



CSLF-T-2005-12
August 24, 2005

TECHNICAL GROUP

Summaries of Projects Proposed for CSLF Recognition at the CSLF Meeting in Berlin, Germany

Note by the Secretariat

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Background

A meeting of the Technical Group of the Carbon Sequestration Leadership Forum (CSLF) was held on 30 April 2005 in Oviedo, Spain. At that meeting, a total of seven new projects were presented for CSLF recognition. Subsequent to that meeting, one additional new project was also presented for CSLF recognition. All of those projects (listed below) were submitted for evaluation by an interim task force established by the Technical Group, consisting of the Technical Group Chair and Vice Chairs, the CSLF Secretariat, and Technical Group delegates from Australia, India and Japan. This task force screened the ten projects against the CSLF Project Recommendation Guidelines.

These eight projects are:

- Anoxic Microbial Sequestration of Carbon Dioxide Present in Flue Gases to Methane / Methanol / Other Biomass (India)
(note: India is the only sponsor of this project as of this date. CSLF Project Recommendation Guidelines require that any proposed project be sponsored by at least two CSLF Members.)
- CO₂ GeoNet (European Commission and United Kingdom)
- Demonstration of Capture, Injection and Geologic Sequestration of CO₂ in Basalt Formations of India (India and United States)
- Development of China's Coalbed Methane Technology / Carbon Dioxide Sequestration Project (Canada, Norway, and United States)
- ENCAP (European Commission, Germany, and France)
- Geologic CO₂ Storage Assurance at In Salah, Algeria (United Kingdom and Norway)
- Regional Carbon Sequestration Partnerships (United States and Canada)
- Regional Opportunities for CO₂ Capture and Storage in China (United States and China)

A short summary of each of these projects is provided in this document.

Action Requested

The Technical Group is requested to consider these projects for recognition.

Conclusion

The Technical Group is requested to note in the minutes of its next meeting that:

“All eight projects were considered for CSLF recognition by the Technical Group.”



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Anoxic Microbial Sequestration of Carbon Dioxide Present in Flue Gases to Methane / Methanol / Other Biomass

Nominators: India (lead)

(note: India is the only sponsor of this project as of this date. CSLF Project Recommendation Guidelines require that any proposed project be sponsored by at least two CSLF Members.)

The project seeks the use of microbes for conversion of carbon dioxide to methane. Microorganisms have a tremendous capacity to convert CO₂ to other useful metabolites in absence or in presence of negligible oxygen. In this process carbonic anhydrase plays an important role in having the atmospheric CO₂ to carbonate, a soluble source of carbon carbon for microorganisms, which is further metabolized to produce useful carbon compounds e.g., methane, methanol etc, which can be used to generate electricity. In this process, formate dehydrogenase plays a major role in the formation of hydrogen which is required for conversion of CO₂ to methane. Methane producing bacteria have considerable capacity to fix the CO₂ irrespective of presence or absence of light and convert around 80% of fixed CO₂ to methane and remaining 20% of CO₂ is utilized for building up of cell-mass. Using this kind of microbial system it may be possible to develop a sustainable process for sequestration of CO₂ coupled with some energy generation.

The project envisages using the latest tools in biotechnology for extraction of enzymes, immobilization of the enzymes, photocatalytic bioreactor and development of anoxic systems.

CO₂ GeoNet

Nominators: European Commission (lead) and United Kingdom

The project "CO₂ GeoNet" (13 institutes), which started in April 2004, contains a critical mass of research activity in the area of underground carbon dioxide (CO₂) storage. The rocks under the North Sea have a theoretical capacity for storing over 800Gt of CO₂.

The project focus of the project is on the geological storage of CO₂ as a greenhouse gas mitigation option (not capture). Project objectives include:

- To form a durable and complimentary partnership comprising of a critical mass of key European research centers whose expertise and capability becomes increasingly mutually interdependent. The initial partnership will be between 13 institutes, most of whom have a long and established history of research in geological sequestration. Some new collaborators are also included, either because they are expected to have significant national strategic profile in future

CO₂ storage projects, or have capabilities which can be realigned to strengthen the network, or even bring uniqueness. For the first time in an EC underground CO₂ storage project, marine biologists will be drawn into this research topic.

- To identify knowledge gaps and formulate new research projects and tools to fill these gaps.
- To provide the authoritative body, in Europe, for technical, impartial, high quality information on geological storage of CO₂, and in so doing enable public confidence in the technology, participate in policy & regulatory formulation and agreement on common standards.
- Provide training to strengthen the partners, bring in new network members and sustain a replacement supply of researchers for the future.

Demonstration of Capture, Injection and Geologic Sequestration of CO₂ in Basalt Formations of India

Nominators: India (lead) and United States

Geological storage has been recognized as an important way for CO₂ mitigation. India has very large basalt covered area. The thickness of the basalt trap cover varies from few hundred meters to thousands meter. Below this trap, thick sedimentary rocks (100-4,000 meters) are there. This project aims to develop necessary technological design and demonstration of deep bed injection of CO₂ and monitoring of CO₂ movement in the sedimentary rocks underlying the basalt formations. The experiments will comprise of selection of a basalt covered area with minimum trap thickness 600 meters underlain sedimentary rocks, injection of approximately 2,000 tons of CO₂ followed by monitoring and modeling. The project will involve intensive monitoring of the fate of the injected CO₂ using broad range of geo-physical and geo-chemical technique, the development of numerical models and leakage risk assessment.

The demonstration project will provide necessary technological know-how to store a large volume of CO₂ in a similar geologic environment in Indian subcontinent. The project will be carried through participation of National Laboratories: National Geo-physical Research Institute (NGRI), India, and Pacific Northwest National Laboratory, USA.

Development of China's Coalbed Methane Technology / Carbon Dioxide Sequestration Project

Nominators: Canada (lead), Norway and United States

This project will address unique issues related to the storage capacities in coalbeds and coalbed methane rate enhancement. The single well micro-pilot test will provide information on the coal reservoir including gas adsorption/desorption characteristics, injectivity variations, permeability changes and CO₂ storage capacities. Each coal basin is unique. However, the knowledge can be quickly applied and advance the enhanced coalbed methane (ECBM) technology to other coal basins in the world. The project does not include CO₂ capture technologies, but it includes an assessment of CO₂ sources in the area to supply CO₂ for potential commercial scale projects.

The project objective is to use the learning from the Alberta, Canada ECBM project to make improved estimates on the technology's technical performance, cost and benefits,

first in south Qinshui basin and to other coal basins in China. It is expected the information from the project would be sufficient to allow others to evaluate their own applications.

ENCAP

Nominators: European Commission (lead), Germany, and France

The ENCAP Project is collaboration between industry, authorities, universities and institutes. The project has the following specifications.

- The project was initiated in March 2004.
- It will end after 60 months in March 2009.
- The total budget is 22.7 million Euros.
- The EU is contributing 0.7 million Euros with industry contributing the rest.
- 29 organizations are cooperating in the project, 16 are industrial partners.

The project's overlying goals are:

- To develop promising pre-combustion CO₂ capture technologies. This includes O₂/CO₂ combustion technologies.
- To propose the most competitive demonstration plant technology, design, process scheme, and component choice in 2008.

The project contains 6 subprojects, each containing several work packages. The subprojects are:

Subproject 1 - Process and Power Systems

Subproject 2 - Pre-Combustion Decarbonisation Technologies

Subproject 3 - O₂/CO₂ combustion (Oxy-fuel) Boiler Technologies

Subproject 4 - Chemical Looping Combustion

Subproject 5 - High-Temperature Oxygen Generation for Power Cycles

Subproject 6 - Novel Pre-Combustion Capture Concepts

Geologic CO₂ Storage Assurance at In Salah, Algeria

Nominators: United Kingdom (lead) and Norway

In Salah Gas is a joint venture between Sonatrach, BP, and Statoil. The project recovers natural gas containing up to 10% CO₂ from several geological reservoirs in Algeria, processes the gas and delivers it to markets in Europe. As a result of the processing, 1 million metric tons per year CO₂ is produced, which is re-injected into a carboniferous sandstone reservoir at a depth of 1,800 metres. Over the life of the project, 17 million metric tons CO₂ will be geologically stored. This joint venture is an industrial-scale demonstration of CO₂ geological storage and will be the first project in the world to store CO₂ in a gas reservoir.

The overall objectives of the In Salah CO₂ Storage Project are:

- Demonstrate to stakeholders that industrial-scale geological storage of CO₂ is a viable greenhouse gas (GHG) mitigation option.
- Provide assurance that secure geological storage of CO₂ can be cost-effectively verified and that long-term assurance can be provided by short-term monitoring.
- Set precedents for the regulation and verification of the geological storage of CO₂.

The In Salah project is expected to last five years with a total cost of \$30 million, and provides the opportunity to build on the experience from the Sleipner and Weyburn projects.

Scientific and Technical Objectives:

- Develop a detailed dataset on the performance of CO₂ storage. This will provide a resource for the testing, development and benchmarking of tools for the prediction of performance of long-term geological storage of CO₂.
- Provide a field-scale example to inform discussions on the verification and regulation of geological storage systems.
- Test technology options for the early detection of low-level seepage of CO₂ out of the primary containment to enable intervention and maintain the integrity of long-term storage.
- Evaluate a range of monitoring options and develop guidelines for an appropriate and cost-effective, long-term monitoring methodology.
- Quantify the interaction of CO₂ re-injection and hydrocarbon production for the strategically important option of long-term storage in oil and gas fields.

Near-term deliverables (year 1):

Establish the CO₂ baseline. Develop and agree the tools, technologies, techniques and management systems required to cost-effectively demonstrate, safe, secure and verifiable CO₂ storage.

Longer-term deliverables (years 2-5):

Carry out the commercial-scale demonstration of the cost-effective application of those technologies to provide an appropriate level of storage assurance. The work program would be split into the following sub-tasks:

- Imaging CO₂ Migration
- Well Based Monitoring
- Rock / Fluid Interactions
- Surface (Geologic) Seepage
- Surface Seepage
- Integration and Risk Assessment
- Communications

Regional Carbon Sequestration Partnerships

Nominators: United States (lead) and Canada

The Regional Carbon Sequestration Partnerships began in September 2003 and represents the collaboration of industry and the research community to help identify and test the most promising opportunities to implement sequestration technologies in the United States and Canada. Seven organizations were selected for funding by the U.S.

Department of Energy (DOE) Office of Fossil Energy to lead Partnerships comprising 40 states, 4 Canadian Provinces, and 3 Native American Nations. The Regional Partnerships consist of over 240 organizations from the United States and six other CSLF countries.

Results from Phase I of the Partnerships have identified over 600Gt of storage capacity in domestic geologic formations, which is enough capacity to store several centuries worth of U.S. point source emissions. These formations include saline reservoirs, depleted oil

and gas fields, coal seams, shale, and basalt formations. Additional characterization during Phase II is expected to identify more potential sinks and refine the estimates determined during Phase I.

The Partnerships have several objectives during the two Phases of the Project through 2009:

- Conduct field validation tests of specific sequestration technology(ies) and infrastructure concepts within the different regions of the United States. As the result of Phase I, regional characterization efforts the Partnerships have identified 25 geologic sequestration projects, including:
 - 4 stacked saline/enhanced oil recover reservoir sequestration tests
 - 6 saline reservoir sequestration tests
 - 6 coal seam sequestration tests with enhanced coal bed methane
 - 8 depleted oil field sequestration tests with enhanced oil recovery (EOR)
 - 1 depleted gas field sequestration tests with enhanced gas recovery
- Refine and implement appropriate measurement, monitoring and verification (MMV) protocols for sequestration projects. Each field test will be required to develop sampling protocols for the most appropriate technologies to conduct MMV at a sequestration project while satisfying both U.S. voluntary reporting guidelines as well as international registries in Canada.
- Characterize the regions to determine the technical and economic storage capacity. Each partnership has developed regional atlases that are being used to estimate storage capacity and link sources with potential sink using decision support tools.
- Implement and continue to research what the regulatory compliance requirements will be for each type of sequestration technology. Partnerships are working to implement action plans to outline and satisfy project permitting requirements to conduct the field validation tests.
- Implement Carbon Sequestration Public Outreach and Education Mechanisms. Each partnership is working to implement action plans to provide outreach and education mechanisms that raise the awareness of sequestration opportunities in the region and provide interested stakeholders with information about existing and future efforts that may be performed applicable to the region.
- At the conclusion of Phase II each of the Partnerships will identify the commercially available sequestration technologies ready for large scale deployment. Implementation plans will include a description of the technology, best management and operating practices, appropriate monitoring protocols, and steps for regulatory compliance and public outreach.
- Facilitate integration of ideas between the partnerships through working groups and review meetings and identify areas for future research.

Regional Opportunities for CO₂ Capture and Storage in China

Nominators: United States (lead) and China

This is a collaborative project which will characterize the technical and economic potential of carbon dioxide capture and storage (CCS) technologies in China. A multinational team will compile key characteristics of large anthropogenic CO₂ sources (including power generation, iron and steel plants, cement kilns, petroleum and chemical

refineries, etc.) as well as candidate geologic storage formations that exist across China, developing estimates of geologic CO₂ storage capacities.

A proven methodology previously developed under the auspices of the IEA Greenhouse Gas R&D Programme will be modified as appropriate and applied to assess the distribution of CO₂ storage potential within China, and the infrastructure needs and costs associated with capturing CO₂ from storage reservoirs. The goal of the project is to characterize the technical and economic potential of CCS in China, and assess the ability of geologic CO₂ storage to help mitigate current and future CO₂ emissions there.

This project is coordinated through the U.S./China Energy and Environmental Technology Center (EETC). Preliminary activities are underway, including initial data collection and mapping of CO₂ storage reservoirs, along with efforts to adapt and refine the assessment methodology for China. Funding for the project has been approved and additional funding is expected in 2005 to accelerate the effort.

Note: "Lead Nominator" in this usage indicates the CSLF Member which proposed the project.

The Carbon Sequestration Leadership Forum (CSLF) is a framework for international cooperation in the research and development for the separation, capture, transportation and storage of carbon dioxide. The CSLF seeks to make carbon capture and storage commercially competitive and environmentally safe. The CSLF Charter does not create any legally binding obligations by, between or among the governments and entities that are Members of the CSLF or that participate in CSLF activities, and each CSLF Member's participation in CSLF activities is subject to its laws, regulations, availability of funds, personnel and other resources of the respective Member.