



The Big Sky Carbon Sequestration Partnership Phase II Competition

The Big Sky Carbon Sequestration Partnership is seeking industrial partners to join its team to compete in a Phase II solicitation from the U.S. Department of Energy which would provide important insights and information regarding potential carbon reduction and sequestration scenarios for power producers and industrials within Montana, Wyoming, Idaho and South Dakota.

Background

Carbon sequestration, or carbon storage, is a suite of technologies and methods that remove carbon dioxide (CO₂) emissions resulting from power plants or large industrial facilities from the atmosphere and securely store the CO₂ in geologic formations (i.e. saline aquifers, mafic rocks, depleted oil and gas fields, deep coal seams), soils, trees and vegetation. Geographical differences in fossil fuel use and sequestration options across the United States (U.S.) dictate targeted regional approaches.

In August 2003, the U.S. Department of Energy (DOE) announced seven Phase I awards of regional carbon sequestration partnerships, including the Big Sky Partnership, led by Montana State University. The Partnership is assessing sequestration options best suited for industries and potential sequestering matrices within the region encompassing Montana, Wyoming, Idaho and South Dakota. The partnerships selected under the DOE Phase II solicitation will build upon the work of Phase I and focus on terrestrial and geologic field validation tests that demonstrate the environmental efficacy of sequestration, verify regional CO₂ sequestration capacities, and satisfy project permitting requirements. The partnerships will also conduct outreach and education activities.

DOE anticipates funding approximately seven Phase II partnerships in the range of \$2-\$4 million per year. Each partnership will be required to provide at least 20 percent in cost-sharing over the duration of the project. The Big Sky Carbon Sequestration Partnership is seeking industrial partners to join its team and provide direction and insight into how carbon reduction and sequestration could impact and/or provide a future competitive advantage to operating and development plans. To that end, we are extending an invitation to join the Phase II team. Proposals are required to be submitted before March 15, 2005, and awards are expected by October 2005.

The Big Sky Partnership Vision

The Big Sky region enjoys some of the lowest cost electricity in the country, produced largely through hydropower and regionally mined coal. Continued access to affordable power is critical

to the region's ability to attract new businesses and jobs. Because coal is abundant in the region and because other large-scale power generation options such as hydroelectric have reached near maximum capacity, coal and gasified or liquefied products of coal will play an increasingly important role in supplying electricity to regional markets. However, given the uncertain regulatory environment regarding carbon dioxide, managers must consider planning a future energy base that supports a carbon-constrained economy. The ability to site future fossil fuel based power plants and industrial facilities could require CO₂ emissions mitigation through CO₂ capture and subsurface storage or through using carbon offsets and terrestrial carbon sequestration. Access to carbon dioxide buyers and geologic storage sites will likely become critical to the economic viability of future industrial sites.

The Big Sky Partnership's vision is to prepare its member organizations for a possible carbon-constrained economy and enable the region to cleanly utilize its abundant fossil energy resources and sequestration sinks to support future energy demand and economic growth. The Partnership will achieve this vision by demonstrating and validating the region's most promising sequestration technologies and creating the supporting infrastructure required to deploy commercial scale carbon sequestration projects. This supporting infrastructure includes a GIS-based economic and risk assessment tool to help determine optimal energy development strategies, regulatory and permitting approaches, and enhanced public understanding and acceptance. The infrastructure also includes a robust outreach program that trains scientists and engineers, and communicates the contribution carbon sequestration technologies and the Big Sky Partnership can make to the region's clean energy future.

Carbon Sequestration Opportunities: Phase II

The Partnership will propose to build on the work conducted in Phase I with a focus on geologic and terrestrial field validation tests that assess the relative efficiency of alternative sequestration options, prove the environmental efficacy and sustainability of sequestration, verify regional CO₂ sequestration capacities and satisfy project permitting and regulatory requirements. Data from validation tests will be integrated into a GIS tool that will assist industry and regional planners to optimize energy development strategies. The Partnership will also conduct extensive public outreach and education and training opportunities for students and young professionals. The following outlines the Partnership's approach to Phase II.

Geologic Sequestration

The Big Sky Partnership region has a range of geologic sites for CO₂ storage including depleted oil reservoirs, deep unminable coal seams, carbonate saline aquifers, and mafic volcanic (basalt) formations (a distinguishing feature of the region's geology). In Phase II, the Partnership will propose the following:

- Conduct two geologic demonstration projects in prominent geological formations located throughout the region - mafic rock formations and sedimentary rock hosted saline aquifers. The Partnership will characterize and test mineral trapping mechanisms in order to determine the flow and migration of CO₂ in the reservoirs and predict its long term fate. It will also determine each test site's operational needs, permitting, regulatory and monitoring requirements, and quantify economic offset opportunities such as enhanced oil recovery and coal bed methane production.

- Update and complete the region's carbon atlas, a GIS tool that visually provides spatially distributed information on CO₂ point source emissions, geologic storage sites (characterization and CO₂ storage capacity) and any supporting transportation infrastructure. Additionally, the GIS tool will incorporate economic data to optimize decision support for energy development in the region.
- Develop a national mafic rock atlas and assess the sequestration potential of these rocks through modeling studies, laboratory testing, and insights developed from mafic rock pilot projects. Of potential economic interest to Big Sky industrial partners is that the majority of this mafic formation lies relatively close to the West Coast power load.

Terrestrial Sequestration

Big Sky Partnership region has extensive land mass that provide tremendous potential for GHG offsets through terrestrial carbon sequestration in forests, range lands, and agricultural crop lands. In Phase II, the Partnership will propose to:

- Conduct pilot projects to demonstrate and validate the technical and economic feasibility of the major terrestrial carbon sinks, implement monitoring and verification protocols, and assess the impacts to existing ecosystems.
- Complete the regional GIS carbon atlas to provide spatially referenced information on terrestrial carbon sequestration potentials, land use practices, and potential co-benefits of changes in land-use management practices.
- Develop protocols for terrestrial carbon contracts that could be used in a market-based carbon emissions reductions credit market or in other government-sponsored programs.
- Implement a terrestrial offset project in conjunction with one or more coal mines and coal-fired power generator(s) to test selected monitoring, measurement and verification protocols and standards.

Outreach and Education

Public acceptance of carbon sequestration technologies and the operational capacity to deploy them is critical to the ability of (1) the Partnership to successfully implement its proposed Phase II validation tests, (2) industry to commercialize sequestration technologies and (3) the region to economically and cleanly meet future energy demand. Therefore, the Partnership will propose the following outreach and education activities:

- Establish the Big Sky Energy Future Coalition that brings together industry, academia environmental non-governmental organizations and regulatory and governmental officials bi-yearly to build dialogue on the role carbon sequestration can play in providing a technology solution to the region's energy requirements.
- Support graduate fellowships and professional development activities focused on science and engineering issues associated with carbon sequestration.
- In support of project demonstrations, organize public events that help meet regulatory, environmental and permitting requirements and build public confidence and acceptance.

- Hold Congressional forums and utilize media networks to inform policy makers and industry of carbon sequestration's potential to support regional clean energy development.

Big Sky Membership Benefits

Should the Partnership be successful in Phase II, industry will be poised to commercially deploy carbon sequestration technologies that will enable the region to cleanly meet its future energy demand. Partnership members will also receive the following benefits:

- GIS-based economic and risk assessment tool to help determine optimal energy and business development strategies
- Opportunity to influence the development of permitting and regulatory schemes
- Opportunity to influence the development of CO2 trading and credit systems
- Inter-industrial ties between CO2 producers and buyers
- Improved business climate through enhanced public understanding and acceptance
- Experience required to successfully compete in a possible carbon-constrained economy
- Economic and job growth associated with regional natural resource and energy development
- Local, regional and national recognition for leadership and environmental stewardship

Cost Share Commitments and Requirements: Phase II

DOE funding for each partnership is expected to be \$2-\$4 million per partnership per year and each partnership will be required to provide at least 20 percent in cost-sharing over the duration of the project. Cost-sharing can be both monetary and third party in-kind contributions. Examples of the latter include operating costs such as salaries, benefits, equipment etc.

Additional Information:

Information on the current partners, publications, news releases and other accomplishments can be found at the Big Sky Carbon Sequestration Partnership web site: www.bigskyco2.org

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A new energy future for Montana, Idaho, South Dakota, Wyoming and the nation.



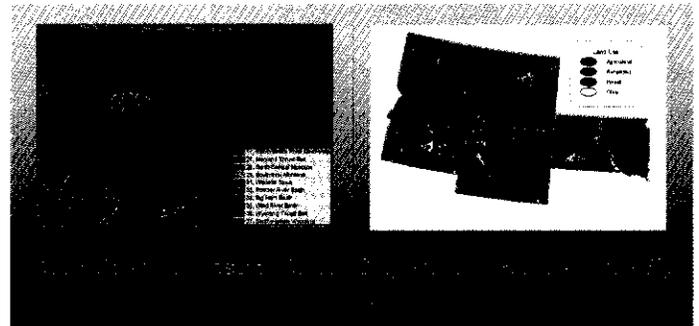
Led by Montana State University, the **Big Sky Partnership** is one of the U.S. Department of Energy's seven regional partnerships. To date, the Partnership includes Montana, Idaho and South Dakota, as well as contiguous parts of neighboring states and Canada. The Partnership is developing a framework to reduce carbon dioxide emissions that contribute to climate change and is working with stakeholders to create the vision for a new, sustainable



energy future that cleanly meets the region's energy needs. Because energy is not an optional commodity, carbon sequestration will play an important role.

Two Approaches To Carbon Sequestration

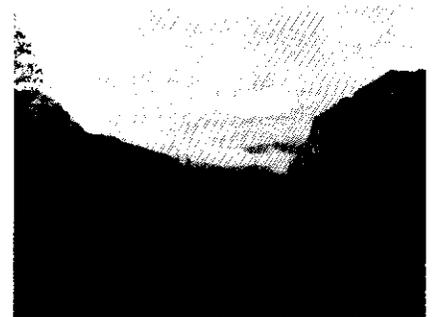
The **Big Sky Partnership** is researching two types of sequestration options: **geologic** and **terrestrial**.



Geologic sequestration involves storing carbon dioxide in geologic formations including oil and gas reservoirs, deep saline reservoirs and coal seams. These are structures that have stored crude oil, natural gas, brine and CO₂ for over millions of years. Many power plants and other large emitters of CO₂ are located near geologic formations that are amenable to CO₂ storage. In many cases the injection of CO₂ into a geologic formation can enhance the recovery of hydrocarbons, providing value-added by-products that can offset the cost of CO₂ capture and sequestration.

Terrestrial sequestration relies on management practices of agricultural lands, rangelands, forests and wetlands to remove CO₂ from the atmosphere via photosynthesis and at the same time reduce CO₂ emissions. No-till or reduced till methods, increased crop rotation intensity, the use of higher residue crops, cover crops or conservation measures are all means of increasing carbon storage in agricultural soils.

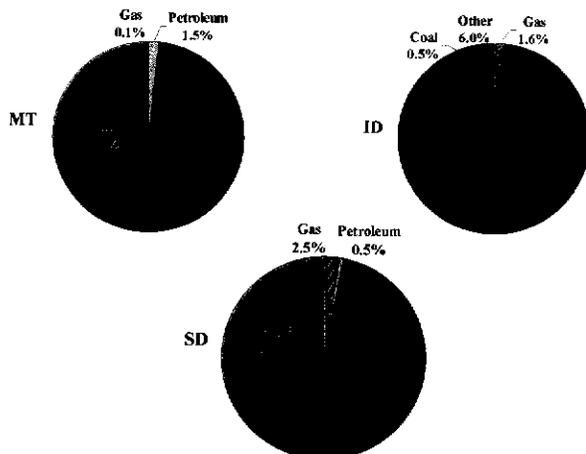
Terrestrial sequestration reduces emissions while improving land and water quality, thus making soils healthier, more productive and less susceptible to large-scale CO₂ release. Enhancing the natural processes that remove CO₂ from the atmosphere is thought to be one of the most cost-effective means of reducing atmospheric levels of CO₂.



What is CO₂ Sequestration?

Carbon dioxide, CO₂, is a major by-product of energy use. Abundant coal and hydropower offer Montana, Idaho and South Dakota some of the lowest cost electricity in the nation. However, burning fossil fuels for transportation, electricity generation and manufacturing emits greenhouse gases (GHG) that may impact regional and global climate. "Carbon sequestration" is a family of methods for capturing and permanently isolating gases that otherwise could contribute to global climate change. Affordable and environmentally safe sequestration approaches could offer a way to stabilize atmospheric levels of carbon dioxide.

Electricity Generation & GHG Emissions in the Big Sky Region



FACT SHEET: Geologic Sequestration of CO₂ in Montana

A Resource Development Grant Proposal

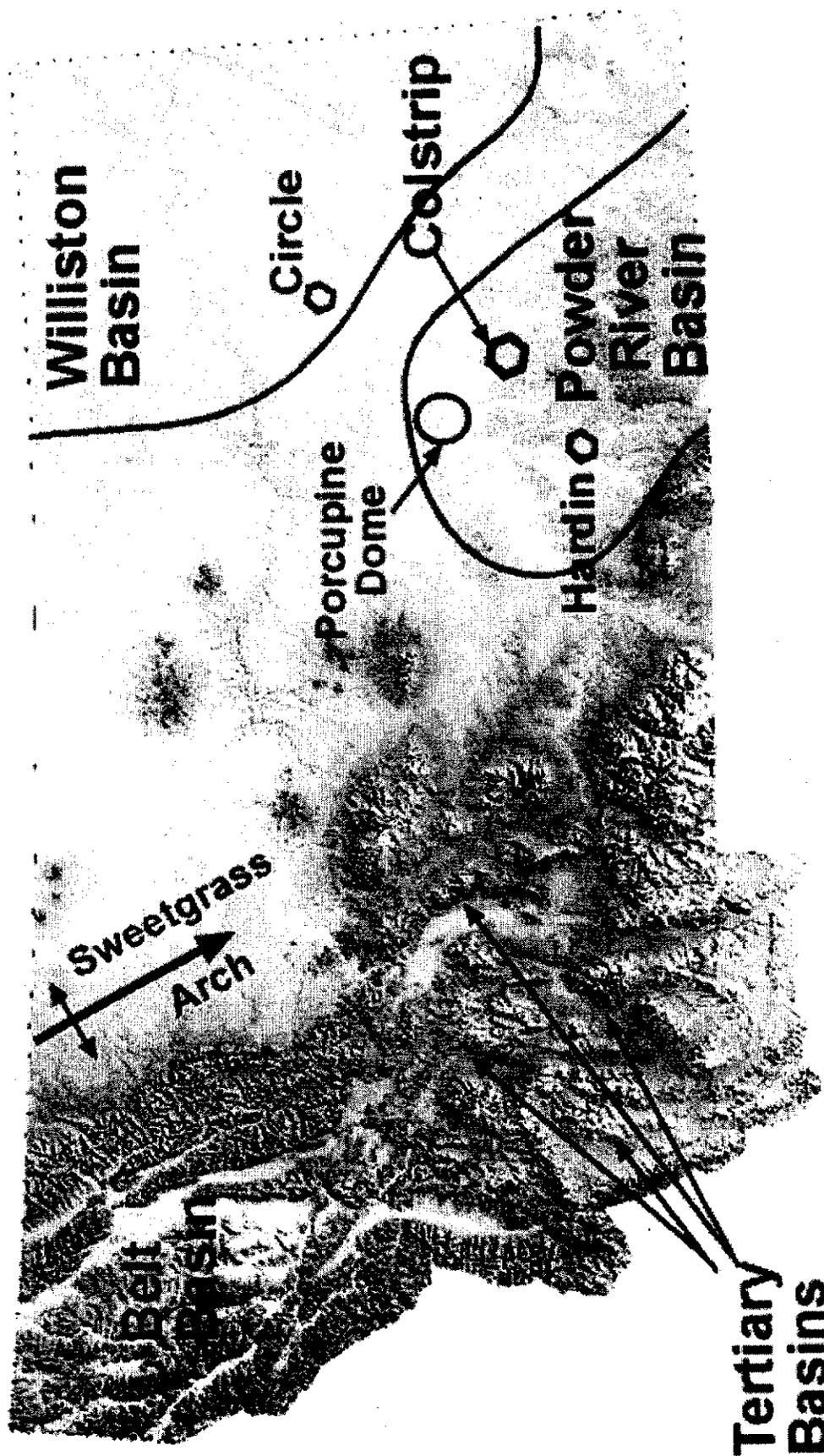
ISSUE: Carbon Dioxide (CO₂) sequestration is one approach to stabilize or reduce greenhouse gases in the Earth's atmosphere. Geologic sequestration is accomplished by injecting CO₂ into subsurface geologic formations. Formations most commonly cited as being conducive to sequestration include: deep saline aquifers, depleted oil/gas reservoirs, deep unmineable coal beds, and mafic/ultramafic rocks. Because many of these natural reservoirs are known to have stored fossil fuels and other fluids over millions of years, they can be expected to have high potential for the long-term sequestration of CO₂. The US Department of Energy (DOE) is funding research leading to selection of sites for pilot plants for actual geologic sequestration of CO₂. Because approximately one third of the CO₂ emitted annually in the United States is from point sources, successful CO₂ capture at the source coupled with geologic entombment can greatly reduce emissions.

Previous work done by the Big Sky Carbon Sequestration Partnership under Phase 1 of DOE funding focused primarily on agricultural sequestration; geologic sequestration was limited to classifying potential CO₂ sequestration reservoirs (plays) in Montana, Wyoming and Idaho. This classification used published data to identify producing oil and gas plays in Montana and Wyoming, and non-traditional plays such as mafic rocks in Idaho. The Montana Bureau of Mines and Geology (MBMG) will be a partner with the Big Sky group in a Phase 2 proposal and will add critical information for evaluating plays in Montana. More importantly, the MBMG has identified several important plays that were missed in Phase 1 because they are not producing oil and gas fields.

THE PROPOSED PROJECT: The selection criteria for potential CO₂ sinks in Montana that have been developed by the Big Sky group in Phase I will be refined based on the MBMG's detailed knowledge of the State's geology. The potential for geologic sequestration plays in Montana as demonstration sites for Phase II DOE funding will be emphasized. Potential Montana plays to be considered for a field-scale demonstration test include:

- Porcupine Dome, which is an uniquely attractive feature because:
 - It is located about 40 to 50 miles north-north east of the Colstrip power plants, which are probably the largest CO₂ sources in the region (15 million tons of CO₂/year), and new coal-fired plants under construction at Hardin and Circle are nearby.
 - It has structural closure encompassing an area in excess of 900 square miles.
 - It has been drilled for oil and gas and has been proven to be barren; therefore, unlike producing oil and gas fields, the number of abandoned drill holes that could cause leakage of CO₂ is minimal.
 - Numerous geologic strata within the dome could be used for CO₂ sequestration. This dome potentially could sequester of trillions of cubic feet of CO₂.
- Coal beds of the Powder River Basin are numerous and relatively thick in the immediate vicinity of Colstrip. The deeper, unminable beds may provide sequestration sites for large amounts of CO₂ proximal to the point of generation.
- Numerous oil fields in the Williston and Powder River Basins and in the Sweet Grass Arch area could benefit from CO₂ injection for enhanced oil recovery (EOR). The technology for CO₂ use in EOR is well known and has been applied successfully in the petroleum industry for decades.
- Other geologic plays include Tertiary basin-fill sediments and thick Proterozoic sedimentary rocks in western Montana that reach thicknesses of tens of thousands of feet.

CONTINGENCY: Because the money requested is to be used as match for a Phase 2 proposal for DOE funding, any funds awarded to this proposal are contingent on success of the DOE proposal.



**Williston
Basin**

Circle

Colstrip

**Porcupine
Dome**

**Hardin Powder
River
Basin**

**Sweetgrass
Arch**

**Belt
Basin**

**Tertiary
Basins**

Regional Sequestration Opportunities

The objectives of the **Big Sky Partnership** fall into four areas:

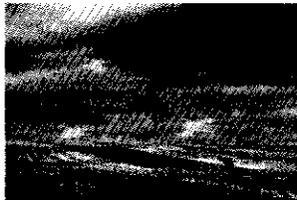
- Evaluation of sources and carbon sequestration sinks with the goal of identifying viable projects;
- Development of GIS-based reporting framework;
- Designing an integrated suite of measuring, monitoring and verification technologies;
- Initiating a comprehensive education and outreach program aimed at connecting with communities and organizations within the region

The region has a diverse array of geologic formations that could provide storage options for carbon in one or more of its three states. Likewise, initial estimates of terrestrial sinks indicate a vast potential for increasing and maintaining soil C on forested, agricultural and reclaimed lands. Both options include the potential for offsetting economic benefits to industry and society.

Complementary to the efforts on evaluation of sources and sinks is the development of the **Big Sky Partnership Carbon Cyberinfrastructure (BSP - CC)** and a GIS Road Map for the Partnership. These efforts are putting in place a map-based integrated information management system or carbon atlas for our Partnership with transferability to the national carbon sequestration effort.

Measurement and Verification

The **Big Sky Partnership** recognizes the critical importance of measurement, monitoring and verification technologies to support not only carbon trading, but other policies and programs the DOE and other agencies may want to pursue in support of GHG mitigation. The efforts begun in developing and implementing MMV



(measurement, monitoring and verification) technologies for geologic sequestration reflect this concern. Research is also underway to identify and validate best management practices for soil C in the Big Sky region, and to design a risk/cost effectiveness framework to make comparative assessments of each viable sink, taking into account economic costs, offsetting benefits, scale of sequestration opportunities, spatial and temporal dimensions, environmental risks and long term viability.

For More Information

Please visit our website: www.bigskyco2.org or contact:

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Marketing Carbon Credits

The **Big Sky Partnership** is assessing the issues surrounding the implementation of a market-based setting for soil C credits. These include the impact of existing local, state and federal permitting issues for terrestrial-based carbon sequestration projects, consistency of final protocols and planning standards with national requirements, and alignments of carbon sequestration projects with existing federal and state cost-share programs.

Connecting with the Communities and Industry

The education and outreach efforts have resulted in a comprehensive plan whose primary goal is to increase awareness, understanding, and public acceptance of sequestration efforts and build support for a constituent-based network, which includes the initial **Big Sky Partnership** and other local and regional businesses and entities.

The Big Sky Partnership Team

- ◆ Montana State University
- ◆ Boise State University
- ◆ EnTech Strategies, LLC
- ◆ National Carbon Offset Coalition
- ◆ South Dakota School of Mines & Technology
- ◆ Texas A & M University
- ◆ University of Idaho
- ◆ Idaho National Engineering and Environmental Laboratory (INEEL)
- ◆ Los Alamos National Laboratory (LANL)
- ◆ Grand Rapids Research Alliance (GRA)

