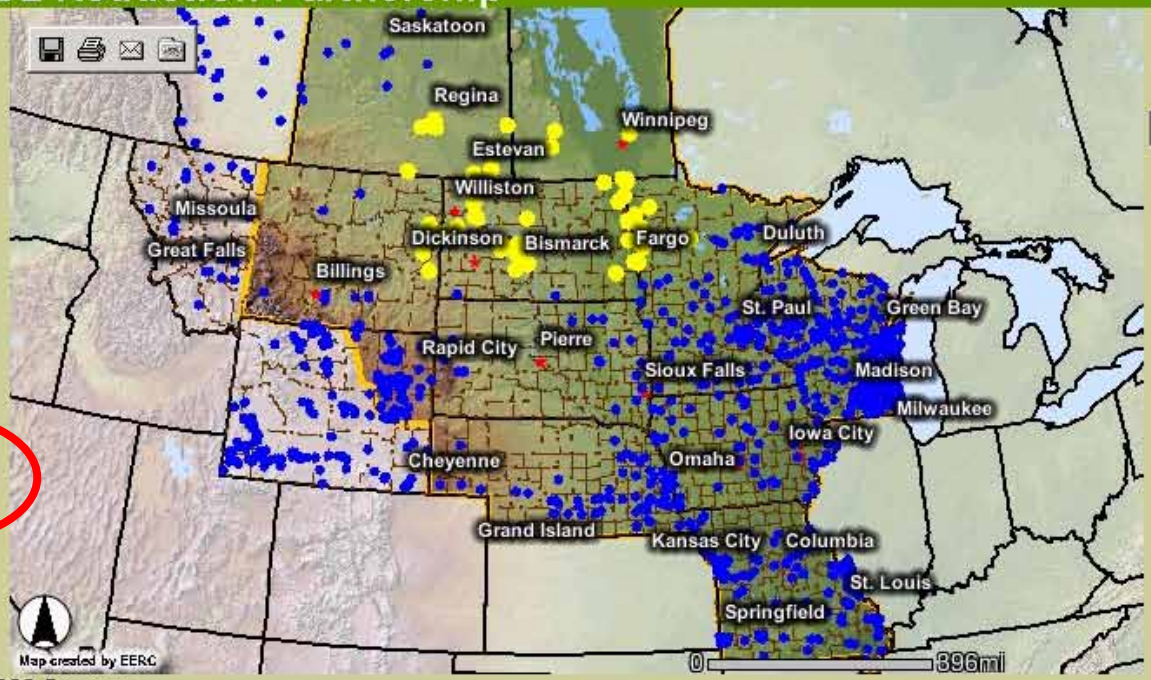
File Edit View Favorites Tools Help

Back Search Favorites Media Links

Plains CO2 Reduction Partnership

GIS Help | Metadata

Overview Map
Legend/ Layer
Zoom In
Zoom Out
Full Extent
Last Extent
Pan
Select
Buffer
Clear Selection



Thematic Maps

— select thematic map —

Layers

Refresh Map

Visible Active

- CO2 Sources
- Towns
- Counties
- State/Province
- Rails
- Coal Fields
- Partnership Region
- Federal Land
- Land Use

Active Layer: CO2 Sources

Total Records: 59 Next 25 Display All Zoom to selected

EXPORT: Help | Sources | Source Commodities | Source Fuels

CO2 Source Name	State	Type	tons CO2/yr	MMcf CO2/yr
ADM Processing	ND	Agricultural Processing	18563	302.8
Alameda	SK	Natural Gas Transmission	126000	2055.1
Alchem Ltd. LLLP	ND	Ethanol Manufacturing	59745	974.4
Amerada Hess Corp: Tioga Gas Plant	ND	Natural Gas Processing	219105	3573.6
Amerada Hess: Antelope #2	ND	Petroleum & Natural Gas Processing	12892	210.3
Amerada Hess: Hawkeye	ND	Petroleum & Natural Gas Processing	14576	237.7

Contains commands for working with the selected items.

ArcIMS Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media Links

Plains CO2 Reduction Partnership

GIS Help | Metadata

Overview Map

Legend/ Layer

Zoom In

Zoom Out

Full Extent

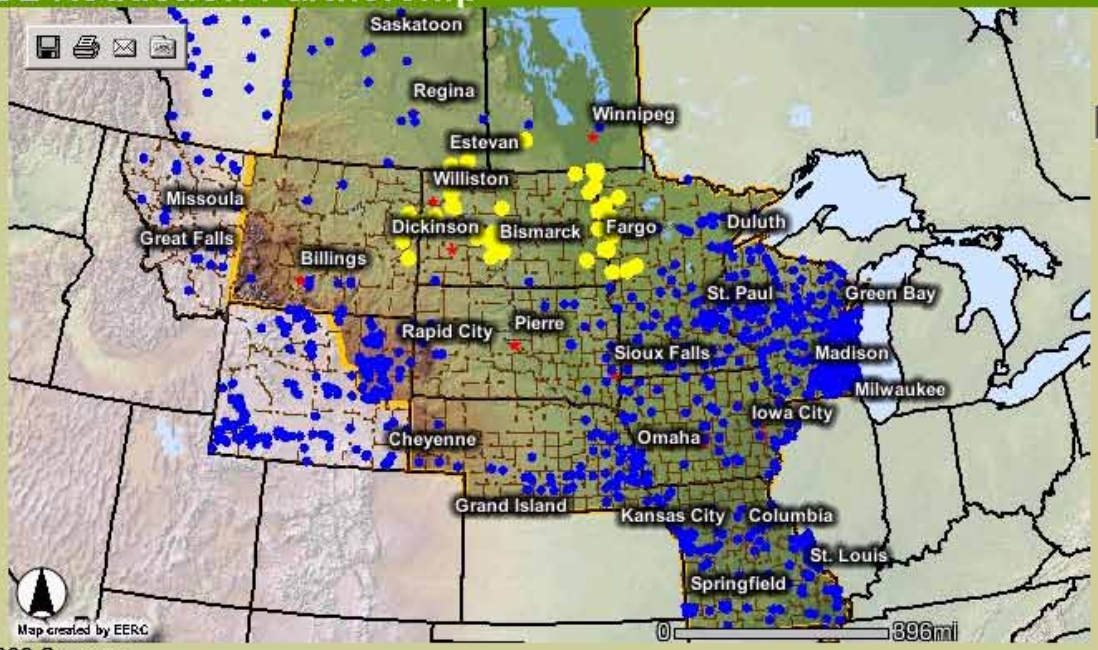
Last Extent

Pan

Select

Buffer

Clear Selection



Thematic Maps

— select thematic map —

Layers

Refresh Map

Visible Active

- CO2 Sources
- Towns
- Counties
- State/Province
- Rails
- Coal Fields
- Partnership Region
- Federal Land
- Land Use

Active Layer: CO2 Sources

CO2 Source Name	State Prov	Type	tonnes CO2/yr	MMcf CO2/yr
Amerada Hess Corp: Tioga Gas Plant	ND	Natural Gas Processing	198772.1	3573.6
Amerada Hess: Antelope #2	ND	Petroleum & Natural Gas Processing	11695.6	210.3
Amerada Hess: Hawkeye	ND	Petroleum & Natural Gas Processing	13223.3	237.7
American Crystal Sugar - Crookston	MN	Sugar Production	379046.3	6814.6
American Crystal Sugar - Drayton	ND	Sugar Production	941498.5	16926.6
American Crystal Sugar - Hillsboro	ND	Sugar Production	814827.1	14649.3
American Crystal Sugar- East Grand Forks	MN	Sugar Production	520823.5	9363.6

Contains commands for working with the selected items.

ArcIMS Viewer - Microsoft Internet Explorer

Plains CO2 Redu

Overview Map
Legend/ Layer
Zoom In
Zoom Out
Full Extent
Last Extent
Pan
Select
Buffer
Clear Selection

Map created by EERC

Active Layer: CO2 Sources

CO2 S

Amerada Hess Corp: Tioga Gas Pla
Amerada Hess: Antelope #2
Amerada Hess: Hawkeye
American Crystal Su ookstc
American Crystal Sugar - Drayton
American Crystal Sugar - Hillsboro
American Crystal Sugar- East Gran
American Crystal Sugar- Moorhead

http://gis.undeerc.org/website/PCORP/CO2Report.asp?SourceID=52&weight=2&volume=5 - Microsoft Internet Explorer

American Crystal Sugar - Drayton

State: ND
Source Type: Sugar Production
Source Type Reference: US EPA TTN
LAT/LON Reference: Reference

Total Emissions			
	Total Emissions	Units	References
CO2 (weight)	1037807	tons CO2/yr	Combustion CO2 Emission Calculations
CO2 (volume)	16926.6	MMcf CO2/yr	Combustion CO2 Emission Calculations
SO2	9145	Tons/Yr	US EPA TTN
NOx	749	Tons/Yr	US EPA TTN

Total CO2 Emissions from Combustion			
		Units	References
Subbituminous Coal			US EPA TTN
Quantity	549313	tons/Yr	US EPA TTN
CO2 Emitted (weight)	1018417.5	tons CO2/yr	Combustion CO2 Emission Calculations
CO2 Emitted (volume)	16610.4	MMcf CO2/yr	Combustion CO2 Emission Calculations

Total CO2 Emissions from Non-Combustion			
		Units	References
Lime			
Quantity		tons/Yr	
CO2 Emitted (weight)	19389.5	Tons/Yr	NonCombustion CO2 Emission Calculations
CO2 Emitted (volume)	316.2	MMcf CO2/yr	NonCombustion CO2 Emission Calculations

Internet

http://gis.undeerc.org/website/PCORP/CO2Report.asp?SourceID=52&weight=2&volume=5

ArcIMS Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media Links

Plains CO2 Reduction Partnership

GIS Help | Metadata

Overview Map

Legend/ Layer

Zoom In

Zoom Out

Full Extent

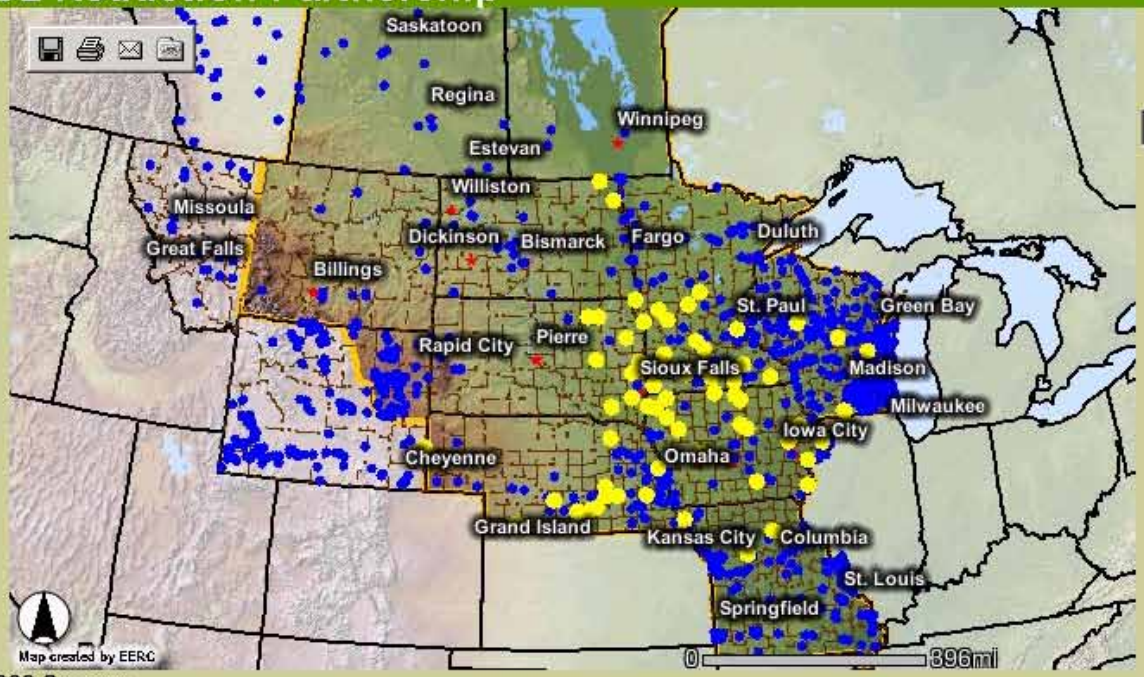
Last Extent

Pan

Select

Buffer

Clear Selection



Thematic Maps

— select thematic map —

Layers

Refresh Map

Visible Active

- CO2 Sources
- Towns
- Counties
- State/Province
- Rails
- Coal Fields
- Partnership Region
- Federal Land
- Land Use

Active Layer: CO2 Sources

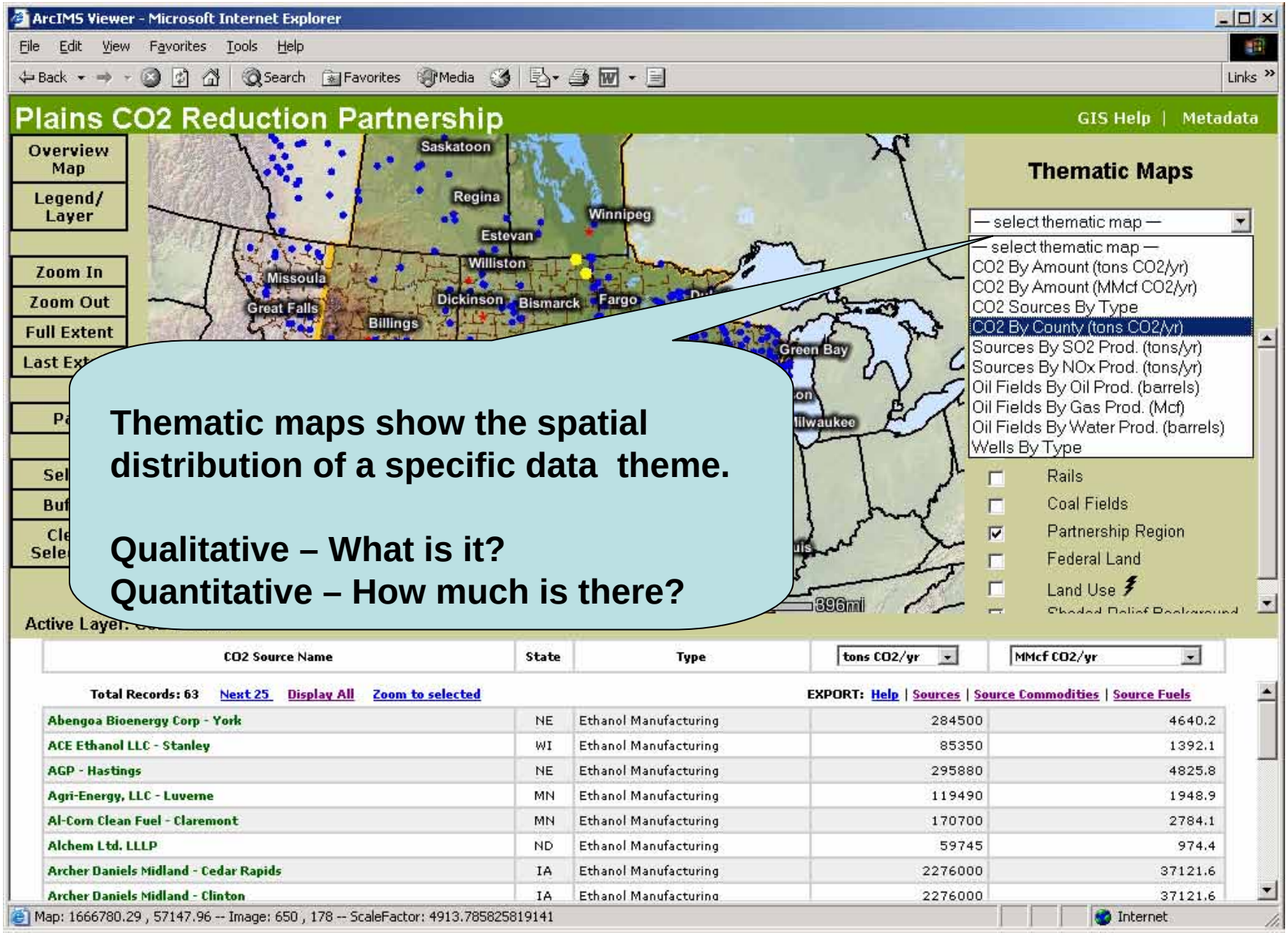
Total Records: 63 Next 25 Display All Zoom to selected

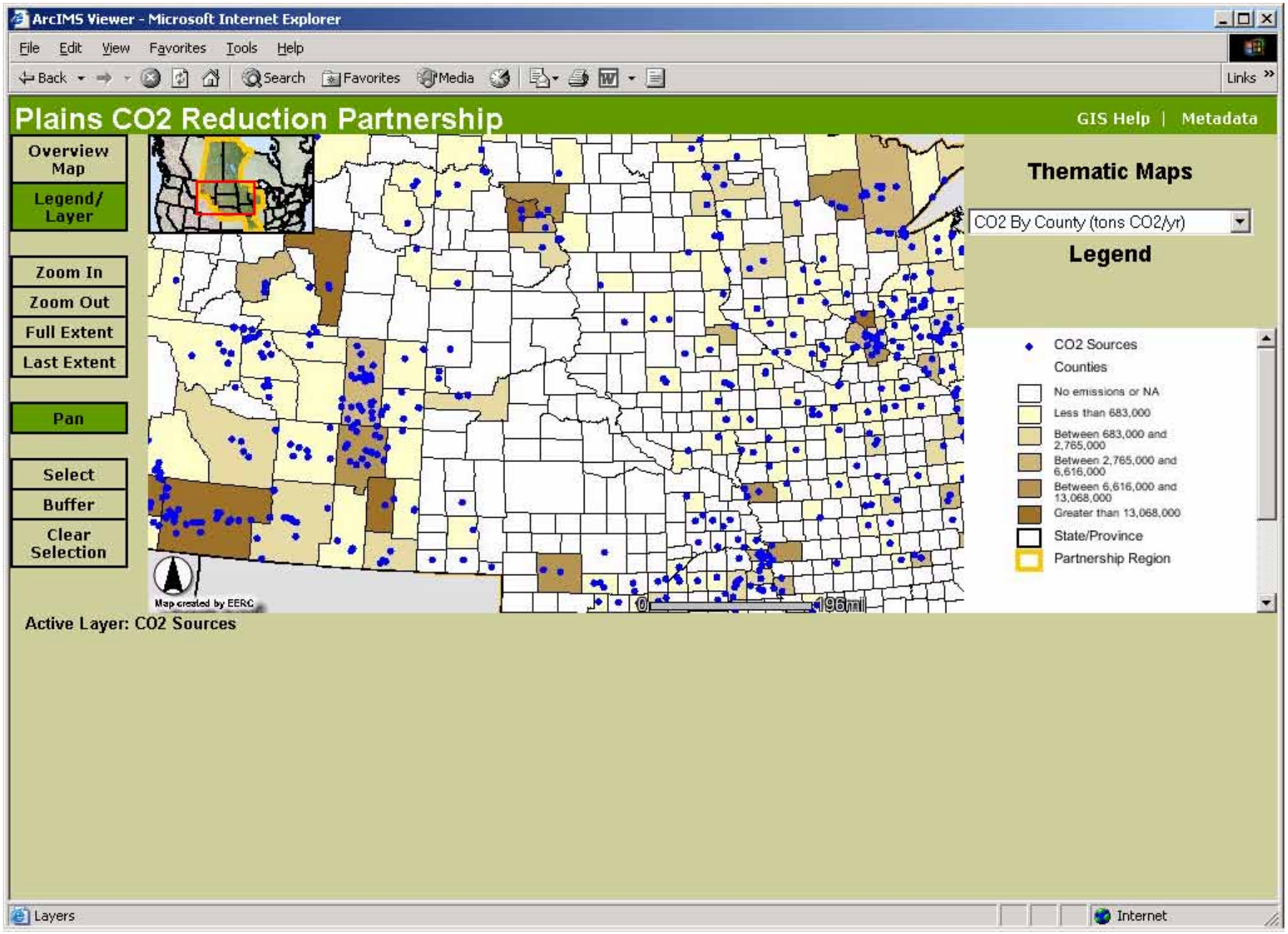
EXPORT: Help | Sources | Source Commodities | Source Fuels

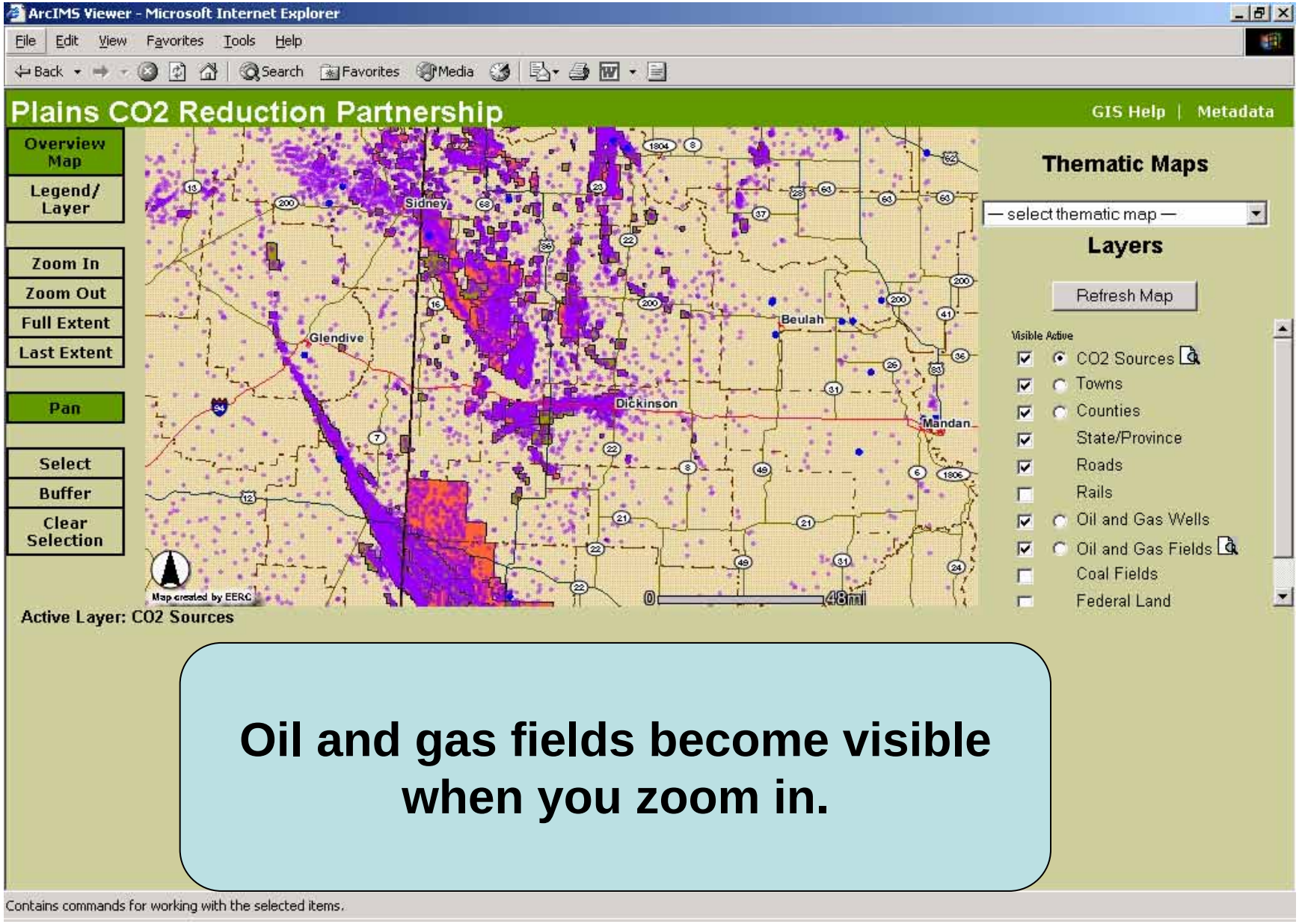
CO2 Source Name	State	Type	tons CO2/yr	MMcf CO2/yr
Abengoa Bioenergy Corp - York	NE	Ethanol Manufacturing	284500	4640.2
ACE Ethanol LLC - Stanley	WI	Ethanol Manufacturing	85350	1392.1
AGP - Hastings	NE	Ethanol Manufacturing	295880	4825.8
Agri-Energy, LLC - Luverne	MN	Ethanol Manufacturing	119490	1948.9
Al-Corn Clean Fuel - Claremont	MN	Ethanol Manufacturing	170700	2784.1
Alchem Ltd. LLLP	ND	Ethanol Manufacturing	59745	974.4
Archer Daniels Midland - Cedar Rapids	IA	Ethanol Manufacturing	2276000	37121.6
Archer Daniels Midland - Clinton	IA	Ethanol Manufacturing	2276000	37121.6

Map: 1617642.44 , -95179.39 -- Image: 640 , 209 -- ScaleFactor: 4913.785825819141

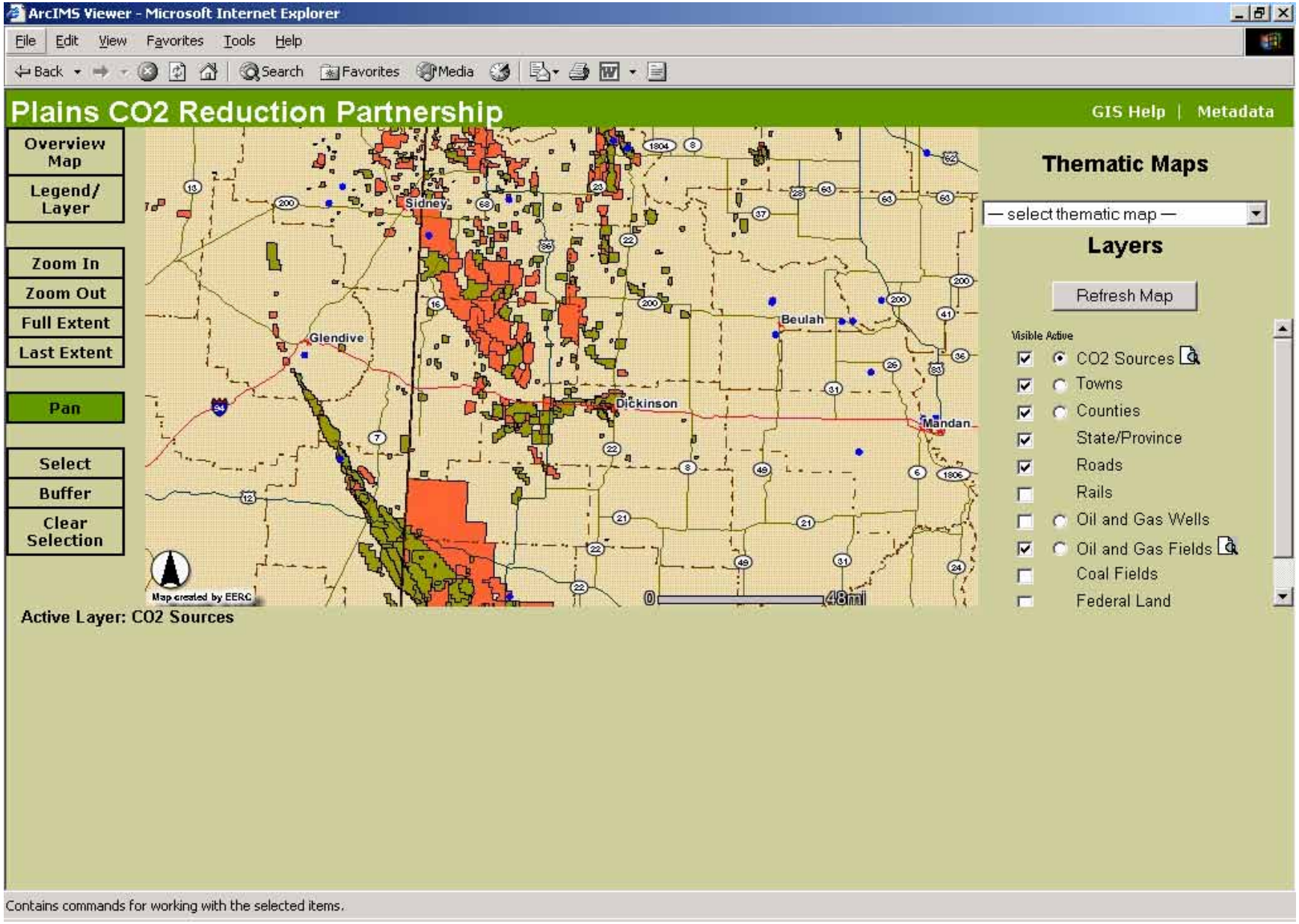
Internet


ArcIMS Viewer - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media Links
Plains CO2 Reduction Partnership
GIS Help | Metadata
Overview Map
Legend/ Layer
Zoom In
Zoom Out
Full Extent
Saskatoon
Regina
Winnipeg
Estevan
Williston
Missoula
Great Falls
Billings
Dickinson
Bismarck
Fargo
Green Bay
Milwaukee
896mi
Thematic Maps
— select thematic map —
— select thematic map —
CO2 By Amount (tons CO2/yr)
CO2 By Amount (MMcf CO2/yr)
CO2 Sources By Type
CO2 By County (tons CO2/yr)
Sources By SO2 Prod. (tons/yr)
Sources By NOx Prod. (tons/yr)
Oil Fields By Oil Prod. (barrels)
Oil Fields By Gas Prod. (Mcf)
Oil Fields By Water Prod. (barrels)
Wells By Type
Rails
Coal Fields
Partnership Region
Federal Land
Land Use
Thematic maps show the spatial distribution of a specific data theme.
Qualitative – What is it?
Quantitative – How much is there?
Active Layer:
CO2 Source Name
State
Type
tons CO2/yr
MMcf CO2/yr
Total Records: 63
Next 25
Display All
Zoom to selected
EXPORT: Help | Sources | Source Commodities | Source Fuels
Abengoa Bioenergy Corp - York NE Ethanol Manufacturing 284500 4640.2
ACE Ethanol LLC - Stanley WI Ethanol Manufacturing 85350 1392.1
AGP - Hastings NE Ethanol Manufacturing 295880 4825.8
Agri-Energy, LLC - Luverne MN Ethanol Manufacturing 119490 1948.9
Al-Corn Clean Fuel - Claremont MN Ethanol Manufacturing 170700 2784.1
Alchem Ltd. LLLP ND Ethanol Manufacturing 59745 974.4
Archer Daniels Midland - Cedar Rapids IA Ethanol Manufacturing 2276000 37121.6
Archer Daniels Midland - Clinton IA Ethanol Manufacturing 2276000 37121.6
Map: 1666780.29 , 57147.96 -- Image: 650 , 178 -- ScaleFactor: 4913.785825819141
Internet


ArcIMS Viewer - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media Links
Plains CO2 Reduction Partnership
GIS Help | Metadata
Overview Map
Legend/ Layer
Zoom In
Zoom Out
Full Extent
Last Extent
Pan
Select
Buffer
Clear Selection
Map created by EERC
0
196mi
Thematic Maps
CO2 By County (tons CO2/yr)
Legend
CO2 Sources
Counties
No emissions or NA
Less than 683,000
Between 683,000 and 2,765,000
Between 2,765,000 and 6,616,000
Between 6,616,000 and 13,068,000
Greater than 13,068,000
State/Province
Partnership Region
Active Layer: CO2 Sources
Layers
Internet



Oil and gas fields become visible when you zoom in.


ArcIMS Viewer - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Plains CO2 Reduction Partnership
GIS Help | Metadata
Overview Map
Legend/ Layer
Zoom In
Zoom Out
Full Extent
Last Extent
Pan
Select
Buffer
Clear Selection
Sidney
Glendive
Beulah
Dickinson
Mandan
Map created by EERC
0
48mi
Active Layer: CO2 Sources
Thematic Maps
— select thematic map —
Layers
Refresh Map
Visible Active
CO2 Sources
Towns
Counties
State/Province
Roads
Rails
Oil and Gas Wells
Oil and Gas Fields
Coal Fields
Federal Land
Contains commands for working with the selected items.

ArcIMS Viewer - Microsoft Internet Explorer

Plains CO2 R

Overview Map
Legend/ Layer
Zoom In
Zoom Out
Full Extent
Last Extent
Pan
Select
Buffer
Clear Selection

Active Layer: Oil and

Oil and Gas Field Name

Total Records:

Barta
Bell
Big Stick
Big Stick Madison unit
Bull Creek
Bullsnake

Contains commands for working with the selected items.

http://gis.undeerc.org/website/PCORP/WellsReport.asp?OilFieldID=95 - Microsoft Internet Explorer

Oil Field: Big Stick

Reference: NDIC

Operator:	EXXON MOBIL CORPORATION
Surface Area:	14529 acres
Unit Status:	Non-Unitized
State/Prov:	ND

	Date	Oil (barrels)	Gas (Mcf)	Water (barrels)
Cumulative Production	3/2004	54199351	67521434	98123159
Month Production	3/2004	63736	44936	404445

+ WELLS

+ POOLS

Contains commands for working with the selected items.

Metadata

Wells
Fields

Mech

2208
3537
404445
25816
0

Oil Field: Big Stick

Reference: NDIC

Operator: EXXON MOBIL CORPORATION
Surface Area: 14529 acres
Unit Status: Non-Unitized
State/Prov: ND

	Date	Oil (barrels)	Gas (Mcf)	Water (barrels)
Cumulative Production	3/2004	54199351	67521434	98123159
Month Production	3/2004	63736	44936	404445

– WELLS

API # / License #	Operator	Well Name	Total Depth	Spud Date	Well Type	Well Status	State Prov
33-007-00597-00-00	AL-AQUITAINE EXPLORATION, LTD.	5-141-100 BN 1-5 1	9530	11/15/1980	Oil and Gas	Dry Hole	ND
33-007-00619-00-00	AMOCO PRODUCTION CO.	USA ARMOR 4	0		Oil and Gas	Permit Now Cancelled	ND
33-007-00584-00-00	AMOCO PRODUCTION CO.	USA ANDERSON "B" 1	0		Oil and Gas	Permit Now Cancelled	ND
33-007-00589-00-00	AMOCO PRODUCTION CO.	USA ANDERSON "A" 1	13500	8/16/1980	Oil and Gas	Dry Hole	ND
33-007-00577-00-00	AMOCO PRODUCTION CO.	USA ARMOR "A" 1	0		Oil and Gas	Permit Now Cancelled	ND
33-007-00580-00-00	AMOCO PRODUCTION CO.	STEVENS FEDERAL "D" 3-29	0		Oil and Gas	Permit Now Cancelled	ND
33-007-00435-00-00	AXEM RESOURCES, INC.	MESCHKE 2-2	12650	6/8/1980	Oil and Gas	Plugged and Abandoned	ND
33-007-	BURLINGTON	BURLINGTON					

http://gis.undeerc.org/website/PCORP/WellsReport.asp?OilFieldID=95 - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Unit Status: Non-Unitized
State/Prov: ND

	Date	Oil (barrels)	Gas (Mcf)	Water (barrels)
Cumulative Production	3/2004	54199351	67521434	98123159
Month Production	3/2004	63736	44936	404445

+ WELLS

- POOLS

The reference for each pool pertains to the entire set of reservoir (pool) data unless otherwise indicated.

	Group	Formation	Sub Formation	Reference
+	Big Horn	Red River		Burt Folsom Personal Statistics, North Dakota Geological Survey

	Group	Formation	Sub Formation	Reference
+	Jefferson	Duperow		Burt Folsom Personal Statistics, North Dakota Geological Survey

	Group	Formation	Sub Formation	Reference
-	Madison	Mission Canyon		NDIC Case# 4447 P#425

+ Reservoir Data

+ Reservoir Oil Data

+ Reservoir Gas Data

+ Reservoir Water Data

Contains commands for working with the selected items.

http://gis.undeerc.org/website/PCORP/WellsReport.asp?OilFieldID=95 - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

- Reservoir Data

Parameter	Value	Units	Additional Reference
Lithology:	Carbonate		
Average Depth to Top of Pay:	9400	Total Depth	
Datum (ft) (MSL):	-6400		Burt Folsom Personal Statistics, North Dakota Geological Survey
Minimum Depth (ft):			
Maximum Depth (ft):			
Average Pay Thickness (ft):	25		
Average Porosity (%):	17		
Secondary Porosity Reported:	No		
Average Permeability (md):	30		
Max Permeability (md):			
Min Permeability (md):			
Average Initial Water Saturation (%):	35		
Average Reservoir Temperature (F):	255		
Initial Reservoir Pressure:	4405	psia	
Current Reservoir Pressure:		psia	
Current Pressure Date:			
Bubble Point:	2717	psia	
Residual Oil/Gas (%):			
Formation Volume Factor at Reservoir Pressure (rb/stb):	1.5		

Done Internet

http://gis.undeerc.org/website/PCORP/WellsReport.asp?OilFieldID=95 - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Oil Formation Volume Factor at Bubble Point (rb/stb):	1.56		
Original Oil in Place:	207471275	BBLS	Original Oil in Place Calculation
Closure (ft):			
Primary Drive Mechanism:	Solution Gas		
Initial Gas Oil Ratio (cf/bbl):	800		
Gas Oil Ratio (cf/bbl):	925		Burt Folsom Personal Statistics, North Dakota Geological Survey

- Reservoir Oil Data

Parameter	Value	Units	Additional Reference
Oil Gravity (API):	40		
Pour Point (F):			
Total Sulfur Wt%:			
Paraffin Wt%:			
Viscosity:	0.342	centipoise	
Salt Content:			
Saturation Pressure:			

- Reservoir Gas Data

Parameter	Value	Units	Additional Reference
Gas Specific Gravity:			
H2S Content:			
CO2 Content:			
N2 Content %:			

+ Reservoir Water Data

Internet

ArcIMS Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media Links

Plains CO2 Reduction Partnership

GIS Help | Metadata

Overview Map

Legend/ Layer

Zoom In

Zoom Out

Full Extent

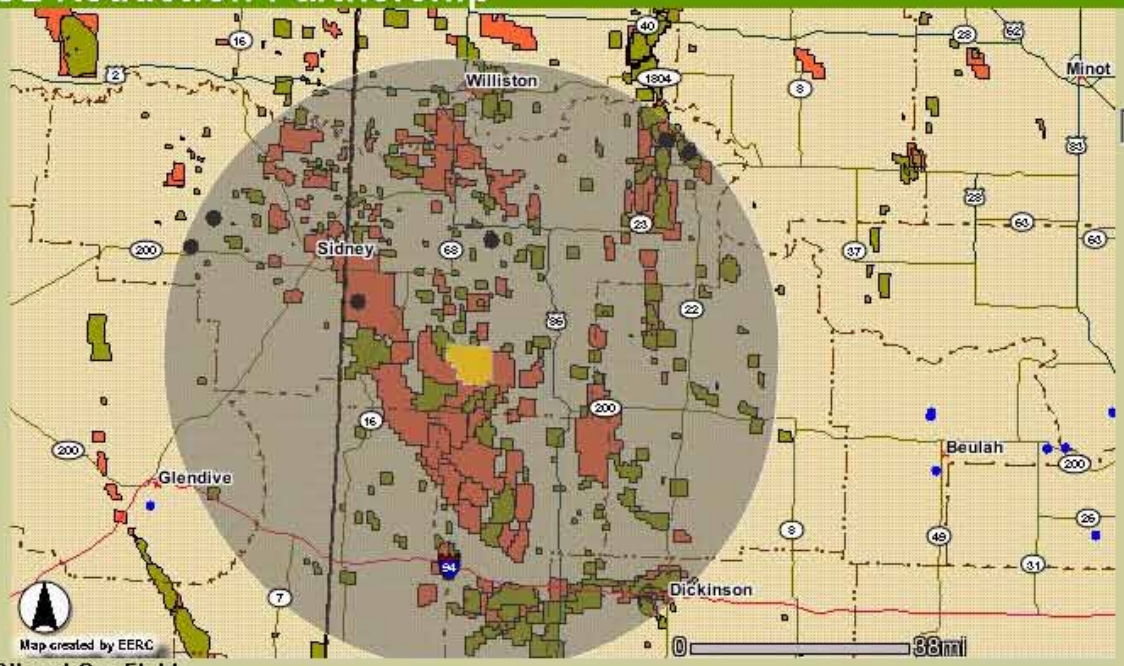
Last Extent

Pan

Select

Buffer

Clear Selection



Thematic Maps

— select thematic map —

Layers

Refresh Map

Visible Active

- CO2 Sources
- Towns
- Counties
- State/Province
- Roads
- Rails
- Oil and Gas Wells
- Oil and Gas Fields
- Coal Fields

Active Layer: Oil and Gas Fields

Total Records: 6

EXPORT: Help | Sources | Source Commodities | Source Fuels

CO2 Source Name	State Prov	Type	tons CO2/yr	MMcf CO2/yr
Amerada Hess: Antelope #2	ND	Petroleum & Natural Gas Processing	12892	210.3
Amerada Hess: Hawkeye	ND	Petroleum & Natural Gas Processing	14576	237.7
Bear Paw Energy, Inc.: Grasslands Plant	ND	Natural Gas Processing	82334	1342.9
Lewis & Clark	MT	Electric Generating	468045	7633.8
Northern Border Pipeline: Cs #4	ND	Natural Gas Transmission	77353	1261.6
Sidney Sugars Inc. - Sidney	MT	Sugar Production	129933	2119.2

Map: -372635.88 , 197101.46 -- Image: 55 , 380 -- ScaleFactor: 478.91092052085696

Internet

ArcIMS Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media Links

Plains CO2 Reduction Partnership

GIS Help | Metadata

Overview Map

Legend/ Layer

Zoom In

Zoom Out

Full Extent

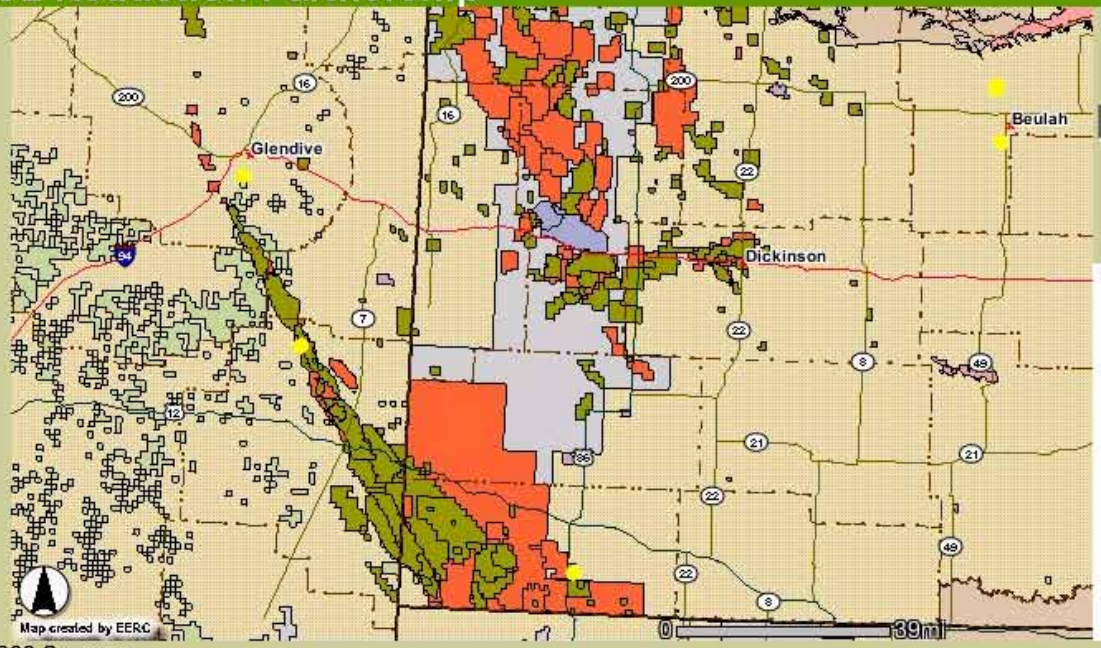
Last Extent

Pan

Select

Buffer

Clear Selection



Thematic Maps

— select thematic map —

Legend

No Pool Data

Federal Land

- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- Department of Defense
- Department of Energy
- Department of Justice
- Forest Service
- Fish and Wildlife Service
- National Park Service
- Partnership Region

Active Layer: CO2 Sources

Total Records: 6 Zoom to selected

EXPORT: Help | Sources | Source Commodities | Source Fuels

CO2 Source Name	State	Type	tons CO2/yr	MMcf CO2/yr
Antelope Valley	ND	Electric Generating	7931145	129357
Continental Resources	ND	Petroleum & Natural Gas Processing	67771	1105.3
Coyote	ND	Electric Generating	3948732	64403.8
Dakota Gasification Company	ND	Fuels/Chemicals	5550057	90521.4
Glendive Station (Montana-Dakota Utilities)	MT	Electric Generating	10453	170.5
Williston Basin -- Cabin Creek Station	MT	Natural Gas Transmission	26481	431.9

Layers Internet

ArcIMS Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media Links

Plains CO2 Reduction Partnership

GIS Help | Metadata

Microsoft Excel - OilFieldPools[1].csv

File Edit View Insert Format Tools Data Window Help

Type a question for help

Reply with Changes... End Review...

SnagIt Window

A1 OilFieldID

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	OilFieldID	Name	PoolID	GeoGroup	GeoForma	GeoSubFo	Lithology	TopOfPay	TopOfPay[	Datum	MinDepth	MaxDepth	DepthType	AvgPayThi
2	51	Bell	9251	Minnelusa	Tyler		Siliciclastic							14
3	51	Bell	9250	Minnelusa	Tyler	Tyler A Sa	Siliciclasti	8150	Total Depth					
4	44	Dickinson	9158	Madison	Charles/Mission Cany		Carbonate				8690	8766	Total Depth	
5	44	Dickinson	9159	Madison	Lodgepole		Carbonate							
6	44	Dickinson	9160	Madison	Undesignated		Carbonate	-6174	Sub-Sea L	-6250	-6174	-6250	Sub-Sea L	37
7	44	Dickinson	8893	Minnelusa	Tyler	Heath	Siliciclasti	-5298	Sub-Sea L	-5300	-5298	-5328	Sub-Sea L	30
8	45	Eland	9344	Madison	Lodgepole		Carbonate	9800	Total Depth					105
9	55	Fryburg	9047	Big Horn	Red River		Carbonate			-9500				18
10	55	Fryburg	9048	Madison	Mission Canyon		Carbonate	9300	Total Depth					17
11	55	Fryburg	9049	Madison	Mission Ca	Mission Ca	Carbonate	9276	Total Depth					7
12	55	Fryburg	8898	Madison	Undesignated		Carbonate	-6625	Sub-Sea L	-6600	-6625	-6650	Sub-Sea L	10
13	55	Fryburg	9050	Madison	Undesigna	Medora	Carbonate	9100	Total Depth					8
14	55	Fryburg	9052	Madison	Undesigna	Tracy Mou	Carbonate							14
15	55	Fryburg	9051	Madison	Undesigna	Upper C-4	Carbonate	9180	Total Depth					4
16	55	Fryburg	9054	Minnelusa	Tyler		Siliciclasti	7975	Total Depth					3
17	55	Fryburg	9053	Minnelusa	Tyler	Heath	Siliciclasti	-5380	Sub-Sea L	-5400	-5380	-5400	Sub-Sea L	11
18	55	Fryburg	9055	Minnelusa	Tyler	Tyler Sand	Siliciclasti	8000	Total Depth					6
19	42	Heart River	8972	Minnelusa	Tyler	Heath	Siliciclastic			-5300				
20	65	Knutson	9193	Madison	Mission Canyon		Carbonate	9050	Total Depth					16
21	65	Knutson	9194	Madison	Undesignated		Carbonate							10

.csv]OilFieldPools[1]

Ready NUM

Davis Creek	Upton Resources	ND	Non-Unitized		3/2004	1267641	475643	2376675	16107	6692	62637
Dickinson	Conoco, Inc.	ND	Non-Unitized	24252	3/2004	32709623	4603589	56837067	18296	6605	170001

Map: -257569.77 , 296344.58 -- Image: 286 , 5 -- ScaleFactor: 565.2360995957588

Internet

PCOR Partnership - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

PCOR Partnership

Decision Support System

PCORP GIS

Indirect Carbon Sequestration

Advisory Board

Presentations

Reports

List of Products

DOE: Global Climate Change Initiative Links

Other Carbon Related Links

- Sources/Sinks/ Infrastructure Data
- General/Background Information
- CO2 Related Projects

Contact Us

PCORP Home

The PCOR Partnership Decision Support System (DSS) is a web-based database, GIS, and scenario modeling system. The DSS will allow our research partners to browse, query, analyze, and download data regarding CO2 sequestration in the PCOR region. The focus of this system is to compile an interactive data analysis and modeling interface that will provide for the definition and inspection of a wide range of transport and sequestration scenarios.

Datasets and models will be updated as new information becomes available and provided to team members performing engineering and scientific calculations. In turn, engineering and scientific results will be used to modify the DSS as they become available. This iterative process will result in the most effective and up-to-date database and modeling system possible. The DSS will leverage and integrate the developing knowledge of the character and spatial relationships of sources, sinks and the transportation links between them into an overall scenario assessment methodology. The scenario assessment methodology will include all of the critical elements to the demonstration or commercial implementation of any scenario including environmental risk, technical feasibility and availability, cost and economics, life cycle assessment impacts, and social and political factors.

PCOR Partnership - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Address http://gis.undeerc.org/website/pcorp/terrestrial/

PCO2R Partnership

Decision Support System

PCORP GIS

Indirect Carbon Sequestration

Advisory Board

Presentations

Reports

List of Products

DOE: Global Climate Change Initiative Links

Other Carbon Related Links

- Sources/Sinks/ Infrastructure Data
- General/Background Information
- CO2 Related Projects

Contact Us

PCORP Home

Indirect Carbon Sequestration Maps

A number of processes affect the rate at which organic carbon can accumulate in soils: land cover and land use, land management practices, the biological activity within the soil, soil properties, the application of waste to the land, and climate (Centre for Ecology and Hydrology, 2002). Through an assessment and understanding of the primary variables governing soil carbon, the optimum factors that promote carbon accumulation can be determined. Of the processes mentioned above, a brief description is given below of the primary variables.
References

- **Land Cover, Land Use, and Land Management Practices**
  Land cover and land use represent the ecosystem type such as agricultural land, wetlands, grasslands, and forestry. It is the properties of these associated ecosystems and the vegetation that are the indicators of potential carbon accumulation and the extent to which the soil carrying capacity can be increased through ecosystem management. click for more ...

- **Soil Conditions**
  Soil conditions discussed here incorporate the soil order, soil texture, drainage, and acidity of soil. These are regarded as the primary soil properties affecting the accumulation of soil carbon (Cihacek, 2004). By knowing the soil order, the native environment under which the soil was formed can be determined, along with the soil's innate capacity to sequester organic carbon under ideal conditions. click for more ...

- **Land Resources**
  The major land resource areas within the U.S. portion of the Plains CO2 Reduction Partnership region are land resource units

Internet

PCOR Partnership - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Address http://gis.undeerc.org/website/pcorp/terrestrial/soil.asp

- Sources/Sinks/ Infrastructure Data
- General/Background Information
- CO2 Related Projects

Contact Us

PCORP Home

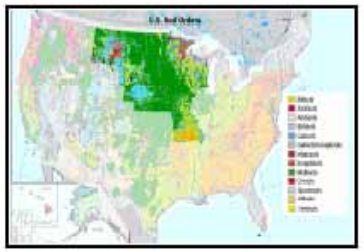
others have observed carbon accumulating in moderate acidity to slightly alkaline soil conditions (pH 5.6 - 7.8; Cihacek, 2004). Click for References.

Soil Orders

Click image to enlarge

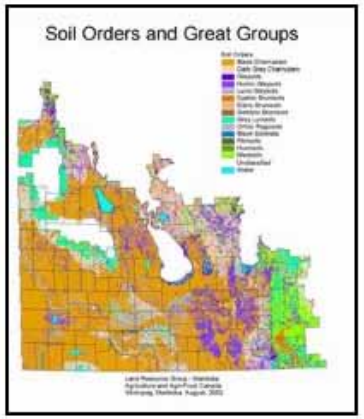
Canadian Great Groups/Subgroups
Chernozemic
Brown Chernozem
Dark Brown Chernozem
Black Chernozem

Correlation of United States and Canadian Soil Taxonomy



U.S. Soil Order

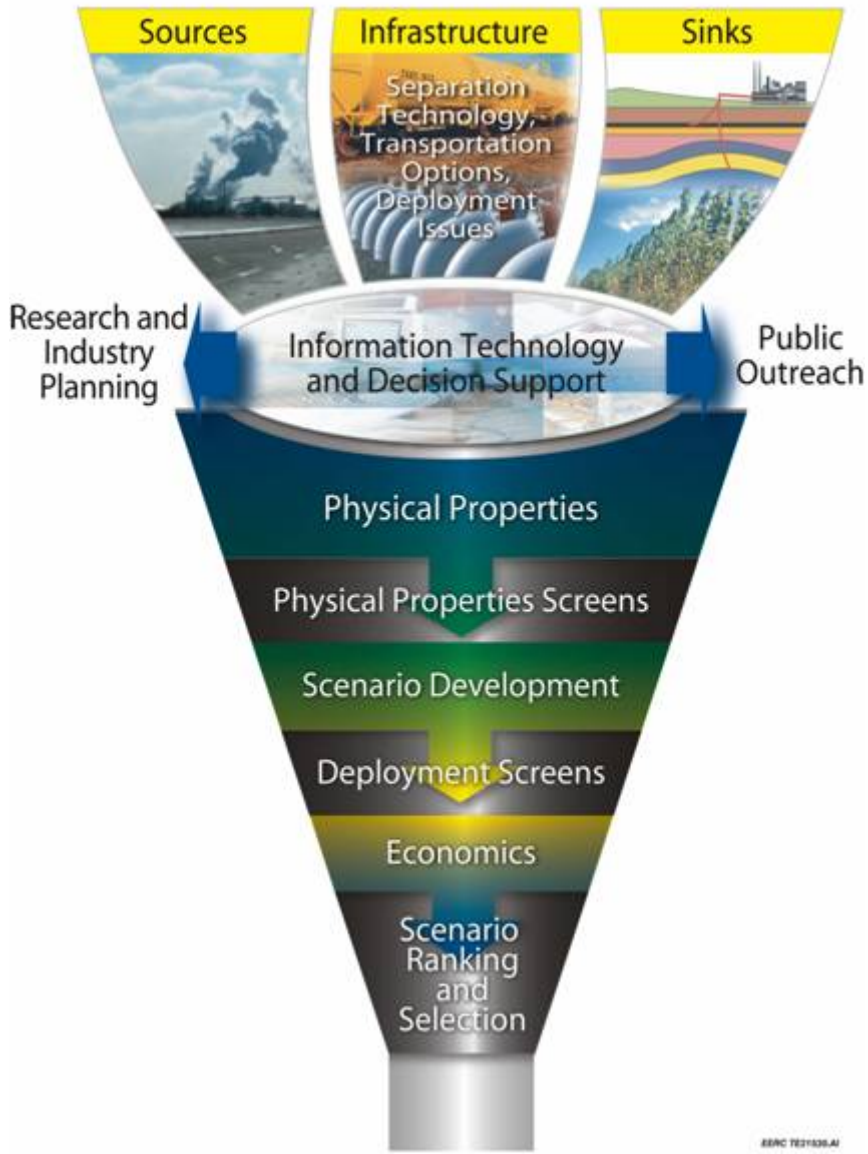
Percent of US Land Area in Mollisols



Soil Orders and Great Groups in Agro-Manitoba

Internet

Modeling and Action Plans



PCO2R Partnership

EERC Energy & Environmental Research Center

Source Physical Properties

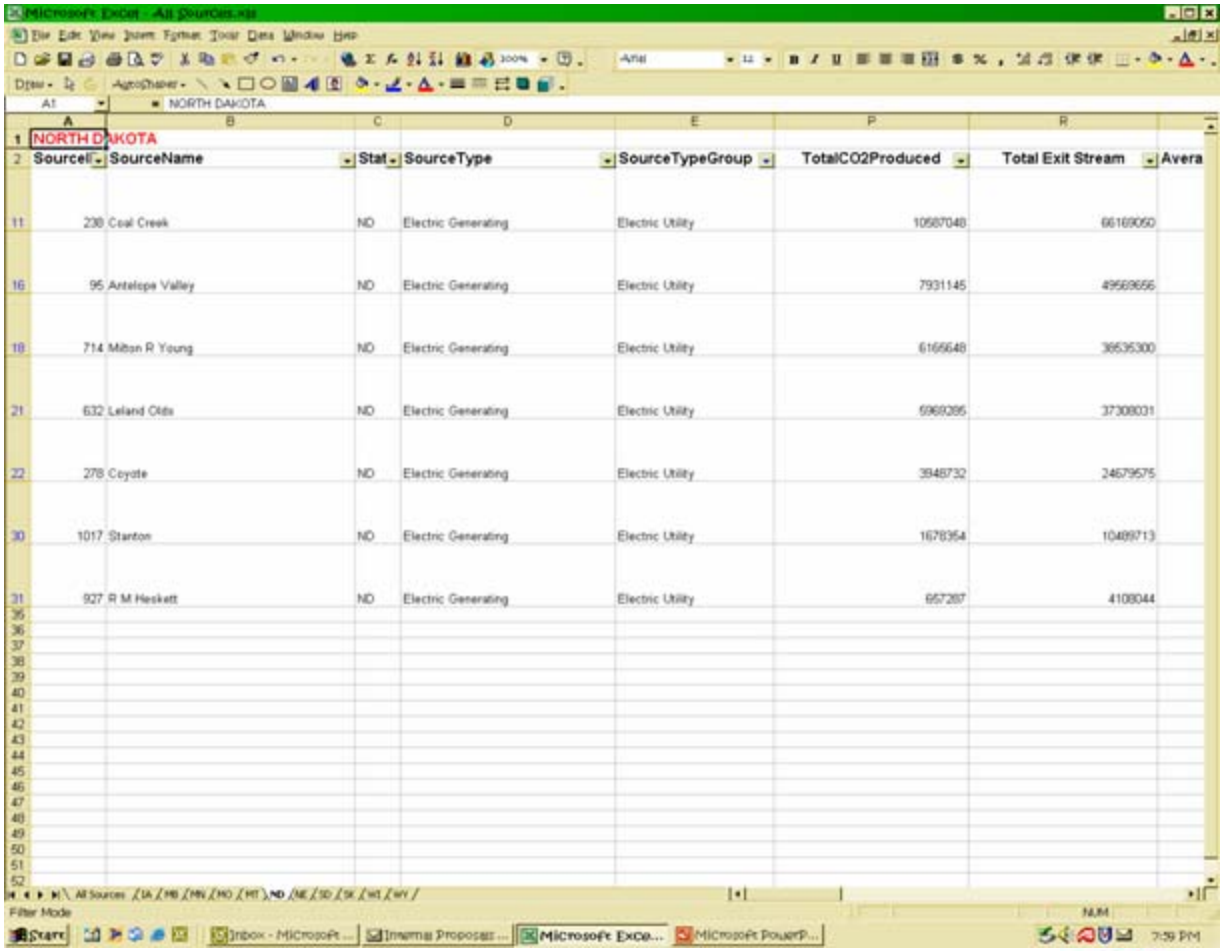
ALL SOURCES

SourceID	SourceName	State	SourceType	SourceTypeGroup	TotalCombustionCO2Produced	TotalCombustio
1	3M - Maplewood	MN	Manufacturing	Industrial	223538	tons CO2/Yr
2	3M - Tape Mfg. Plant	MN	Manufacturing	Industrial	104414	tons CO2/Yr
3	3M Co - Building Service	WI	Manufacturing	Industrial	5459	tons CO2/Yr
4	3M Company	SD	Manufacturing	Industrial		
5	3M Cottage Grove Boilers	MN	Manufacturing	Industrial	153637	tons CO2/Yr
6	3M Cottage Grove Incinerator	MN	Waste Processing	Industrial	664972	tons CO2/Yr
7	3M Springfield ITSD/TMD	MO	Manufacturing	Industrial	13210	tons CO2/Yr
8	A.L. Gebhardt Co W Greves St	WI	Manufacturing	Industrial	3601	tons CO2/Yr
9	A.P. Green Industries Inc	MO	Minerals Processing	Industrial	66950	tons CO2/Yr
10	ABB Power T&D Company Inc	MO	Manufacturing	Industrial	9853	tons CO2/Yr
11	Abengoa Bioenergy Corp - York	NE	Ethanol Manufacturing	Ethanol	119500	tons CO2/Yr
12	Abitec Corporation	WI	Manufacturing	Industrial	5517	tons CO2/Yr
13	Access Industries Inc Assembly	MO	Manufacturing	Industrial		
14	ACE Ethanol LLC - Stanley	WI	Ethanol Manufacturing	Ethanol	35850	tons CO2/Yr
15	Acme Galvanizing Inc	WI	Manufacturing	Industrial	3940	tons CO2/Yr
16	Ad Tech Industries Inc	WI	Manufacturing	Industrial	11208	tons CO2/Yr
17	ADM - Cocoa	WI	Agricultural Processing	Ag Processing	6639	tons CO2/Yr
18	ADM Malting Division - Fleischmann Malting	WI	Agricultural Processing	Ag Processing	17057	tons CO2/Yr
19	ADM Milling	WI	Agricultural Processing	Ag Processing	10918	tons CO2/Yr
20	ADM Processing	ND	Agricultural Processing	Ag Processing	18563	tons CO2/Yr
21	ADM Processing/200 West 19th Avenue	MO	Agricultural Processing	Ag Processing	18235	tons CO2/Yr
22	ADM, Des Moines	IA	Agricultural Processing	Ag Processing		
23	Ag Processing Inc	IA	Agricultural Processing	Ag Processing		
24	Ag Processing Inc	MO	Agricultural Processing	Ag Processing	18235	tons CO2/Yr
25	AGP - Hastings	NE	Ethanol Manufacturing	Ethanol	124280	tons CO2/Yr
26	Agri-Energy, LLC - Luverne	MN	Ethanol Manufacturing	Ethanol	60190	tons CO2/Yr
27	Agrium US Inc	NE	Fertilizer Production	Industrial		
28	Akrosil	WI	Paper and Wood Products	Industrial	8188	tons CO2/Yr
29	Albany Chicago	WI	Manufacturing	Industrial	3252	tons CO2/Yr
30	Alchem Ltd. LLLP	ND	Ethanol Manufacturing	Ethanol	25095	tons CO2/Yr
31	Al-Corn Clean Fuel - Claremont	MN	Ethanol Manufacturing	Ethanol	71700	tons CO2/Yr
32	Algoma Hardwoods Inc	WI	Paper and Wood Products	Industrial	12827	tons CO2/Yr
33	Aliant Communications	NE	Industrial/Institutional Heat & Power	Industrial		
34	Allcast, Inc	WI	Manufacturing	Industrial	26655	tons CO2/Yr
35	Allen S King	MN	Electric Generating	Electric Utility	3579175	tons CO2/Yr
36	Allied Processors, Inc	WI	Agricultural Processing	Ag Processing	8014	tons CO2/Yr
37	Allied Signal Laminate Systems	WI	Manufacturing	Industrial	16980	tons CO2/Yr
38	Alma	WI	Electric Generating	Electric Utility	816078	tons CO2/Yr
39	Alto Dairy Cooperative	WI	Agricultural Processing	Ag Processing	21631	tons CO2/Yr
40	Alumax Foils	MO	Manufacturing	Industrial	16899	tons CO2/Yr
41	Aluminum Castings & Engineering Co Inc	WI	Metals Processing	Industrial	13705	tons CO2/Yr
42	Amcast Industrial Corp - Amcast Automotive	WI	Manufacturing	Industrial	14014	tons CO2/Yr
43	Amerada Hess Corp. Tioga Gas Plant	ND	Natural Gas Liquids	Petroleum and Natural Gas	116436	tons CO2/Yr
44	Amerada Hess: Antelope #2	ND	Petroleum & Natural Gas Processing	Petroleum and Natural Gas	12892	tons CO2/Yr
45	Amerada Hess: Hawkeye	ND	Petroleum & Natural Gas Processing	Petroleum and Natural Gas	14576	tons CO2/Yr
46	American Asphalt Division Plant #22	WI	Asphalt Production	Industrial	4789	tons CO2/Yr

PCOR Partnership

EERC Energy & Environmental Research Center

Data Screening and Matching



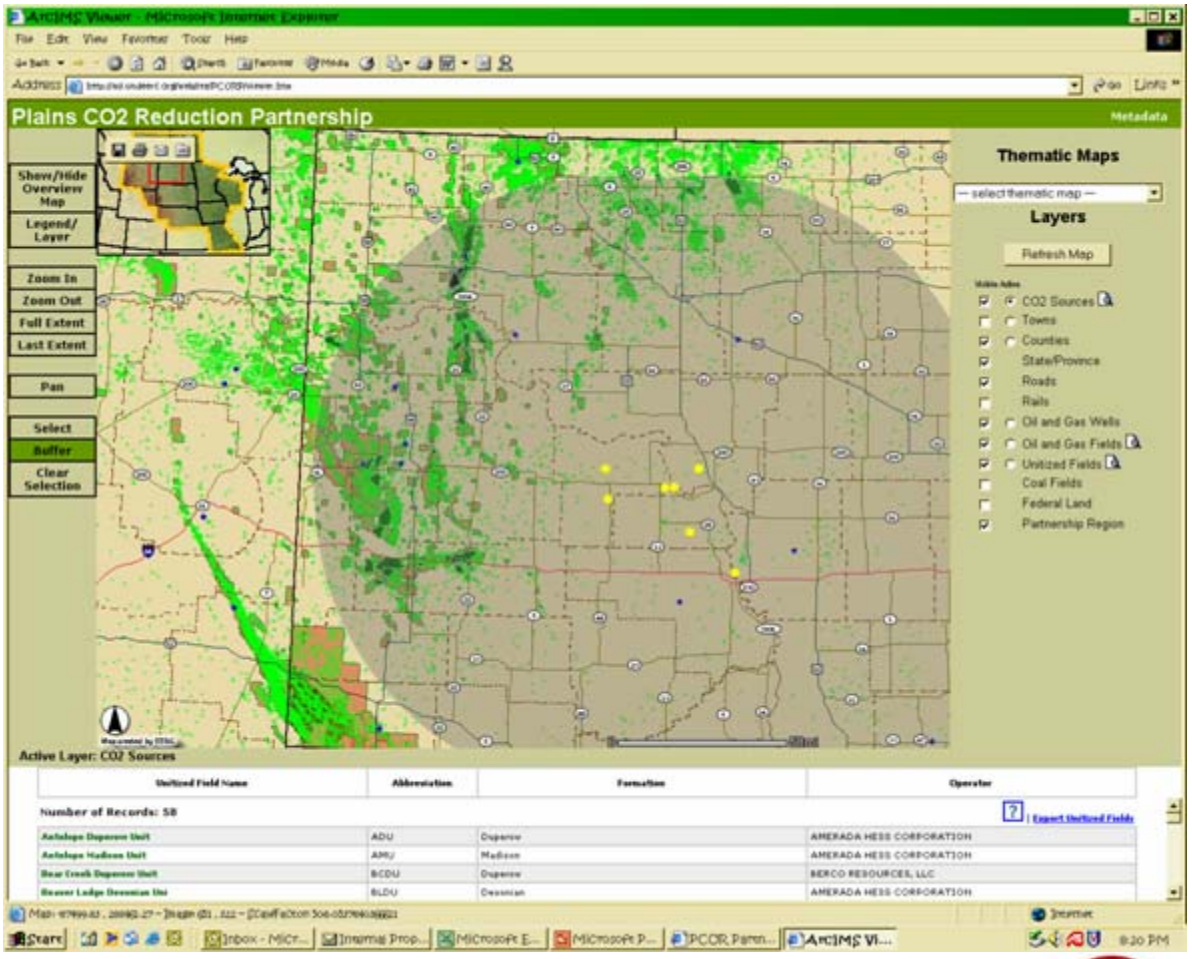
NORTH DAKOTA

SourceID	SourceName	State	SourceType	SourceTypeGroup	TotalCO2Produced	Total Exit Stream	Avera
238	Coal Creek	ND	Electric Generating	Electric Utility	10587048	66169060	
95	Antelope Valley	ND	Electric Generating	Electric Utility	7931145	49569656	
714	Milton R Young	ND	Electric Generating	Electric Utility	6166648	38535300	
632	Leland Olds	ND	Electric Generating	Electric Utility	5968286	37308031	
278	Coyote	ND	Electric Generating	Electric Utility	3948732	24679575	
1017	Stanton	ND	Electric Generating	Electric Utility	1678354	10489713	
927	R M Heskett	ND	Electric Generating	Electric Utility	657287	4108044	

PCOR Partnership

EERC Energy & Environmental Research Center

Source–Sink Matching



PCOR Partnership

EERC Energy & Environmental Research Center

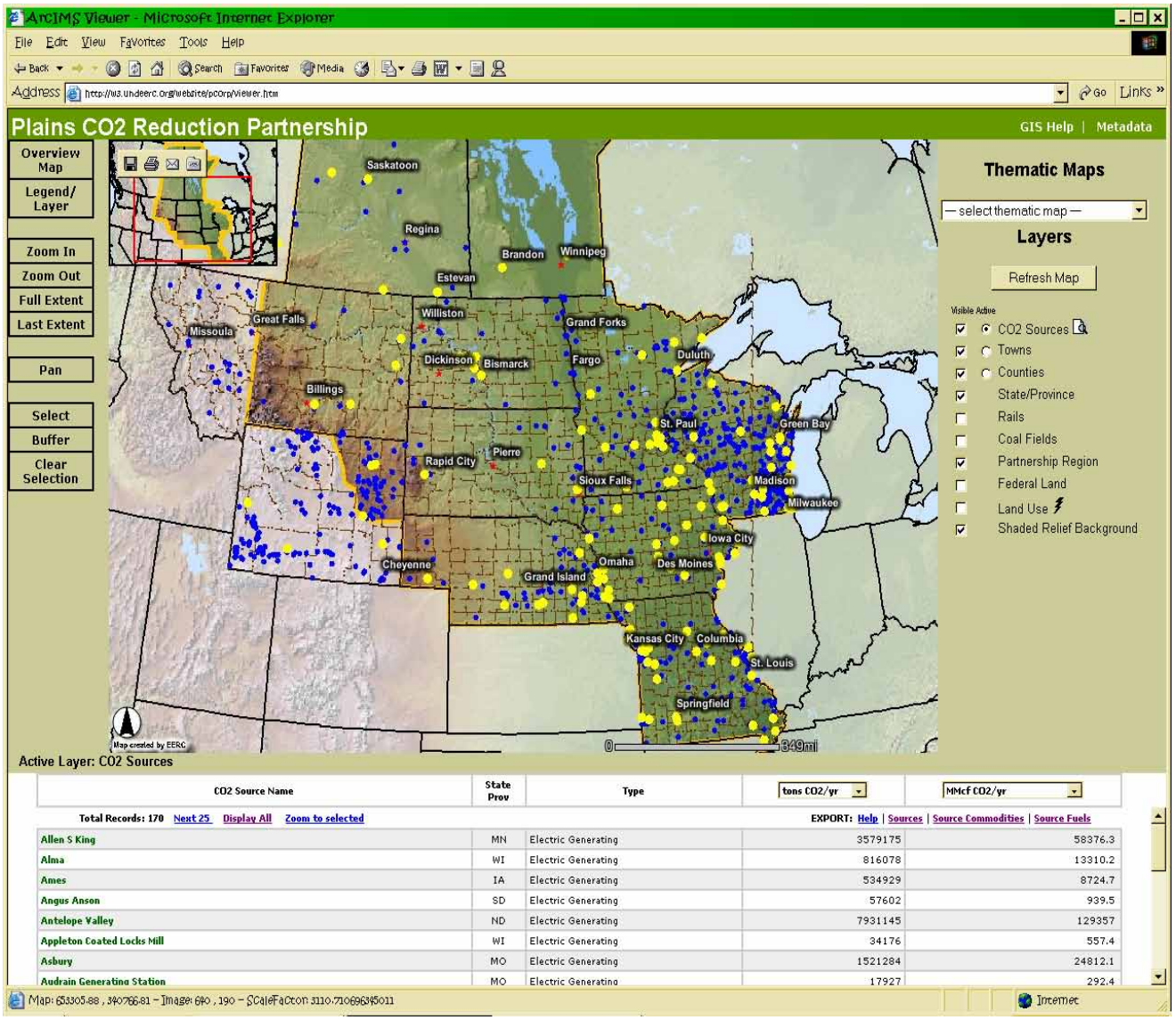
Sink Physical Properties

	Field Name:	Group	Formation	Sub Formation	Operator	Field Surface Area (acres)	Field Surface Area (ft^2)	Average Pay Thickness (ft)	Average Porosity	Approximate Pore Volume (ft^3)
1					*NDIC Website*	*NDIC Website*				
3										
4	Ambrose	Big Horn	Red River		Whiting Petroleum	4475.215454	194,941,182	6	0.18	210,536,47
5	Ambrose	Jefferson	Duperow		Whiting Petroleum	4475.215454	194,941,182	5	0.11	107,217,65
6	Amor	Big Horn	Red River	B	Luff Exploration	6513.151675	283,714,046		0.21	
7	Amor	Big Horn	Red River	C	Luff Exploration	6513.151675	283,714,046		0.14	
8	Amor	Big Horn	Red River		Luff Exploration	6513.151675	283,714,046	49	0	
9	Antelope	Big Horn	Red River		Amerada Hess	15744.79865	685,846,232	21	0.118	1,699,526,96
10	Antelope	Big Horn	Stonewall		Amerada Hess	15744.79865	685,846,232	6	0.146	600,801,29
11	Antelope	Jefferson	Duperow		Amerada Hess	15744.79865	685,846,232	50	0.101	3,463,523,47
12	Antelope	Jefferson	Duperow & Birdbear		Amerada Hess	15744.79865	685,846,232	43	0.101	2,978,630,18
13	Antelope	Madison			Amerada Hess	15744.79865	685,846,232	67	0.047	2,159,729,78
14	Antelope	Winnipeg	Deadwood		Amerada Hess	15744.79865	685,846,232	14	0.069	662,527,46
15	Antelope	Winnipeg	Lower Black Island		Amerada Hess	15744.79865	685,846,232	17	0.065	757,860,08
16	Antelope		Interlake		Amerada Hess	15744.79865	685,846,232	21	0.075	1,080,207,81
17	Antelope		Sanish		Amerada Hess	15744.79865	685,846,232	20	0.085	1,165,938,59
18	Ash Coulee	Big Horn	Red River		BTA Oil	11429.8196	497,884,976	10	0.107	532,736,92
19	Ash Coulee	Jefferson	Birdbear		BTA Oil	11429.8196	497,884,976	2	0.17	169,280,89
20	Ash Coulee		Bakken		BTA Oil	11429.8196	497,884,976		0	
21	Bear Creek	Jefferson	Duperow		Berco Resources	8974.009163	390,909,436	8	0.136	425,309,46
22	Bear Creek	Madison			Berco Resources	8974.009163	390,909,436	50	0.03	586,364,15
23	Bear Den	Big Horn	Red River		Flying "J" Oil	3153.086284	137,349,000	24	0.16	527,420,15
24	Bear Den	Jefferson	Duperow		Flying "J" Oil	3153.086284	137,349,000	9	0.124	153,281,48
25	Bear Den	Madison			Flying "J" Oil	3153.086284	137,349,000	27	0	
26	Bear Den		Bakken		Flying "J" Oil	3153.086284	137,349,000	43	0.005	29,530,03
27	Beaver Creek	Big Horn	Red River		BTA Oil	5319.513779	231,718,967	8	0.165	305,869,03
28	Beaver Creek	Big Horn	Stonewall		BTA Oil	5319.513779	231,718,967	6	0.14	194,643,93
29	Beaver Creek	Jefferson	Birdbear		BTA Oil	5319.513779	231,718,967	12	0.199	553,344,89
30	Beaver Creek	Jefferson	Duperow		BTA Oil	5319.513779	231,718,967	13	0.125	376,543,32
31	Beaver Creek		Bakken		BTA Oil	5319.513779	231,718,967	6	0	
32	Beaver Lodge	Big Horn	Red River		Amerada Hess	25945.94196	1,130,209,850	48	0.08	4,340,005,82
33	Beaver Lodge	Jefferson	Duperow		Amerada Hess	25945.94196	1,130,209,850	17	0.124	2,382,482,36
34	Beaver Lodge	Madison			Amerada Hess	25945.94196	1,130,209,850	66	0.08	5,967,508,01
35	Beaver Lodge		Gunton		Amerada Hess	25945.94196	1,130,209,850	8	0.085	768,542,69

PCOR Partnership

EERC Energy & Environmental Research Center

Electric Generating Utilities in the PCOR Partnership Region



Electricity Generation

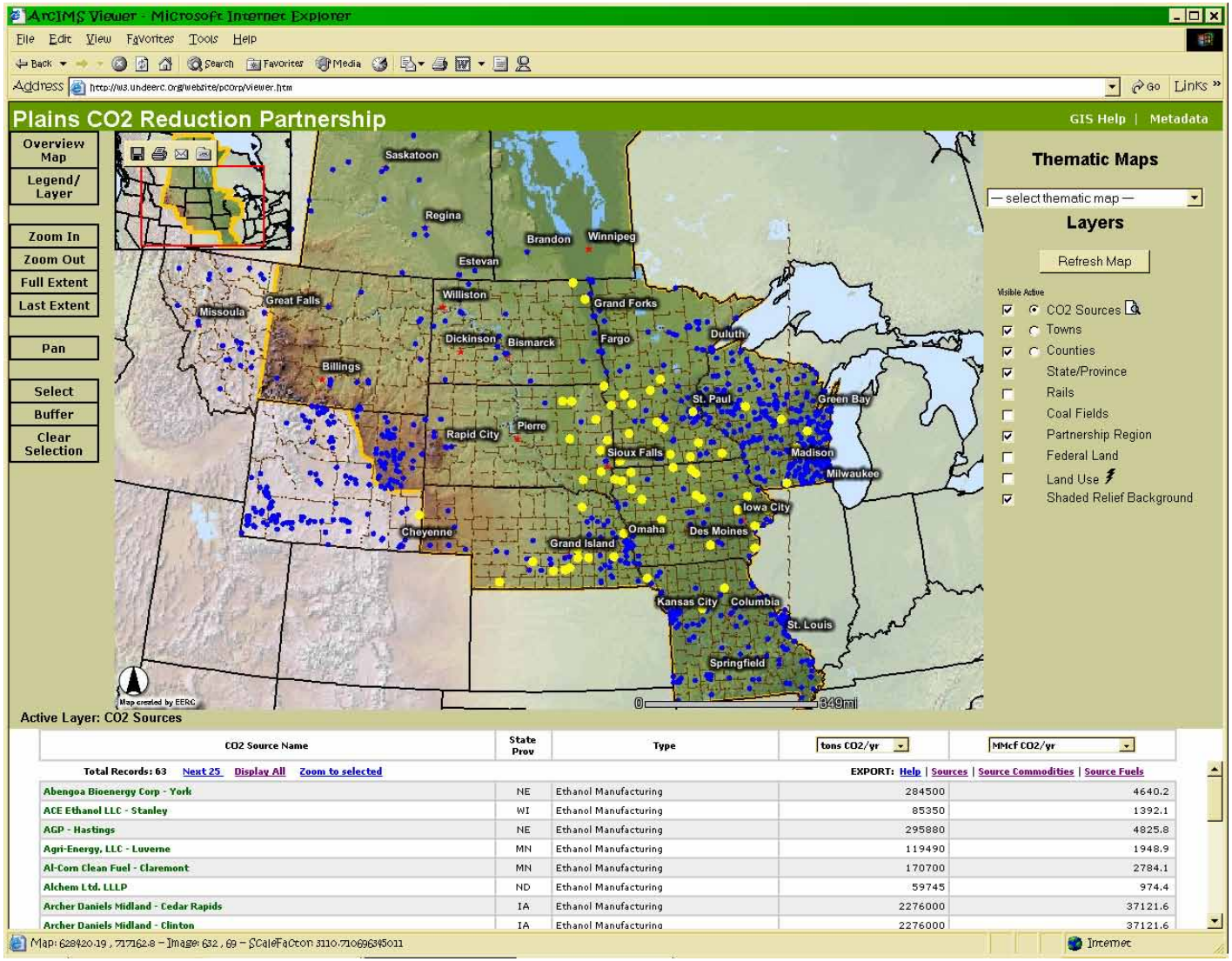
- There are 23.1 MMTCE per year produced by electricity generation plants in the PCOR Partnership region. Of this amount, 22.6% is produced within 350 miles of the Coal Creek Station in North Dakota.

- Oil fields, aquifers, and coal seams screened to date that are located within the 350-mile radius could sequester all of this CO_2 for 803 years.

PCOR Partnership

EERC Energy & Environmental Research Center

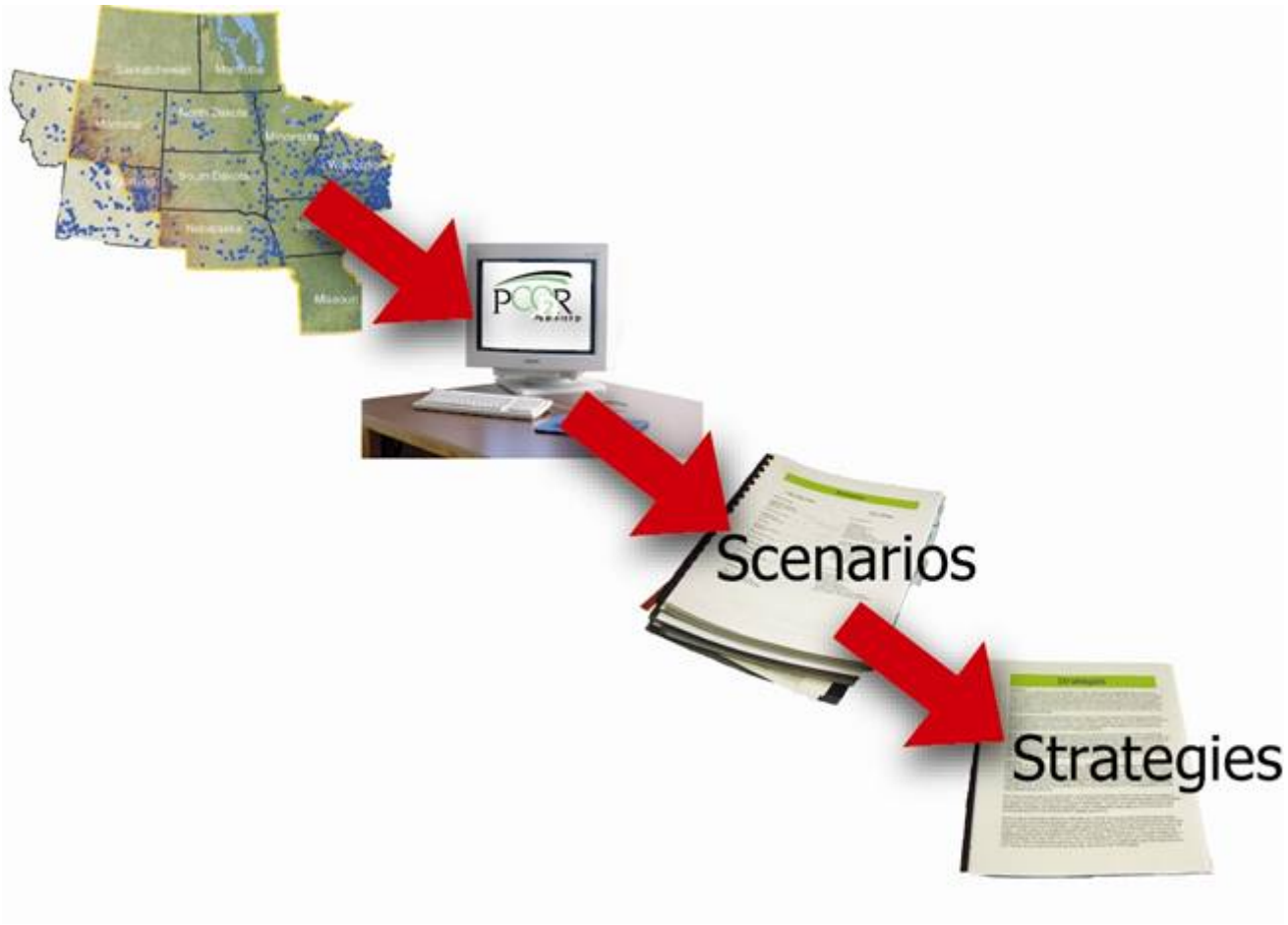
Ethanol Manufacture Facilities in the PCOR Partnership Region



Ethanol Manufacture

- About 4 MMTCE per year is produced during ethanol manufacture in the PCOR Partnership region. Of this amount, 21% is produced within 350 miles of EOR opportunities that have been evaluated (to date).

Determination of Ranked Strategies



PCOR Partnership

EERC
Energy & Environmental Research Center

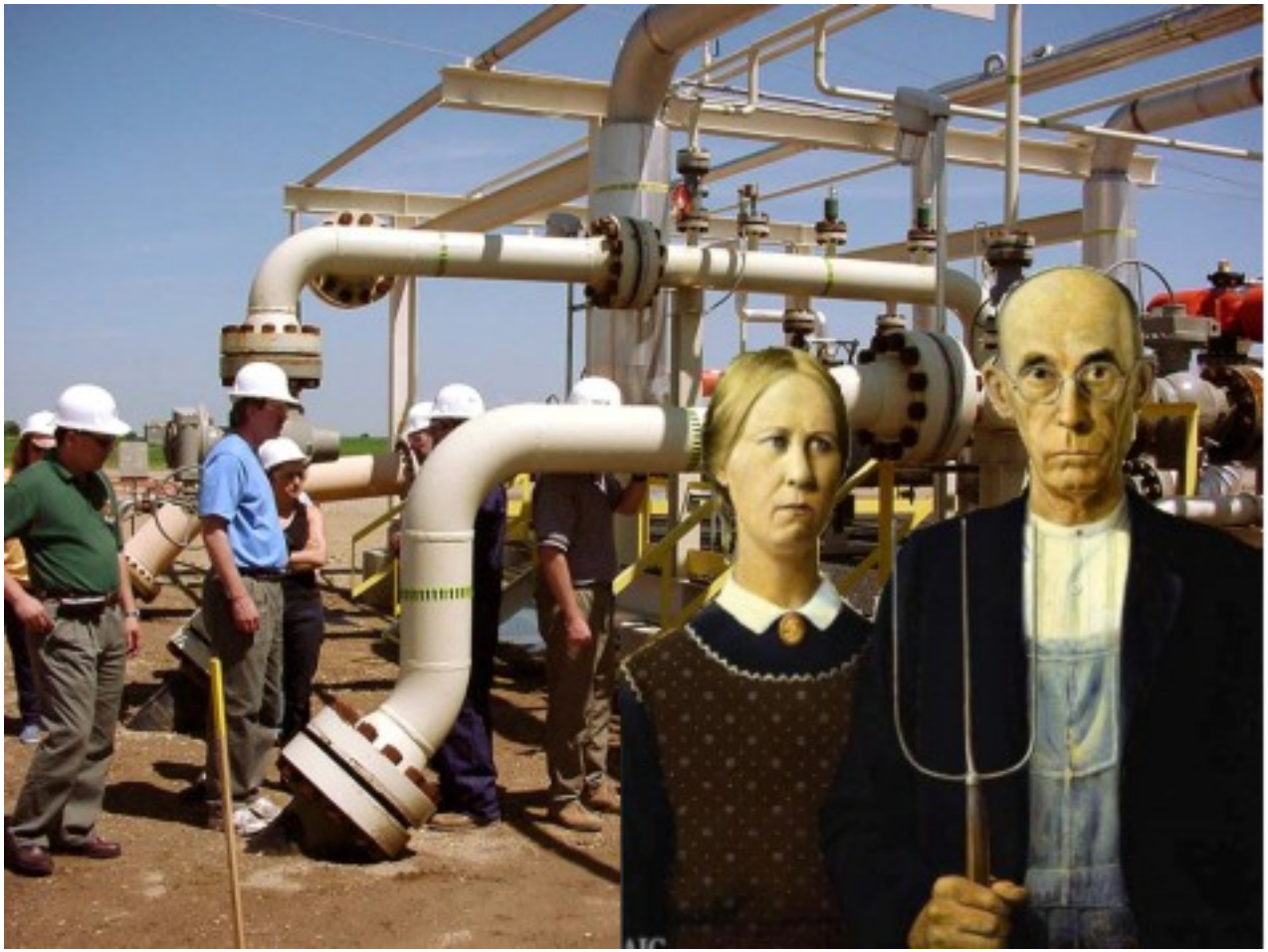
PLAINS CO_2 REDUCTION (PCOR) PARTNERSHIP

Practical, Environmentally Sound CO_2 Sequestration

LIST OF PRODUCTS

MODELING AND DECISION SUPPORT

Document	Title	Status
Topical Report	The PCOR Partnership Decision Support System	Final draft to partners
Fact Sheet	Identifying CO_2 Sequestration Opportunities (MJ)	Final draft to partners
Topical Report	Sequestration Potential of the PCOR Partnership Region	Draft in preparation
Software	The PCOR Partnership Decision Support System http://w3.undeerc.org/website/PCORP/	Ongoing



PCOR Partnership

EERC
Energy & Environmental Research Center

PCOR Partnership

EERC
Energy & Environmental Research Center

Project Milestones

Milestone	Description	Status
Management, Reporting, and Technical Outreach		
1	**Negotiate and award contract**	**Completed**
2	**Final report**	**Future activity**
Technology Deployment Issues		
1	**Detailed work plan**	**Completed**
2	**Final task report**	**Future activity**
3	**Input for scenario selection/action plans**	**In progress**
Public Outreach		
1	**Detailed work plan**	**Completed**
2	**Middle school education materials**	**In progress**
3	**30-minute general video**	**Nearing Completion**
4	**10-minute technology videos**	**Future activity**
Regional Characterization		
1	**Detailed work plan**	**Completed**
2	**Final task report**	**In Progress**
Data Management, Scenario Selection, and Action Plans		
1	**Detailed work plan**	**Completed**
2	**Scenario screening**	**In progress**
3	**Scenario modeling**	**In progress**
4	**Scenario action plans**	**Future activity**

Project Deliverables

Deliverable	Description	Status
Management, Reporting, and Technical Outreach		
1	**DOE management/PCOR Partnership Project Review Meeting**	**Ongoing**
2	**Advisory group meetings**	**Ongoing**
3	**PCOR Partnership Web site**	**In progress**
4	**Attendance/presentations at technical meetings**	**Ongoing**
5	**Technical outreach Web pages**	**In progress**
6	**PCOR Partnership meetings/workshops**	**Ongoing**
7	**Quarterly reports**	**Ongoing**
Technology Deployment Issues		
1	**Workshop background/products**	**In progress**
Public Outreach		
1	**Workshop materials**	**In progress**
2	**Public survey/assessment**	**In progress**
3	**Public outreach Web pages**	**Completed**
Regional Characterization		
1	**Workshop materials**	**In progress**
2	**Information assessment**	**In progress**
3	**Criteria and inputs for scenario selection/action plans**	**In progress**
Data Management, Scenario, Selection and Action Plans		
1	**Workshop materials**	**Ongoing**
2	**Populated relational/GIS database**	**In progress**

Vision for PCOR Partnership – Phase II

- Enhance and refine regional assessment
- Develop one or more terrestrial demonstrations (wetlands)
- Work with the PTRC/ITC and industrial partners on optimization of capture technologies for regional applications
- Develop an enhanced resource recovery project
- Develop one or more test wells for the evaluation of CO_2 sequestration
- Evaluate and quantify mineralization rates for CO_2 in selected, high-priority geologic sequestration units

PCO2R Partnership

EERC Energy & Environmental Research Center

Please Keep in Touch!!
Ed Steadman
(701) 777-5279
esteadman@undeerc.org