



## **CSLF Recognized Projects**

The 30 projects formally recognized by the international Carbon Sequestration Leadership Forum bring together developed and developing nations in a collaborative quest to curtail manmade emissions of the greenhouse gas CO<sub>2</sub>. All are aimed at gathering the knowledge and experience required to initiate widespread carbon capture and to conduct safe, secure geologic storage on the order of thousands of years.

### **Projects Recognized by the CSLF:**

1. **TXE Carbon Management and Gasification Project** (Beaumont, Texas, USA). The goal of this project is to commercialize an industrial gasification plant that will capture several million tons per year of carbon dioxide (CO<sub>2</sub>). The plant will be built in Beaumont, Texas by TX Energy, LLC, a wholly-owned subsidiary of Eastman Chemical Company. The project will gasify petroleum residue (petcoke) to produce synthesis gas (a mixture of CO and H<sub>2</sub>) for use in production of industrial materials such as hydrogen, methanol and ammonia. Most of the CO<sub>2</sub> generated by the gasification process will be captured as a concentrated stream for sequestration in enhanced oil recovery or other geologic sequestration applications.  
*Recognized by the CSLF at its London meeting, October 2009*
2. **ZeroGen Project** (Emerald, Queensland, Australia). The ZeroGen project will develop a commercial scale IGCC power station with carbon capture and storage. The power plant will be located at a “mine-mouth” site in the southern Bowen Basin. CO<sub>2</sub> storage is slated to occur in the northern Denison Trough in central Queensland. ZeroGen is a Queensland Government-owned corporation whose mandate is to implement the design and construction of a commercial scale IGCC power station, and to capture and store the CO<sub>2</sub> emissions within deep saline aquifers.  
*Recognized by the CSLF at its London meeting, October 2009*
3. **Fort Nelson Carbon Capture and Storage (CCS) Project** (Fort Nelson, British Columbia, Canada). The goal of the Fort Nelson CCS Project is to permanently sequester CO<sub>2</sub> emissions from Spectra’s Fort Nelson natural gas-processing plant, estimated to be 2.0 Mt per year, in the deep saline formations of the Western Canadian Sedimentary Basin. The Fort Nelson CCS Project is a partnership initiative of Spectra Energy Transmission, the Energy & Environmental Research Center Plains CO<sub>2</sub> Reduction Partnership, the Province of British Columbia, and the Government of Canada. If proven feasible, the project would be one of the first commercial-scale CCS projects to inject over one million tonnes per year of CO<sub>2</sub> into a brine-saturated formation in North America, making it one of the largest CCS projects in the world.  
*Recognized by the CSLF at its London meeting, October 2009*

4. **CO<sub>2</sub> Storage in the Limburg Coal and Sandstone Layers** (Geleen, Limburg, Netherlands). The goal of this project is to store by-product CO<sub>2</sub> produced from two ammonia plants into porous sandstone and coal layers 1-2 km deep. It is believed the technology can be used for other European locations where large amounts of CO<sub>2</sub> are produced (heavy industry, chemical complexes, steel industry) in areas where coal and sandstone layers are present.  
*Recognized by the CSLF at its London meeting, October 2009*
5. **CCS Rotterdam** (Rotterdam, Netherlands). The Rotterdam Climate Initiative wants to achieve 50% emission reduction in CO<sub>2</sub> in 2025 (compared to 1990). The CCS project is an essential part of that ambition. It aims to achieve an annual capture and storage of 20 Mt in 2025. Rotterdam offers a favorable location for a CCS network due to the concentration of industrial emissions in the Port of Rotterdam area and the Port's proximity to significant volumes of storage capacity, both offshore (on the Dutch continental shelf) and onshore.  
*Recognized by the CSLF at its London meeting, October 2009*
6. **The European CO<sub>2</sub> Technology Centre Mongstad** (Mongstad, Norway). The European CO<sub>2</sub> Technology Centre Mongstad will be a test and demonstration facility for CO<sub>2</sub> capture from flue gases. The facility will comprise two capture technologies; an amine plant and a chilled ammonia plant with a total capacity of 100,000 tons of CO<sub>2</sub>.  
*Recognized by the CSLF at its London meeting, October 2009*
7. **CCS Northern Netherlands** (Groningen, Netherlands). Achieve significant CO<sub>2</sub> reductions in the short term, but also place the Northern Netherlands on the map as a leading region with respect to energy innovation. The Northern Netherlands provides excellent perspectives for the development of a national and international CO<sub>2</sub> cluster. In addition to an extensive knowledge network, the region offers large potential storage locations and there are plans to build multiple large CO<sub>2</sub> point sources. Furthermore, the region offers both onshore and offshore possibilities for the storage of CO<sub>2</sub>.  
*Recognized by the CSLF at its London meeting, October 2009*
8. **Demonstration of an Oxyfuel Combustion Systems** (Renfrew, Scotland, United Kingdom). The project goal is to demonstrate oxyfuel technology on a full-scale 40MW burner, making it the largest demonstration of oxyfuel combustion in the world.  
*Recognized by the CSLF at its London meeting, October 2009*
9. **Lacq CO<sub>2</sub> Capture and Storage Project** (Lacq, France). The project is the first French industrial scale operation that will test and demonstrate an entire CO<sub>2</sub> capture and storage process, from the CO<sub>2</sub> emissions source (an oxyboiler) to an underground storage in an onshore depleted gas field. The capture portion of the project will take place in the industrial complex of Lacq, a town located in the South West of France in the Pyrénées-Atlantiques department in the Aquitaine Region; and the storage at Jurançon, 30 km away from Lacq and south of the city of Pau.  
*Recognized by the CSLF at its London meeting, October 2009*

**10. Heartland Area Redwater Project** (Redwater, Alberta, Canada). The HARP will implement, on a commercial scale, storage in a brine-saturated carbonate reef. The project is led by ARC Resources, Ltd., a Canadian oil company. The project will take CO<sub>2</sub> from various emitters in the industrial heartland of Alberta, such as fertilizer plants, chemical and petrochemical plants, refineries and oil sands upgrading facilities (e.g., hydrogen plants). The storage target is a very large carbonate reef with an estimated storage capacity of several hundreds of million tonnes of CO<sub>2</sub>.

*Recognized by the CSLF at its London meeting, October 2009*

**11. Alberta Enhanced Coal-Bed Methane Recovery Project** (completed)

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

This pilot-scale project is aimed at demonstrating, from both economic and environmental criteria, the overall feasibility of coal bed methane (CBM) production and simultaneous CO<sub>2</sub> storage in deep unmineable coal seams. Specific objectives of the project are to determine baseline production of CBM from coals; determine the effect of CO<sub>2</sub> injection and storage on CBM production; assess economics; and monitor and trace the path of CO<sub>2</sub> movement by geochemical and geophysical methods.

*Recognized by the CSLF at its Melbourne meeting, September 2004*

**12. CANMET Energy Technology Centre (CETC) R&D Oxyfuel Combustion for CO<sub>2</sub>**

*Nominators: Canada (lead) and United States*

This is a pilot-scale project that will demonstrate oxyfuel combustion technology with CO<sub>2</sub> capture. The goal of the project is to develop energy-efficient integrated multi-pollutant control, waste management and CO<sub>2</sub> 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*

**13. CASTOR** (completed)

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

This is a multifaceted project that has activities in three main areas: strategy for CO<sub>2</sub> reduction, post-combustion capture, and CO<sub>2</sub> storage performance and risk assessment studies. The goal of the project is to reduce the cost of post-combustion CO<sub>2</sub> capture and to develop and validate, in public/private partnerships, all the innovative technologies needed to capture and store CO<sub>2</sub> in a reliable and safe way.

*Recognized by the CSLF at its Melbourne meeting, September 2004*

**14. China Coalbed Methane Technology / CO<sub>2</sub> Sequestration Project** (completed)

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

This is a pilot-scale project that aims to successfully demonstrate that coal seams in this part of China are permeable and stable enough to absorb CO<sub>2</sub> 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 carry out field testing at relatively low CO<sub>2</sub> injection rates.

*Recognized by the CSLF at its Berlin meeting, September 2005*

**15. CO<sub>2</sub> Capture Project** (completed)

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

This is a pilot-scale project that will continue the development of new technologies to reduce the cost of CO<sub>2</sub> separation, capture, and geologic storage from combustion sources such as turbines, heaters and boilers. The goal of the project is to reduce cost of CO<sub>2</sub> capture from large fixed combustion sources by 60–80% while addressing critical issues such as storage site/project certification, well integrity, and monitoring.

*Recognized by the CSLF at its Melbourne meeting, September 2004*

**16. CO<sub>2</sub> GeoNet**

*Nominators: European Commission (lead) and United Kingdom*

This multifaceted project is focused on geologic storage options for CO<sub>2</sub> 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 CO<sub>2</sub>, identification of knowledge gaps in the long-term geologic storage of CO<sub>2</sub>, 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 duplication of research effort. It will also contribute to the knowledge base for CO<sub>2</sub> storage site selection, injection operations, monitoring, verification, safety, environmental protection, and training standards.

*Recognized by the CSLF at its Berlin meeting, September 2005*

**17. CO<sub>2</sub> Separation from Pressurized Gas Stream**

*Nominators: Japan (lead) and United States*

This is a small-scale project that will evaluate processes and economics for CO<sub>2</sub> 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 CO<sub>2</sub> 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*

**18. CO<sub>2</sub> Sink**

*Nominators: European Commission (lead) and Germany*

This is a pilot-scale project that will test and evaluate CO<sub>2</sub> capture and storage at an existing natural gas storage facility and in a deeper land-based saline formation. A key part of the project will be monitoring the migration characteristics of the stored CO<sub>2</sub>. The goal of the project is to advance understanding of the science and practical processes involved in underground storage of CO<sub>2</sub> and to provide real case experience for use in development of future regulatory frameworks for geologic storage of CO<sub>2</sub>.

*Recognized by the CSLF at its Melbourne meeting, September 2004*

**19. CO<sub>2</sub>STORE** (completed)

*Nominators: Norway (lead) and European Commission*

This project is a follow-on to the Sleipner project and involves monitoring of CO<sub>2</sub> migration (involving a seismic survey) in an saline formation beneath the North Sea and additional studies to gain further knowledge of geochemistry and dissolution processes.

There will also be several preliminary feasibility studies for additional geologic settings of future candidate project sites. The goal of the project is to develop sound scientific-based methodologies for the assessment, planning, and long-term monitoring of underground CO<sub>2</sub> storage, both onshore and offshore.

*Recognized by the CSLF at its Melbourne meeting, September 2004*

**20. ENCAP**

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

This is a multifaceted project consists of six sub-projects: Process and Power Systems, Pre-Combustion Decarbonization Technologies, O<sub>2</sub>/CO<sub>2</sub> Combustion (Oxy-fuel) Boiler Technologies, Chemical Looping Combustion, High-Temperature Oxygen Generation for Power Cycles, and Novel Pre-Combustion Capture Concepts. The goals of the project are to develop promising pre-combustion CO<sub>2</sub> capture technologies (including O<sub>2</sub>/CO<sub>2</sub> combustion technologies) and propose the most competitive demonstration plant technology, design, process scheme, and component choices.

*Recognized by the CSLF at its Berlin meeting, September 2005*

**21. Feasibility Study of Geological Sequestration of CO<sub>2</sub> in Basalt Formations (Deccan Trap) in India**

*Nominators: India (lead) and United States*

The feasibility of CO<sub>2</sub> storage in India's basalt formations will be established using mainly noninvasive technologies like 2D/3D and MT studies, physical and chemical characterization of formations, kinetic studies, wire logging for temperature and pressure profiles, and detailed modeling. Subsequent detailed schemes will be developed for CO<sub>2</sub> injection and monitoring in these basalt formations.

*Recognized by the CSLF at its Berlin meeting, September 2005*

**22. Frio Project**

*Nominators: United States (lead) and Australia*

This is a pilot-scale project that will demonstrate CO<sub>2</sub> sequestration in an on-shore underground saline formation. The project involves injecting relatively small quantities of CO<sub>2</sub> into the formation and monitoring its movement for several years thereafter. The goals of the project are to verify conceptual models of CO<sub>2</sub> 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 CO<sub>2</sub> injection experiments.

*Recognized by the CSLF at its Melbourne meeting, September 2004*

**23. Geologic CO<sub>2</sub> 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 CO<sub>2</sub> storage in conjunction with commercial natural gas production. The goals of the project are to develop a detailed dataset on the performance of CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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. IEA GHG Weyburn-Midale CO<sub>2</sub> Monitoring and Storage Project**

*Nominators: Canada and United States (leads) and Japan*

This is a commercial-scale project that will utilize CO<sub>2</sub> for enhanced oil recovery at a Canadian oil field. The goal of the project is to determine the performance and undertake a thorough risk assessment of CO<sub>2</sub> 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 CO<sub>2</sub> Enhanced Oil Recovery projects.

*Recognized by the CSLF at its Melbourne meeting, September 2004*

**25. ITC CO<sub>2</sub> Capture with Chemical Solvents**

*Nominators: Canada (lead) and United States*

This is a pilot-scale project that will demonstrate CO<sub>2</sub> 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 CO<sub>2</sub> from flue gas.

*Recognized by the CSLF at its Melbourne meeting, September 2004*

**26. 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*

**27. Regional Opportunities for CO<sub>2</sub> Capture and Storage in China (completed)**

*Nominators: United States (lead) and China*

This project will characterize the technical and economic potential of CO<sub>2</sub> capture and storage technologies in China. The goal of the project is to compile key characteristics of large anthropogenic CO<sub>2</sub> 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, and to develop estimates of geologic CO<sub>2</sub> storage capacities in China.

*Recognized by the CSLF at its Berlin meeting, September 2005*

**28. CO<sub>2</sub> CRC Otway Project**

*Nominators: Australia (lead) and United States*

This project involves transport and injection of approximately 100,000 tons of CO<sub>2</sub> into a depleted natural gas well over a two year period. Besides the operational aspects of processing, transport and injection of a CO<sub>2</sub>-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 CO<sub>2</sub> 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 CO<sub>2</sub> capture and storage (CCS) in Australia.

*Recognized by the CSLF at its Paris meeting, March 2007*

**29. 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% CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> per year.

*Recognized by the CSLF at its Paris meeting, March 2007*

**30. Dynamis (completed)**

*Nominators: European Commission (lead) and Norway*

This is the first phase of the multifaceted Hypogen program, which will result in construction and operation of an advanced commercial-scale power plant with hydrogen production and CO<sub>2</sub> management, with the goal of operation and validation in the 2012-2015 timeframe. The Dynamis project will assess the various options for large-scale hydrogen production, focusing on the technological economic and societal issues.

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

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