



Active and Completed CSLF Recognized Projects

(as of December 2011)

1. Alberta Enhanced Coal-Bed Methane Recovery Project (*Completed*)

Nominators: Canada (lead), United States, and United Kingdom

This pilot-scale project, located in Alberta, Canada, aimed at demonstrating, from both economic and environmental criteria, the overall feasibility of coal bed methane (CBM) production and simultaneous CO₂ storage in deep unmineable coal seams. Specific objectives of the project were to determine baseline production of CBM from coals; determine the effect of CO₂ injection and storage on CBM production; assess economics; and monitor and trace the path of CO₂ movement by geochemical and geophysical methods. All testing undertaken was successful, with one important conclusion being that flue gas injection appears to enhance methane production to a greater degree possible than with CO₂ while still sequestering CO₂, albeit in smaller quantities.

Recognized by the CSLF at its Melbourne meeting, September 2004

2. CANMET Energy Technology Centre (CETC) R&D Oxyfuel Combustion for CO₂ Capture

Nominators: Canada (lead) and United States

This is a pilot-scale project, located in Ontario, Canada, that will demonstrate oxy-fuel combustion technology with CO₂ capture. The goal of the project is to develop energy-efficient integrated multi-pollutant control, waste management and CO₂ capture technologies for combustion-based applications and to provide information for the scale-up, design and operation of large-scale industrial and utility plants based on the oxy-fuel concept.

Recognized by the CSLF at its Melbourne meeting, September 2004

3. CASTOR (*Completed*)

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

This was a multifaceted project that had activities at various sites in Europe, in three main areas: strategy for CO₂ reduction, post-combustion capture, and CO₂ storage performance and risk assessment studies. The goal was to reduce the cost of post-combustion CO₂ capture and to develop and validate, in both public and private partnerships, all the innovative technologies needed to capture and store CO₂ in a reliable and safe way. The tests showed the reliability and efficiency of the post-combustion capture process.

Recognized by the CSLF at its Melbourne meeting, September 2004

4. CCS Belchatów Project

Nominators: Poland (lead), European Commission, and United States

This is a large-scale project, located in central Poland, which will demonstrate commercial-scale CO₂ capture, transport and storage at a new lignite-fired power plant unit. The project will demonstrate the full CCS value chain, including capture, transport, and safe geological storage of up to 1.8 million tonnes of CO₂ per year. Project components include identification of potential issues related to intellectual property,

storage site selection, permitting, facilities and pipeline construction, and public engagement activities. Success of this project will expedite commercialization of CCS for large-scale fossil fuel power generation.

Recognized by the CSLF at its Warsaw meeting, October 2010

5. CCS Northern Netherlands Project

Nominators: Netherlands (lead) and Norway

This project will implement a large-scale regional plan for capture, transport and storage of CO₂ around the Eemsharbor complex in Groningen province in the northern part of the Netherlands. The project will capture CO₂ from existing and planned power plants, transport the CO₂ to the storage location, and store the CO₂ safely underground in on-shore and off-shore natural gas fields. The project represents all elements of the CCS chain (capture, transport, reuse and storage), as well as including all CO₂ capture techniques (pre-combustion, post-combustion and oxyfuel combustion). Additionally, the project will develop a communication strategy, engage stakeholders, and work toward developing a legal framework for CCS in the region.

Recognized by the CSLF at its London meeting, October 2009

6. CCS Rotterdam Project

Nominators: Netherlands (lead) and Germany

This project will implement a large-scale “CO₂ Hub” for capture, transport, utilization, and storage of CO₂ in the Rotterdam metropolitan area. The project is part of the Rotterdam Climate Initiative (RCI), which has a goal of reducing Rotterdam’s CO₂ emissions by 50% by 2025 (as compared to 1990 levels). A “CO₂ cluster approach” will be utilized, with various point sources (e.g., CO₂ captured from power plants) connected via a hub / manifold arrangement to multiple storage sites such as depleted gas fields under the North Sea. This will reduce the costs for capture, transport and storage compared to individual CCS chains. The project will also work toward developing a policy and enabling framework for CCS in the region.

Recognized by the CSLF at its London meeting, October 2009

7. CGS Europe Project

Nominators: Netherlands (lead) and Germany

This is a collaborative venture, involving 35 partners from participant countries in Europe, with extensive structured networking, knowledge transfer, and information exchange. A goal of the project is to create a durable network of experts in CO₂ geological storage and a centralized knowledge base which will provide an independent source of information for European and international stakeholders. The CGS Europe Project is intended to provide an information pathway toward large-scale implementation of CO₂ geological storage throughout Europe. This is intended to be a three-year project, starting in November 2011, and has received financial support from the European Commission’s 7th Framework Programme (FP7).

Recognized by the CSLF at its Beijing meeting, September 2011

8. China Coalbed Methane Technology/CO₂ Sequestration Project (Completed)

Nominators: Canada (lead), United States, and China

This pilot-scale project successfully demonstrated that coal seams in the anthracitic coals of Shanxi Province of China are permeable and stable enough to absorb CO₂ and enhance methane production, leading to a clean energy source for China. The project evaluated reservoir properties of selected coal seams of the Qinshui Basin of eastern China and carried out field testing at relatively low CO₂ injection rates. The project

recommendation was to proceed to full scale pilot test at south Qinshui, as the prospect in other coal basins in China is good.

Recognized by the CSLF at its Berlin meeting, September 2005

9. CO₂ Capture Project – Phase 2 (Completed)

Nominators: United Kingdom (lead), Italy, Norway, and United States

This pilot-scale project continued the development of new technologies to reduce the cost of CO₂ separation, capture, and geologic storage from combustion sources such as turbines, heaters and boilers. These technologies will be applicable to a large fraction of CO₂ sources around the world, including power plants and other industrial processes. The ultimate goal of the entire project is to reduce the cost of CO₂ capture from large fixed combustion sources by 20-30%, while also addressing critical issues such as storage site/project certification, well integrity and monitoring.

Recognized by the CSLF at its Melbourne meeting, September 2004

10. CO₂ Capture Project – Phase 3

Nominators: United Kingdom (lead) and United States

This is a collaborative venture of seven partner companies (international oil and gas producers) plus the Electric Power Research Institute. The overall goals of the project are to increase technical and cost knowledge associated with CO₂ capture technologies, to reduce CO₂ capture costs by 20-30%, to quantify remaining assurance issues surrounding geological storage of CO₂, and to validate cost-effectiveness of monitoring technologies. The project is comprised of four areas: CO₂ Capture; Storage Monitoring & Verification; Policy & Incentives; and Communications. A fifth activity, in support of these four teams, is Economic Modeling. This third phase of the project will include at least two field demonstrations of CO₂ capture technologies and a series of monitoring field trials in order to obtain a clearer understanding of how to monitor CO₂ in the subsurface. Third phase activities began in 2009 and are expected to continue into 2013. Financial support is being provided by project consortium members.

Recognized by the CSLF at its Beijing meeting, September 2011

11. CO₂CRC Otway Project

Nominators: Australia (lead) and United States

This is a pilot-scale project, located in southwestern Victoria, Australia, that involves transport and injection of approximately 100,000 tons of CO₂ over a two year period into a depleted natural gas well. Besides the operational aspects of processing, transport and injection of a CO₂-containing gas stream, the project also includes development and testing of new and enhanced monitoring, and verification of storage (MMV) technologies, modeling of post-injection CO₂ behavior, and implementation of an outreach program for stakeholders and nearby communities. Data from the project will be used in developing a future regulatory regime for CO₂ capture and storage (CCS) in Australia.

Recognized by the CSLF at its Paris meeting, March 2007

12. CO₂ Field Lab Project

Nominators: Norway (lead), France, and United Kingdom

This is a pilot-scale project, located at Svelvik, Norway, which will investigate CO₂ leakage characteristics in a well-controlled and well-characterized permeable geological formation. Relatively small amounts of CO₂ will be injected to obtain underground distribution data that resemble leakage at different depths. The resulting underground CO₂ distribution will resemble leakages and will be monitored with an extensive set of methods deployed by the project partners. The main objective is to assure and increase

CO₂ storage safety by obtaining valuable knowledge about monitoring CO₂ migration and leakage. The outcomes from this project will help facilitate commercial deployment of CO₂ storage by providing the protocols for ensuring compliance with regulations, and will help assure the public about the safety of CO₂ storage by demonstrating the performance of monitoring systems.

Recognized by the CSLF at its Warsaw meeting, October 2010

13. CO₂ GeoNet

Nominators: European Commission (lead) and United Kingdom

This multifaceted project is focused on geologic storage options for CO₂ as a greenhouse gas mitigation option, and on assembling an authoritative body for Europe on geologic sequestration. Major objectives include formation of a partnership consisting, at first, of 13 key European research centers and other expert collaborators in the area of geological storage of CO₂, identification of knowledge gaps in the long-term geologic storage of CO₂, and formulation of new research projects and tools to eliminate these gaps. This project will result in re-alignment of European national research programs and prevention of site selection, injection operations, monitoring, verification, safety, environmental protection, and training standards.

Recognized by the CSLF at its Berlin meeting, September 2005

14. CO₂ Separation from Pressurized Gas Stream

Nominators: Japan (lead) and United States

This is a small-scale project that will evaluate processes and economics for CO₂ separation from pressurized gas streams. The project will evaluate primary promising new gas separation membranes, initially at atmospheric pressure. A subsequent stage of the project will improve the performance of the membranes for CO₂ removal from the fuel gas product of coal gasification and other gas streams under high pressure.

Recognized by the CSLF at its Melbourne meeting, September 2004

15. CO₂ SINK (Completed)

Nominators: European Commission (lead) and Germany

This is a pilot-scale project that tested and evaluated CO₂ capture and storage at an existing natural gas storage facility and in a deeper land-based saline formation. A key part of the project was monitoring the migration characteristics of the stored CO₂. The project was successful in advancing the understanding of the science and practical processes involved in underground storage of CO₂ and provided real case experience for use in development of future regulatory frameworks for geological storage of CO₂.

Recognized by the CSLF at its Melbourne meeting, September 2004

16. CO₂ STORE (Completed)

Nominators: Norway (lead) and European Commission

This project, a follow-on to the Sleipner project, involved the monitoring of CO₂ migration (involving a seismic survey) in a saline formation beneath the North Sea and additional studies to gain further knowledge of geochemistry and dissolution processes. There were also several preliminary feasibility studies for additional geologic settings of future candidate project sites in Denmark, Germany, Norway, and the UK. The project was successful in developing sound scientific methodologies for the assessment, planning, and long-term monitoring of underground CO₂ storage, both onshore and offshore.

Recognized by the CSLF at its Melbourne meeting, September 2004

17. Demonstration of an Oxyfuel Combustion System

Nominators: United Kingdom (lead) and France

This project, located at Renfrew, Scotland, UK, will demonstrate oxyfuel technology on a full-scale 40-megawatt burner. The goal of the project is to gather sufficient data to establish the operational envelope of a full-scale oxyfuel burner and to determine the performance characteristics of the oxyfuel combustion process at such a scale and across a range of operating conditions. Data from the project will be used to develop advanced computer models of the oxyfuel combustion process, which will be utilized in the design of large oxyfuel boilers.

Recognized by the CSLF at its London meeting, October 2009

18. Dynamis (Completed)

Nominators: European Commission (lead), and Norway

This was the first phase of the multifaceted European Hypogen program, which will result in the construction and operation of an advanced commercial-scale power plant with hydrogen production and CO₂ management. The overall aim is for operation and validation of the power plant during the 2012-2015 timeframe. The Dynamis project assessed the various options for large-scale hydrogen production while focusing on the technological, economic, and societal issues.

Recognized by the CSLF at its Cape Town meeting, April 2008

19. ENCAP (Completed)

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

This multifaceted research project consisted of six sub-projects: Process and Power Systems, Pre-Combustion Decarbonization Technologies, O₂/CO₂ Combustion (Oxy-fuel) Boiler Technologies, Chemical Looping Combustion (CLC), High-Temperature Oxygen Generation for Power Cycles, and Novel Pre-Combustion Capture Concepts. The goals were to develop promising pre-combustion CO₂ capture technologies (including O₂/CO₂ combustion technologies) and propose the most competitive demonstration power plant technology, design, process scheme, and component choices. All sub-projects were successfully completed by March 2009.

Recognized by the CSLF at its Berlin meeting, September 2005

20. European CO₂ Technology Centre Mongstad (TCM) Project

Nominators: Norway (lead) and Netherlands

This is a large-scale project (100,000 tonnes per year CO₂ capacity) that will establish a facility for parallel testing of amine-based and chilled ammonia CO₂ capture technologies from two flue gas sources with different CO₂ contents. The goal of the project is to reduce cost and technical, environmental, and financial risks related to large scale CO₂ capture, while allowing evaluation of equipment, materials, process configurations, different capture solvents, and different operating conditions. The project will result in validation of process and engineering design for full-scale application and will provide insight into other aspects such as thermodynamics, kinetics, engineering, materials of construction, and health / safety / environmental (HSE).

Recognized by the CSLF at its London meeting, October 2009

21. Fort Nelson Carbon Capture and Storage Project

Nominators: Canada (lead) and United States

This is a large-scale project in northeastern British Columbia, Canada, which will permanently sequester approximately two million tonnes per year CO₂ emissions from a large natural gas-processing plant into deep saline formations of the Western Canadian

Sedimentary Basin (WCSB). Goals of the project are to verify and validate the technical and economic feasibility of using brine-saturated carbonate formations for large-scale CO₂ injection and demonstrate that robust monitoring, verification, and accounting (MVA) of a brine-saturated CO₂ sequestration project can be conducted cost-effectively. The project will also develop appropriate tenure, regulations, and MVA technologies to support the implementation of future large-scale sour CO₂ injection into saline-filled deep carbonate reservoirs in the northeast British Columbia area of the WCSB.

Recognized by the CSLF at its London meeting, October 2009

22. Frio Project (Completed)

Nominators: United States (lead) and Australia

This pilot-scale project demonstrated the process of CO₂ sequestration in an on-shore underground saline formation in Eastern Texas, USA. This location was ideal, as very large scale sequestration may be needed in the area to significantly offset anthropogenic CO₂ releases. The project involved injecting relatively small quantities of CO₂ into the formation and monitoring its movement for several years thereafter. The goals were to verify conceptual models of CO₂ sequestration in such geologic structures; demonstrate that no adverse health, safety or environmental effects will occur from this kind of sequestration; demonstrate field-test monitoring methods; and develop experience necessary for larger scale CO₂ injection experiments.

Recognized by the CSLF at its Melbourne meeting, September 2004

23. Geologic CO₂ Storage Assurance at In Salah, Algeria

Nominators: United Kingdom (lead) and Norway

This multifaceted project will develop the tools, technologies, techniques and management systems required to cost-effectively demonstrate, safe, secure, and verifiable CO₂ storage in conjunction with commercial natural gas production. The goals of the project are to develop a detailed dataset on the performance of CO₂ storage; provide a field-scale example on the verification and regulation of geologic storage systems; test technology options for the early detection of low-level seepage of CO₂ out of primary containment; evaluate monitoring options and develop guidelines for an appropriate and cost-effective, long-term monitoring methodology; and quantify the interaction of CO₂ re-injection and hydrocarbon production for long-term storage in oil and gas fields.

Recognized by the CSLF at its Berlin meeting, September 2005

24. Gorgon CO₂ Injection Project

Nominators: Australia (lead), Canada, and United States

This is a large-scale project that will store approximately 120 million tonnes of CO₂ in a water-bearing sandstone formation two kilometers below Barrow Island, off the northwest coast of Australia. The CO₂ stored by the project will be extracted from natural gas being produced from the nearby Gorgon Field and injected at approximately 3.5 to 4 million tonnes per year. There is an extensive integrated monitoring plan, and the objective of the project is to demonstrate the safe commercial-scale application of greenhouse gas storage technologies at a scale not previously attempted. The project has already progressed through its early development stages including site selection and appraisal, and is fully funded. Injection operations are expected to commence by the end of 2014.

Recognized by the CSLF at its Warsaw meeting, October 2010

25. IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project

Nominators: Canada and United States (leads) and Japan

This is a large-scale project that will utilize CO₂ for enhanced oil recovery (EOR) at a Canadian oil field. The goal of the project is to determine the performance and undertake a thorough risk assessment of CO₂ storage in conjunction with its use in enhanced oil recovery. The work program will encompass four major technical themes of the project: geological integrity; wellbore injection and integrity; storage monitoring methods; and risk assessment and storage mechanisms. Results from these technical themes, when integrated with policy research, will result in a Best Practices Manual for future CO₂ Enhanced Oil Recovery projects.

Recognized by the CSLF at its Melbourne meeting, September 2004

26. ITC CO₂ Capture with Chemical Solvents Project

Nominators: Canada (lead) and United States

This is a pilot-scale project that will demonstrate CO₂ capture using chemical solvents. Supporting activities include bench and lab-scale units that will be used to optimize the entire process using improved solvents and contactors, develop fundamental knowledge of solvent stability, and minimize energy usage requirements. The goal of the project is to develop improved cost-effective technologies for separation and capture of CO₂ from flue gas.

Recognized by the CSLF at its Melbourne meeting, September 2004

27. Lacq Integrated CCS Project

Nominators: France (lead) and Canada

This is an intermediate-scale project that will test and demonstrate an entire integrated CCS process, from emissions source to underground storage in a depleted gas field. The project will capture and store 60,000 tonnes per year of CO₂ for two years from an oxyfuel industrial boiler in the Lacq industrial complex in southwestern France. The goal is demonstrate the technical feasibility and reliability of the integrated process, including the oxyfuel boiler, at an intermediate scale before proceeding to a large-scale demonstration. The project will also include geological storage qualification methodologies, as well as monitoring and verification techniques, to prepare future larger-scale long term CO₂ storage projects.

Recognized by the CSLF at its London meeting, October 2009

28. Quest CCS Project

Nominators: Canada (lead), United Kingdom, and United States

This is a large-scale project, located at Fort Saskatchewan, Alberta, Canada, with integrated capture, transportation, storage, and monitoring, which will capture and store up to 1.2 million tonnes per year of CO₂ from an oil sands upgrading unit. The CO₂ will be transported via pipeline and stored in a deep saline aquifer in the Western Sedimentary Basin in Alberta, Canada. This is a fully integrated project, intended to significantly reduce the carbon footprint of the commercial oil sands upgrading facility while developing detailed cost data for projects of this nature. This will also be a large-scale deployment of CCS technologies and methodologies, including a comprehensive measurement, monitoring and verification (MMV) program.

Recognized by the CSLF at its Warsaw meeting, October 2010

29. Regional Carbon Sequestration Partnerships

Nominators: United States (lead) and Canada

This multifaceted project will identify and test the most promising opportunities to implement sequestration technologies in the United States and Canada. There are seven different regional partnerships, each with their own specific program plans, which will conduct field validation tests of specific sequestration technologies and infrastructure concepts; refine and implement (via field tests) appropriate measurement, monitoring and verification (MMV) protocols for sequestration projects; characterize the regions to determine the technical and economic storage capacities; implement and continue to research the regulatory compliance requirements for each type of sequestration technology; and identify commercially available sequestration technologies ready for large scale deployment.

Recognized by the CSLF at its Berlin meeting, September 2005

30. Regional Opportunities for CO₂ Capture and Storage in China (Completed)

Nominators: United States (lead) and China

This project characterized the technical and economic potential of CO₂ capture and storage technologies in China. The goals were to 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, and to develop estimates of geologic CO₂ storage capacities in China. The project found 2,300 gigatons of potential CO₂ storage capacity in onshore Chinese basins, significantly more than previous estimates. Another important finding is that the heavily developed coastal areas of the East and South Central regions appear to have less access to large quantities of onshore storage capacity than many of the inland regions. These findings present the possibility for China's continued economic growth with coal while safely and securely reducing CO₂ emissions to the atmosphere.

Recognized by the CSLF at its Berlin meeting, September 2005

31. Rotterdam Opslag en Afvang Demonstratieproject (ROAD)

Nominators: Netherlands (lead) and the European Commission

This is a large-scale integrated project, located near the city of Rotterdam in the Netherlands, which includes CO₂ capture from a coal-fueled power plant, pipeline transportation of the CO₂, and offshore storage of the CO₂ in a depleted natural gas reservoir beneath the seabed of the North Sea (approximately 20 kilometers from the power plant). The goal of the project is to demonstrate the feasibility of a large-scale, integrated CCS project while addressing the various technical, legal, economic, organizational, and societal aspects of the project. ROAD will result in the capture and storage of approximately 1.1 million tonnes of CO₂ annually over a five year span starting in 2015. Subsequent commercial operation is anticipated, and there will be continuous knowledge sharing. This project has received financial support from the European Energy Programme for Recovery (EPR), the Dutch Government, and the Global CCS Institute, and is a component of the Rotterdam Climate Initiative CO₂ Transportation Network.

Recognized by the CSLF at its Beijing meeting, September 2011

32. SaskPower Integrated CCS Demonstration Project at Boundary Dam Unit 3

Nominators: Canada (lead) and the United States

This is a large-scale project, located in the southeastern corner of Saskatchewan Province in Canada, which will be the first application of full stream CO₂ recovery from flue gas of a 139 megawatt coal-fueled power plant unit. A major goal is to demonstrate that a post-combustion CO₂ capture retrofit on a commercial power plant can achieve optimal integration with the thermodynamic power cycle and with power production at full commercial scale. The project will result in capture of approximately one million tonnes of CO₂ per year, which will be sold to oil producers for enhanced oil recovery (EOR) and injected into a deep saline aquifer. Commissioning of the reconfigured power plant unit is expected by early 2014. The project has received financial support from the Government of Canada and the Saskatchewan Provincial Government, and SaskPower is investing additional funds for refurbishment of the power plant unit and installation of the CO₂ capture system.

Recognized by the CSLF at its Beijing meeting, September 2011

33. SECARB Early Test at Cranfield Project

Nominators: United States (lead) and Canada

This is a large-scale project, located near Natchez, Mississippi, USA, which involves transport, injection, and monitoring of approximately one million tonnes of CO₂ per year into a deep saline reservoir associated with a commercial enhanced oil recovery operation, but the focus of this project will be on the CO₂ storage and monitoring aspects. The project will promote the building of experience necessary for the validation and deployment of carbon sequestration technologies in the United States, and will increase technical competence and public confidence that large volumes of CO₂ can be safely injected and stored. Components of the project also include public outreach and education, site permitting, and implementation of an extensive data collection, modeling, and monitoring plan. This “early” test will set the stage for a subsequent large-scale integrated project that will involve post-combustion CO₂ capture, transportation via pipeline, and injection into a deep saline formation.

Recognized by the CSLF at its Warsaw meeting, October 2010

34. Zama Acid Gas EOR, CO₂ Sequestration, and Monitoring Project

Nominators: Canada (lead) and United States

This is a pilot-scale project that involves utilization of acid gas (approximately 70% CO₂ and 30% hydrogen sulfide) derived from natural gas extraction for enhanced oil recovery. Project objectives are to predict, monitor, and evaluate the fate of the injected acid gas; to determine the effect of hydrogen sulfide on CO₂ sequestration; and to develop a “best practices manual” for measurement, monitoring, and verification of storage (MMV) of the acid gas. Acid gas injection was initiated in December 2006 and will result in sequestration of about 25,000 tons (or 375 million cubic feet) of CO₂ per year.

Recognized by the CSLF at its Paris meeting, March 2007

35. Zero Emission Porto Tolle Project (ZEPT)

Nominators: Italy (lead) and European Commission

This is a large-scale project, located in northeastern Italy, which will demonstrate post-combustion CCS on 40% of the flue gas from one of the three 660 megawatt units of the existing Porto Tolle Power Plant (which is being converted from heavy oil fuel to coal). The goal of the project is to demonstrate industrial application of CO₂ capture and geological storage for the power sector at full commercial scale. The demonstration plant will be operated for an extended period (approx. 10 years) in order to fully demonstrate

the technology on an industrial scale, clarify the real costs of CCS, and prove the retrofit option for high-efficiency coal fired units which will be built (or replaced) in the coming 10-15 years. Storage of approx. 1 million tonnes per year of CO₂ will take place in a deep saline aquifer beneath the seabed of the Adriatic Sea approx. 100 kilometers from the project site.

Recognized by the CSLF at its Beijing meeting, September 2011

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