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September 1, 2005

Ms. Karlene Fine
Executive Director
Attn: Oil and Gas Research Program
North Dakota Industrial Commission
State Capitol – Fourteenth Floor
600 East Boulevard Avenue
Bismarck, ND 58505

Dear Ms. Fine:

Subject: EERC Proposal No. 2006-0037

Enclosed please find an original and 15 copies of the proposal entitled "Proposal to North Dakota Oil and Gas Research Council for the Plains CO_2 Reduction Partnership Program – Phase II." This proposal reflects the prior letter of support provided by the North Dakota Industrial Commission (NDIC) Oil and Gas Research Council at the time of the proposal to the U.S. Department of Energy (DOE) (see Appendix A). The EERC has recently been awarded approximately $14.3 million from DOE for this activity as well as commitments from our partners for cash and in-kind cost share totaling an additional $7.1 million. The EERC looks forward to the opportunity to work with NDIC on this rapidly developing opportunity. Also enclosed is the $100 application fee.

If you have any questions, please contact me by telephone at (701) 777-5279 or by e-mail at esteadman@undeerc.org.

Sincerely,

Edward N. Steadman
PCOR Partnership Project Manager
Senior Research Advisor

ENS/jlb
Enclosures

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PROPOSAL TO NORTH DAKOTA OIL AND GAS RESEARCH COUNCIL FOR THE PLAINS CO_2 REDUCTION PARTNERSHIP PROGRAM – PHASE II

EERC Proposal No. 2006-0037

Submitted to:

Ms. Karlene Fine

North Dakota Industrial Commission
State Capitol – Fourteenth Floor
600 East Boulevard Avenue
Bismarck, ND 58505

Proposal Amount: $500,000

Submitted by:

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September 2005

TABLE OF CONTENTS

PROPOSAL TO NORTH DAKOTA OIL AND GAS RESEARCH COUNCIL FOR THE PLAINS CO_2 REDUCTION PARTNERSHIP PROGRAM – PHASE II

ABSTRACT

The Plains CO_2 Reduction (PCOR) Partnership at the Energy & Environmental Research Center (EERC) has been established as a Phase II Regional Carbon Sequestration Partnership (RCSP) program. The partnership region includes nine states and three provinces, including North Dakota. Phase II of the PCOR Partnership will include, among other tasks, field-based demonstration projects that focus on injecting CO_2 into geologic formations for the dual purpose of CO_2 sequestration and enhanced hydrocarbon production. Three sites have been selected for geologic field demonstrations, including the Beaver Lodge oil field in North Dakota, the Harmon coal seam in North Dakota, and the Zama oil field in Alberta, Canada. The primary objectives of these activities are twofold: 1) to develop data sets that verify the ability of the target formations to store CO_2 and produce incremental hydrocarbons and 2) to develop a mechanism by which carbon credits can be monetized for CO_2 sequestered in geologic formations. Successful implementation of the results of these activities will lead to the development of new sources of CO_2 for tertiary recovery operations and will extend the economic life of many of the region's productive oil and gas fields by up to 30 years. The project will be conducted over 4 years. Ultimately, billions of dollars worth of incremental oil production could be achieved by using CO_2 tertiary recovery operations. The total value of the project is $21,487,892, of which the North Dakota Industrial Commission Oil and Gas Research Council is being asked to contribute $500,000. This funding is critical to support field validation tests in North Dakota's Williston Basin. Key among the more than 40 partners in the project are the EERC, the U.S. Department of Energy, Amerada Hess Corporation, Apache Canada, the Dakota Gasification Company, the Encore Acquisition Company, and the North Dakota Petroleum Council.

PROPOSAL TO NORTH DAKOTA OIL AND GAS RESEARCH COUNCIL FOR THE PLAINS CO_2 REDUCTION PARTNERSHIP PROGRAM – PHASE II

PROJECT SUMMARY

The Plains CO_2 Reduction (PCOR) Partnership at the Energy & Environmental Research Center (EERC) has been established as a Phase II Regional Carbon Sequestration Partnership (RCSP) program. The partnership region includes North Dakota, South Dakota, Minnesota, Wisconsin, Iowa, Nebraska, Missouri, parts of Wyoming and Montana, and the Canadian provinces of Manitoba, Saskatchewan, and Alberta. Phase I efforts of the PCOR Partnership were largely focused on characterizing the major stationary CO_2 sources and geologic sinks in the region. The regional characterization activities conducted under Phase I confirmed that while there are numerous large stationary CO_2 emission sources, the region also has tremendous capacity for CO_2 sequestration. Phase I also showed that the most economically viable near-term opportunities for sequestering CO_2 in the region are projects that use CO_2 for value-added processes such as enhanced oil recovery (EOR) or enhanced coalbed methane (ECBM) recovery. Phase II efforts of the PCOR Partnership will therefore include field-based demonstration projects that focus on injecting CO_2 into geologic formations for the dual purpose of CO_2 sequestration and enhanced hydrocarbon production. The goals of these demonstrations are twofold: 1) to develop approaches and attendant data sets that verify the ability of the target formations to store CO_2 and produce incremental hydrocarbons and 2) to develop a scientifically defendable, engineering- and science-based methodology and mechanism by which carbon credits can be monetized for CO_2 sequestered in geologic formations. The monetization of carbon credits will enhance the economics of tertiary recovery operations in the Williston Basin. PCOR Partnership activities will also promote the implementation of technology for the capture, transport, and storage of anthropogenic CO_2 emissions from stationary sources across the region, which will ultimately increase the amount of CO_2 available for EOR and ECBM projects in North Dakota.

PROJECT DESCRIPTION

Objectives

The objectives of the proposed work are to develop regional solutions for the capture, transport, and storage of anthropogenic CO_2 in the PCOR Partnership region, particularly with respect to ensuring the safe and economical storage of CO_2 in geologic formations and terrestrial ecosystems. With respect to the North Dakota oil and gas industry, the objectives of PCOR Partnership Phase II efforts are 1) to match regional CO_2 sources with appropriate economically viable geologic sinks in North Dakota (i.e., tertiary EOR and/or ECBM projects) and 2) to develop a means by which a carbon credit market for geologic sequestration of CO_2 can be established, thereby enhancing and extending the economic life of the region's oil and gas fields. There are a number of complementary PCOR Partnership Phase II activities that are not specifically discussed herein. Among them are further regional characterization; a terrestrial sequestration project; research into safety, regulatory, and permitting issues; and public outreach and education.

Methodology

The PCOR Partnership Phase II objectives that most directly match the goals of the North Dakota Oil and Gas Research Council (OGRC) will be accomplished through three technology validation projects that focus on hydrocarbon recovery. Two projects will focus on the incremental recovery of oil through tertiary operations in carbonate reservoirs. One project will inject CO_2 into the Duperow Formation at the Beaver Lodge oil field in North Dakota. A second project will inject acid gas, which consists of 60% CO_2 and 40% H_2S, into a pinnacle reef structure at the Zama field in Alberta, Canada. The demonstration at Zama is relevant to North Dakota in that 1) similar pinnacle structures exist in North Dakota and 2) at least two similar sources of acid gas exist in the Williston Basin, and the results from Zama will provide insight into the use of such gas for tertiary recovery projects in North Dakota. The third project will focus on evaluating the potential for ECBM through the injection of CO_2 into the Harmon lignite seam in southwestern North Dakota.

These field validation tests will be accomplished through a systematic 4-year effort. Methods of accomplishing the objectives for each field validation test project include the following:

- Preinjection baseline site characterization
- Development and implementation of appropriate measurement, mitigation, and verification (MMV) protocols
- Public outreach activities
- Continued development of regional opportunities for EOR and ECBM

Although a vibrant carbon credit trading market for sequestration in geologic formations would facilitate economic recovery of oil and gas by providing incremental financial incentive, there are several hurdles to establishing such a market. The primary hurdles include 1) demonstrating that the injected CO_2 can be monitored and verified in manners that are technically accurate and cost-effective, 2) demonstrating that the injection and storage processes are safe, and 3) packaging the credits generated by verified storage projects for sale. Using the data generated by the field demonstrations, a Regional Technology Implementation Plan will be developed that will provide producers in the Williston Basin the tools they need to quantify, verify, and package geologically sequestered CO_2 for market. It is important to note that, at present, geologically sequestered CO_2 is not readily traded in rapidly evolving carbon credit markets. It is the intention of the PCOR Partnership, through activities such as those proposed herein, to facilitate their introduction into those markets. On August 29, 2005, U.S. trades of terrestrial (nongeologic) carbon credits on the voluntary Chicago Climate Exchange were valued at $2.02/metric ton CO_2 ($0.11/mcf CO_2).

With respect to matching regional CO_2 sources to potential EOR and ECBM projects in North Dakota, other partnership tasks will focus on identifying potential new sources of CO_2 and an economically viable means of transporting that CO_2 to those projects. Under Phase II, the PCOR Partnership will enhance already established working relationships with ethanol plants, existing power generating facilities, and at least one new integrated gasification combined cycle (IGCC) power plant. In addition, the partnership will continue to track the development of newly announced plants (e.g., the

planned coal-to-liquids facility near Underwood, North Dakota) that may provide additional CO_2 for utilization and will also track new technology for capture of CO_2 at existing large stationary sources. In particular, the PCOR Partnership will develop a CO_2 management plan for the Excelsior Energy, Inc., power plant (the "Mesaba Energy Project" or "Mesaba"), to be completed in northern Minnesota in the 2010–2012 time frame. The Mesaba power plant will generate tremendous amounts of capture-ready CO_2, and the EERC will examine the technical and economic viability of capturing and transporting that CO_2 to the Williston Basin for use in tertiary EOR projects.

Facilities

The EERC and its partners will apply an impressive combination of skills, resources, capabilities, and facilities to meet and exceed PCOR Partnership Phase II objectives. The EERC's 216,000 square feet of laboratory, technology demonstration, and office space, located on the University of North Dakota (UND) campus provides facilities, equipment, and experienced personnel. The EERC has the capability to conduct evaluations of parameters related to petroleum geology and to utilize relational database design, geographic information system (GIS) programming, database applications and decision support tools, and predictive modeling. The PCOR Partnership's industrial sponsors and collaborative partners offer personnel, expertise, locations, and facilities that will be used for the demonstration of CO_2 separation, transportation, and capture technologies as well as EOR and sequestration during Phase II activities.

Anticipated Results

The results of these field validation tests will be used to 1) demonstrate the effectiveness of using CO_2 to enhance the production of hydrocarbons in North Dakota reservoirs, 2) exhibit the cost-effective use of North Dakota oil reservoirs and lignite coal seams for safe storage of CO_2, and 3) establish a means by which a carbon credit market can facilitate more recovery of oil and gas from the region.

Environmental Impacts

CO_2 is a greenhouse gas. In 2003, the Bush Administration, through the U.S. Department of Energy (DOE), launched an initiative to achieve reductions in CO_2 emissions in the United States through a variety of means, including sequestration in geological formations. The establishment of CO_2 EOR

operations in North Dakota could ultimately lead to the sequestration of millions of tons of CO_2 a year into deep geological formations. With respect to local impacts from project activities, each technology validation test will be designed and implemented according to applicable state and federal regulations to ensure that the environmental impact of the project activities are minimal. MMV activities will be conducted at each technology validation test site to ensure that shallow groundwater resources and the surface environment are not significantly impacted by the injection activities.

Economic Impacts

Successful conduct of Phase II can provide tremendous economic benefit to the state of North Dakota. To date, projections made by the North Dakota Industrial Commission Oil & Gas Division (NDIC OGD) and the PCOR Partnership suggest that there are 180 million barrels of oil remaining to be recovered from the currently unitized pools in North Dakota using primary and secondary (waterflood) techniques. NDIC OGD projects that an additional 280 million barrels of oil could be recovered from these same unitized fields by using tertiary (CO_2) EOR (Lynn D. Helms, Director, NDIC OGD, personal communication, 2003). The value of 280 million barrels of oil on the current market, at $51/barrel (Williston Basin Sweet, Plains Marketing, L.P., August 5, 2005), would exceed $14.2 billion. The state, counties, schools, and cities of North Dakota are direct beneficiaries of oil and gas tax collections. State revenues from oil and gas in 2004 were $95.8 million (North Dakota Petroleum Council, North Dakota Oil and Gas Industry Facts & Figures, 2005 Edition). Ultimately, monetization of carbon credits could result in additional revenues to the oil and gas industry that can be used to facilitate more production and extend the productive lives of the state's oil and gas fields.

Ultimate Technological and Economic Impacts

The results of this project will provide technical guidance to facilitate the development of existing and future opportunities to use regional CO_2 for tertiary EOR in North Dakota. Successful demonstrations of the economic viability of tertiary recovery using regional CO_2 will 1) enhance the long-term economic vitality of the Williston Basin's exploration and production companies and 2) catalyze the development and implementation of new technologies for the capture, transportation, and utilization of CO_2.

STANDARDS OF SUCCESS

The overall success of this project will be determined through the successful implementation of CO_2 enhanced recovery demonstration projects using CO_2 and subsequent commercial application of CO_2 EOR in North Dakota oil fields. The overall success is based on identifying candidate opportunities and addressing and solving the economic, technical, environmental, and regulatory concerns facing those opportunities.

BACKGROUND

Positive contributions to the Phase I efforts of the PCOR Partnership were made by North Dakota's oil and gas industry through its direct and active participation. These efforts were largely focused on characterizing the CO_2 sources and sinks in the region in order to identify the most viable opportunities for CO_2-based demonstration projects. The regional characterization activities conducted under Phase I confirmed that while there are numerous large stationary CO_2 emission sources, the region also has tremendous capacity for CO_2 sequestration. In North Dakota, large coal-fired power plants, ethanol plants, gas-processing plants, and a refinery were identified as being significant CO_2 sources. Among the region's largest CO_2 sources are coal-fired power plants located in western North Dakota that emit a total of 45 million tons of CO_2 each year. A long-term goal of the PCOR Partnership is to set the stage for the economically viable utilization of CO_2 from those power plants in EOR projects (see attached PCOR Partnership Prospectus in Appendix B).

Several sinks already considered to be capable of sequestering large volumes of CO_2 were identified in North Dakota, including oil fields, lignite coal seams, saline aquifers, and terrestrial opportunities in the grasslands and Prairie Pothole Region. CO_2-based EOR and ECBM are value-added sequestration technologies that have the potential for future large-scale deployment in the region if pilot projects demonstrate technical and economic feasibility. The specific sites at which geologic demonstrations will be conducted are discussed below.

Activities in North Dakota's Beaver Lodge oil field will result in the injection of at least 3000 tons of CO_2 for simultaneous sequestration and EOR. The project will evaluate the potential for geological

sequestration of CO_2 in a deep carbonate reservoir and the technical and economic viability of EOR. The target injection zone will be the Duperow Formation. At a depth of 10,500 feet, this will be the deepest CO_2 sequestration/EOR project ever attempted. The project will also test the accuracy with which CO_2 storage capacity can be predicted, demonstrate MMV technologies and protocols, and provide field validation testing of sequestration technologies and infrastructure. The overall potential capacity for EOR-related CO_2 storage in this oil field has been estimated at over 47 million tons.

The field validation test slated for the Zama field of Alberta, Canada, will evaluate the potential for geological sequestration of CO_2 as part of an acid gas stream that includes high concentrations of H_2S for the concurrent purposes of EOR CO_2 sequestration, and H_2S disposal. Approximately 340,000 tons of acid gas will ultimately be stored in the oil field. The project will provide insight regarding the impact of high concentrations of H_2S on sink integrity, MMV, and EOR success within a carbonate reservoir. Additionally, the Zama pinnacles are similar to some reef structures in North Dakota, and Phase I efforts identified at least two potential sources of similar acid gas streams within the Williston Basin.

Approximately 1000 tons of CO_2 will be injected into unminable portions of North Dakota's Harmon coal seam to determine its suitability for both CO_2 sequestration and coalbed methane (CBM) production. The project will determine whether long-term contact with CO_2 affects the physical stability and gas storage capacity properties of lignite and the hydrodynamic properties of the seam. In addition, the practicality and economics of using CO_2 to enhance natural gas recovery from lignite seams will be evaluated. Phase I efforts indicated that the Williston Basin coal seams have the potential to store 379 million tons of CO_2. With respect to potential CBM reserves, preliminary estimates based on unpublished data indicate that it is conceivable that there may be as much as 1.1 Tcf of recoverable natural gas in the Harmon lignite of North Dakota. While the nature of this estimate is somewhat speculative and is highly debatable, it does speak to the potential gas resource that may lie untapped within the low-rank coals of North Dakota, and it is the absence of robust data that makes such estimates extremely uncertain. The gas resource assessment data that will be generated by the proposed project will

reduce speculation on that potential resource and could lead to the addition of the Williston Basin to the nation's list of large frontier gas plays.

QUALIFICATIONS

The EERC is a research facility that operates as a business unit of UND. The EERC currently has an annual budget of $20.4 million and has worked with over 800 clients in all 50 states and in 47 countries. The EERC has a multidisciplinary staff of more than 270 that has expertise and partnerships in a broad spectrum of energy and environmental programs, including many related to the oil and gas industry. The EERC has the proven ability to develop and lead multiyear, multidisciplinary, multiclient programs, including many public–private and stakeholder-based partnerships as exhibited by the success of the PCOR Partnership Phase I.

Key personnel for the PCOR Partnership Phase II activities include select administrative and technical staff from all of the PCOR Partnership research partners, representing a broad range of scientific and engineering disciplines and real-world experience. Indeed, the success of Phase I was due to the commitment of our industry partners who are even more critical to the success of Phase II. Relevant EERC expertise includes project management; data management and GIS programming; geological characterization and assessment; permitting and regulation compliance; and public outreach. The PCOR Partnership members bring technical expertise in sources, systems, permitting and regulations, transportation, reservoir engineering, EOR, CO_2 sequestration (including value-added applications), and outreach.

VALUE TO NORTH DAKOTA

Successful conduct of the PCOR Partnership Phase II activities can provide tremendous economic benefit to the state of North Dakota. The project will develop the information needed to encourage CO_2 EOR and ECBM in North Dakota. NDIC OGD projects that 280 million barrels of incremental oil could be recovered in currently unitized fields through the use of CO_2 EOR (Lynn D. Helms, Director, NDIC OGD personal communication, 2003). The value of 280 million barrels of oil on the current market, at $51/barrel (Williston Basin Sweet, Plains Marketing, L.P., August 5, 2005) would exceed $14.2 billion.

Activity of such magnitude would result in increased employment opportunities and tax revenues for the citizens of North Dakota and extend the productive lives of key existing North Dakota oil fields by up to 30 years.

MANAGEMENT

Mr. Ed Steadman, EERC Senior Research Advisor, will serve as Project Manager of the Phase II PCOR Partnership. He will have overall responsibility for the contract and will interface regularly with the PCOR Partnership Partners, principal investigators, and EERC senior management. He will be responsible for regular reporting to OGRC program management and timely dissemination of information to other project partners. Other members of the project management team will include Mr. John Harju, EERC Associate Director for Research, and Mr. James Sorensen, EERC Senior Research Manager. The project management team will focus on providing timely completion of milestones; timely, high-quality deliverables; and effective communication between the PCOR Partnership and OGRC. Regular project review meetings (annual or as otherwise directed) between representatives of the PCOR Partnership and OGRC will be scheduled.

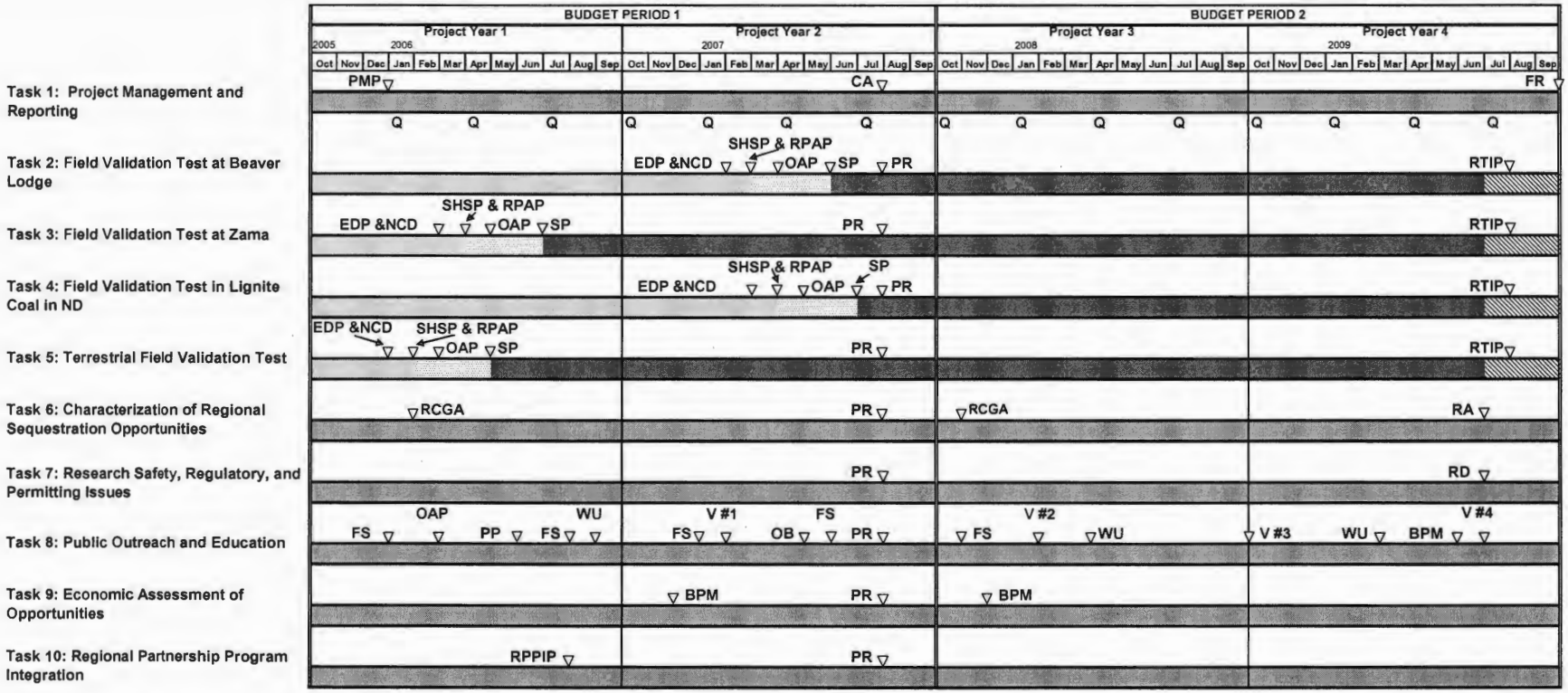
BUDGET

The EERC is requesting $500,000 from OGRC for PCOR Phase II. Additional cost share of $20,987,892 is shown on page 15.

The total project budget is necessary to adequately address the concerns surrounding the use of CO_2 for EOR in North Dakota. The level of OGRC funding is critical to adequately represent the perspective of the North Dakota oil industry in this project. Funding of a lesser amount is inadequate to demonstrate a serious commitment to considering the use of regional CO_2 resources for tertiary EOR projects in North Dakota. In funding Phase II of the PCOR Partnership, DOE assumes the OGRC will monetarily support the program as outlined in a letter from OGRC to the EERC (see Appendix A). The scope of work developed for overall project funding assumes funding is received from OGRC. A detailed budget is provided in Appendix C.

TIMETABLE

The following is a project schedule for PCOR Partnership Phase II activities. Only Tasks 2, 3, and 4 are discussed in detail within this proposal.



BPM = Best Practice Manual
CA = Continuation Application
EDP = Experimental Design Package
FR = Final Report
FS = Fact Sheet
NCD = NEPA Compliance Doc.
OAP = Outreach Action Plan
OB = Outreach Booth
PMP = Project Manag. Plan
PP= PowerPoint Present.
PR = Progress Report
Q = Quarterly Reports
RA = Regional Atlas
RD = Roadmap Document
RPAP = Regulatory Permitting Action Plan
RCGA = Regional Characterization Gap Assessment
RPPIP = Regional Partnership Prog. Integ. Plan
RTIP = Regional Technology Implementation Plan
SHSP = Site H&S Plan
SP = Sampling Protocols
WU = Web Site Update
V = Video

Design Phase | Implementation Phase | Operations Phase | Closeout/Reporting Phase | ▽ Milestone

MATCHING FUNDS

Matching funds being provided to the PCOR Partnership Phase II program are listed below.

	Cash Cost Share					In-Kind Cost Share					Grand Total
Organization	Year 1	Year 2	Year 3	Year 4	Total	Year 1	Year 2	Year 3	Year 4	Total	
US DOE	$2,300,000	$4,000,000	$4,000,000	$4,000,000	$14,300,000						$14,300,000
NDIC-LRC	$180,000	$180,000	$180,000	$180,000	$720,000						$720,000
NDIC-OGRC	$125,000	$125,000	$125,000	$125,000	$500,000						$500,000
Excelsior	$15,000	$50,000	$15,000	$15,000	$95,000						$95,000
Great River Energy	$15,000	$15,000	$15,000	$15,000	$60,000						$60,000
Otter Tail Power	$15,000	$15,000	$15,000	$15,000	$60,000						$60,000
SaskPower	$15,000	$15,000	$15,000	$15,000	$60,000						$60,000
Xcel Energy	$15,000	$15,000	$15,000	$15,000	$60,000						$60,000
Great Northern Power	$15,000	$15,000	$15,000	$15,000	$60,000						$60,000
NDIC-OGD						$38,375	$38,599	$39,645	$40,689	$157,308	$157,308
NDGS						$34,532	$34,571	$35,493	$36,414	$141,010	$141,010
PPTV						$74,500	$77,338	$74,500	$49,850	$276,188	$276,188
NDSU						$12,478	$18,711	$18,711	$18,711	$68,611	$68,611
Ducks Unlimited						$44,800	$53,323	$55,462	$47,174	$200,759	$200,759
EUB						$153,486	$146,662	$143,561	$127,339	$571,048	$571,048
Apache Canada						$263,056	$1,098,094	$1,086,614	$710,204	$3,157,968	$3,157,968
Amerada Hess						$150,000	$350,000	$350,000	$150,000	$1,000,000	$1,000,000
TOTAL	$2,695,000	$4,430,000	$4,395,000	$4,395,000	$15,915,000	$771,227	$1,817,298	$1,803,986	$1,180,381	$5,572,892	$21,487,892

TAX LIABILITY

The EERC—a research organization within UND, which is an institution of higher education within the state of North Dakota—is not a taxable entity.

CONFIDENTIAL INFORMATION

No confidential information is included in this proposal.

PATENTS AND RIGHTS TO TECHNICAL DATA

It is anticipated that no patents will be generated by PCOR Partnership Phase II activities. The rights to the technical data generated by this project will be held jointly by the EERC and the sponsoring partners.