



Strategic Plan Implementation Report

April 2010

Carbon Sequestration leadership forum

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CSLF Technical Group Meeting Pau, France ■ 15-17 March 2010



CSLF Technical Group at the Lacq Integrated CCS Project ■ 17 March 2010



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**CSLF Projects Interaction
Review Team (PIRT)
Working Session at the
CO2CRC Otway Project in
Canberra, Australia on
05 February 2010**



Carbon Sequestration Leadership Forum

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**CSLF Projects
Interaction Review
Team (PIRT) Working
Session visit to the
CO2CRC Otway Project
in Canberra, Australia
on 05 February 2010**



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* Added after original publication in April

Report from the CSLF Secretariat



Geoscience Australia hosted the CSLF Projects Interaction Review Team from 01-03 February in Canberra, Australia

1st Row (seated from left): Trygve Riis, CSLF Technical Group Chair; Nick Otter, CEO Global CCS Institute; Clinton Foster, CSLF PIRT Chairman, Geoscience Australia; Nils A. Røkke, SINTEF;
2nd Row (standing from left): Peter Cook, CO2CRC Otway Project; Stefan Bachu, Canada; Harry Schreurs, Netherlands; Colin Whyte, Zerogen Project; Victor Der, CSLF Policy Group Chair; Bill Koppe, Global CCS Institute; John Panek, CSLF Secretariat; Didier Bonijoly, France

Recent Headline Events

- 01-03 February – CSLF PIRT working session meeting in Canberra, Australia
- 05 February – CSLF PIRT visit to the CO2CRC Otway Project
- 11 March – CSLF “CCS Ready” definition meeting in Ottawa, Canada
- 15-16 March – CSLF Technical Group meeting in Pau, France
- 17 March – CSLF Technical Group visit to the Lacq Integrated CCS Project
- 06 April – CSLF Financing CCS Task Force Financing Roundtable in Washington, D.C., United States
- 15-16 April – CSLF Secretariat participation in a peer review workshop in Genoa, Italy

CSLF Policy Group

The new CSLF Capacity Building Governing Council, which will oversee financial aspects of Capacity Building Program, held its first meeting on 24-25 March in Oslo, Norway. The Governing Council’s Terms of Reference is being developed and the CSLF Capacity Building Task Force is working to refine and endorse capacity building criteria. The next meeting of the Governing Council will take place in June.

The CSLF Financing CCS Task Force held two Financing Roundtables on the “Commercial and Financial Structuring of Commercial-Scale Projects with CCS”, on 27 January in London, UK, and on 06 April in Washington, D.C., United States, to engage the investor community in a dialog on the critical policies and incentives needed to finance and build the initial wave of energy or industrial plants with CCS. Results of these

Roundtables were used as input for the process of addressing the financial gap for early large-scale CCS projects.

A meeting co-sponsored by the IEA, the Global CCS Institute, and the CSLF was held in Ottawa, Canada, on 11 March to develop an accepted definition for the term “CCS Ready”. The meeting was attended by many CSLF delegates and other experts, and resulted in a preliminary draft definition that is similar to the IEA Greenhouse gas R&D Programme’s definition of the term. This definition has since undergone several additional rounds of discussion and comment, and will be included in a report to the G8 that is now in preparation. The Secretariat has provided draft language of the definition to Policy Group delegates.

The CSLF Secretariat participated in a peer review workshop, in

Genoa, Italy, on 15-16 April, sponsored by the IEA Working Party on Fossil Fuels, the CSLF, and the Global CCS Institute, for identification of large-scale CCS demonstration plants to be recognized by the G8. A report on this workshop is currently in progress, and is being edited by the IEA.

CSLF Technical Group

The CSLF Projects Interaction and Review Team (PIRT) held a working session on 01-03 February in Canberra, Australia, which resulted in the following outcomes:

- PIRT activities were prioritized.
- A new plan for analysis of CSLF-recognized projects in relation to technology gaps was developed.
- A new plan for engaging CSLF-recognized projects and attracting new projects was developed.
- Extension of CSLF Charter beyond its current expiry date of 2013 was recommended.
- A schedule for updating the CSLF Technology Roadmap was developed.
- Current collaborations involving the Technical Group were reviewed and opportunities for new collaboration were examined.

These recommendations formed the basis of a draft Technical

Action Plan that was created by the Technical Group at its 15-16 March meeting in Pau, France.

Near-term activities include:

- Form a new Task Force for Assessing Progress on Closing the Gaps in the areas of capture, transport, storage, and integration.
- Complete an update to the CSLF Technology Roadmap.
- Develop a plan for attracting new projects for CSLF recognition.
- Prepare a technology readiness assessment for all CSLF-recognized projects.
- Develop a plan for implementing a projects workshop.

Longer-term activities in the Action Plan include:

- Accomplish periodic assessments of gaps and upgrades of the CSLF Technology Roadmap.
- Completion of activities by the new Task Force for Assessing Progress on



From right: CSLF Technical Group Chair Trygve Riis, Pau Vice Mayor; CSLF Secretariat John Panek at the Pau, France Town Hall on 16 March 2010 during the CSLF Technical Group Meeting

Closing the Gaps.

- Promote awareness of activities among the CSLF Members and stakeholders.
- Engage projects through workshops, events, and networks.
- Pursue opportunities for collaboration with other organizations.



Nicolas Aimard gives a presentation at the Lacq Integrated CCS Project on 17 March 2010 during the CSLF Technical Group Meeting in Pau, France

Jean-François Rocchi, President and CEO, BRGM, France gives the welcoming remarks on 15 March 2010 during the CSLF Technical Group Meeting in Pau, France



Nobumichi Morishita and Shinichi Terada represent Japan on 16 March 2010 during the CSLF Technical Group Meeting



From right: CSLF Technical Group Delegate Didier Bonijoly, France talks with the Pau, France Vice Mayor at the Pau Town Hall on 16 March 2010 during the CSLF Technical Group Meeting

CSLF Technical Group (continued)

One other outcome from the Technical Group meeting in Pau was a recommendation to the Policy Group that the Gorgon CO₂ Injection Project (nominated by Australia, Canada, and the United States) receive CSLF recognition.

The CSLF CCS in the Academic Community Task Force has implemented a near-term work plan that includes developing contacts within academic community and identifying academic perspectives and programs on CCS for universities in CSLF Member countries. Regional reports covering academic programs in the European Union, Australia, and North & South America are in progress.

Two visits to CSLF-recognized projects took place since the beginning of 2010. On 05 February, attendees of the CSLF PIRT Working Session

at Canberra visited the CO₂CRC Otway Project, while on 17 March, attendees of the CSLF Technical Group meeting at Pau visited the Lacq CO₂ Capture and Storage Project.

Upcoming Events

- *CSLF Capacity Building Governing Council Meeting June 2010*
Date & Venue TBA
- *CSLF Annual Meeting 6-8 October 2010*
Warsaw, Poland
- *CSLF Projects Workshop*
Date & Venue TBA
- *CSLF Projects Interaction Review Team Meeting*
Date & Venue TBA



CSLF Technical Group Delegates on 16 March 2010 during the CSLF Technical Group Meeting in Pau, France

CSLF Secretariat Richard Lynch along with CSLF Technical Group Delegates on 16 March 2010 during the CSLF Technical Group Meeting in Pau, France



Report from the Stakeholders

April 2010

3D-GEO Pty Ltd
Melbourne, Australia

See the 3D animation link below from the ***3D-GEO*** website which shows the shape of the Onshore Gippsland basin at the deepest basement level and then its sedimentary fill is shown as a moving cross-section travels along the basin.

http://www.3d-geo.com/index.php?option=com_content&view=article&id=206&Itemid=407

* * * * *

Gorgon Project
Chevron Australia Pty Ltd.
Perth, Australia

Construction of the Gorgon Project has commenced following the Gorgon Joint Venturers making their Final Investment Decision on 14th September 2009. Site operations are currently focused upon construction of the accommodation village. Contracts for long lead items, such as the carbon dioxide compressors have also been awarded.

In March 2010 the Gorgon Carbon Dioxide Injection Project was nominated by Australia, the USA and Canada for recognition as a CSLF Project. The nomination was supported by the CSLF Technical Panel and will be recommended for endorsement by the Policy Committee at its next meeting.

Further details on the Gorgon Project and the carbon dioxide injection component of this project can be found at <http://www.chevroustralia.com/ourbusinesses/gorgon.aspx>

* * * * *

Director, CCS Policy
Alberta Energy
The Government of Alberta (GOA), Canada

- After running a competitive process, the Government of Alberta has signed Letters of Intent (LOIs) to allocate the \$2 billion Alberta CCS Fund to four projects, as mentioned in the December 2009 Report from Stakeholders. The four projects are expected to store 5 million tonnes of CO₂ per year by 2015.
- Alberta's funding program balances the need for project proponents to collect and publicly disseminate information with the recognition that certain proprietary information and data should remain confidential.
- To provide more clarity and gather advice on the scientific and technical data on the knowledge sharing requirements, Alberta Energy held an Information Sharing Workshop in Calgary, Alberta, on April 19th. Invitations went out to the research community, proponents of the four projects, academia, members of the Plains CO₂ Reduction (PCOR) Partnership and representatives from the Governments of Alberta, Saskatchewan and

Canada. Topics included data identification, reporting requirements and access to technical information. Alberta believes knowledge sharing will maximize the learning from these projects – both the successes and the opportunities for improvement, so that industry can see costs coming down and CCS technology accelerates the deployment for the next wave of projects.

- Alberta Energy and representatives of the four CCS projects toured Europe March 14-23, along with Alberta Energy Parliamentary Assistant Diana McQueen. The delegation travelled to Norway, the United Kingdom, Belgium, and Germany and met with representatives of government, industry and academia.

* * * * *

***ATKEPP International Consulting Ltd.
Beijing, China***

(1) Shenhua CCS Demonstration Project

With support from the Chinese government, the project feasibility study has been concluded via an international cooperation program.

- Short- term target: CO₂ storage of 100 kt/a
- Preliminary investigation of Ordos Basin has been finished.

(2) Sasol CTL Plant at Ningxia China

A preliminary investigation and evaluation of potential Carbon Capture Sequestration (CCS) options within 500 km radius of Ningdong Base was completed

- The CTL plant is designed as CO₂ capture ready.
- Strives to use its projects to pioneer EOR and then the Carbon Capture Sequestration (CCS) solutions in China.

* * * * *

N.B. Note of Apology:

***Powerfuel Power Ltd
Hatfield, UK***

Please note ***Powerfuel Power Ltd*** is in Hatfield and not “Herts.” as previously reported in SPIR.

*Capacity Building in Emerging Economies Task Force
CSLF Task Force Strategic Implementation Report
April 2010*

1. Task Force Members
<ul style="list-style-type: none">▪ Saudi Arabia – Abdulmuhsen Alsunaid (Chair)▪ Australia – John Hartwell; Clinton Foster▪ Canada – Stefan Bachu▪ European Commission – Jeroen Schuppers▪ France – Pierre Le Thiez; Claudia Vivalda▪ Italy – Pierpaolo Garibaldi▪ Mexico - José Miguel González Santaló▪ South Africa – Elizabeth Marabwa; Tony Surridge▪ United Kingdom – Ruth Herbert▪ United States – George Guthrie
2. Purpose of Task Force
Assist emerging economy CSLF Members to develop the knowledge, skills, expertise and institutions needed to deploy carbon capture and storage (CCS) technologies, develop training and educational resources that all CSLF Members can utilize, build on lessons learned from CSLF-recognized projects, and collaborate with other international CCS initiatives.
3. Milestones
<ul style="list-style-type: none">▪ Six workshops held (2007-2008)▪ New Capacity Building Initiative launched at CSLF Ministerial Meeting (2009)
4. Status
<ul style="list-style-type: none">▪ Task Force workshops have evolved and been tailored to meet the needs and inputs from participants. Each workshop has built on the successes and lessons-learned from previous workshops, helping to create a solid CCS knowledge foundation that will carry into the future.▪ The Task Force continues to explore creation of standardized, core training modules for capacity building based on materials from the initial workshops. These materials would be aimed at both public and private sector decision-makers.▪ The CSLF Capacity Building Governing Council is overseeing financial aspects of Capacity Building Program and had a meeting on 24-25 March 2010 in Oslo, Norway. The next meeting will be in June.▪ Letters were sent to all emerging country members seeking their input on their needs for capacity building with the view of integrating the responses in the future capacity building programs. The Capacity Building Task Force is working to refine and endorse capacity building criteria based on responses received.▪ A presentation on activities and goals of Task Force was given by Task Force Chairman at Abu Dhabi in January for World Energy Council CFFS Committee Forum on Carbon Capture & Storage & Cleaner Fossil Fuels Strategies in the Middle East & North Africa.

Communications Task Force
CSLF Task Force Strategic Implementation Report
April 2010

1. Task Force Members
<ul style="list-style-type: none"> ▪ Australia – John Hartwell ▪ European Commission – Marisa Atienza Morales ▪ Mexico – José Miguel González Santaló ▪ Norway – Tone Skogen ▪ United Kingdom – Ruth Herbert ▪ United States – John Grasser (Chair)
2. Purpose of Task Force
Implement a communications strategy to raise the profile of the CSLF and CCS.
3. Milestones
<ul style="list-style-type: none"> ▪ Initiated development of an overall CSLF outreach strategy; ▪ Initiated the rebuilding of the CSLF web so as to have a first-rate site and a communications tool available to help promote the organization; ▪ Initiated the redevelopment of the CSLF information kit; ▪ Initiated the establishment of a CSLF daily clipping service to all members; ▪ Initiated conceptual redesign of CSLF exhibit with new graphics to mirror web page and handout material graphics; ▪ Initiated development of CSLF web page linking policy; ▪ Initiated development of CSLF conference sponsorship policy; ▪ Initiated development of CSLF speech for member use; ▪ Initiated development of CSLF power point presentation for member use; ▪ Initiated development of CSLF event at COP-15; ▪ Initiated development and preparation of CCS message paper series; ▪ Initiated development of DVDs containing CSLF materials.
4. Status
<ul style="list-style-type: none"> ▪ Communications strategy finalized and now being implemented; ▪ Completed development of new CSLF web site with improved functionality and graphic presentation; ▪ Completed development of CSLF daily clipping service for members and stakeholders; ▪ Completed redesign and printing of new CSLF handout materials; ▪ Completed redesign of a new CSLF exhibit; ▪ Completed CSLF web page linking policy; ▪ Completed CSLF conference sponsoring policy; ▪ Standard CSLF speech completed and distributed to Policy and Technical Groups; ▪ CSLF presentation completed and distributed to Policy and Technical Groups; ▪ CSLF event at COP-15 in Copenhagen successfully conducted. ▪ Completed CCS message papers as directed by the Policy Group; the “InFocus” message papers have been approved by Communications and Risk Assessment Task Forces and ready for public distribution; ▪ Completed production of DVDs containing various CSLF materials for public distribution.

Financing CCS Task Force
CSLF Task Force Strategic Implementation Report
April 2010

1. Task Force Members
<ul style="list-style-type: none"> ▪ France (Chair: Bernard Frois) ▪ Australia (Margaret Sewell) ▪ Canada (Siddiq McDoom) ▪ European Commission (Jeroen Schuyters) ▪ Japan (Shinichi Terada) ▪ Mexico (José González) ▪ New Zealand (Kate Riddell) ▪ South Africa (Muzi Mkhize) ▪ United Kingdom (Ruth Herbert) ▪ Asian Development Bank (Ashok Bhargava) ▪ GCCSI (Nick Otter) ▪ World Bank (Richard Zechter) ▪ CSLF Stakeholders (Peta Ashworth, Australia; Tomohiro Sembongi, Japan; Monica Lupion, Spain; Luke Warren, UK; Stu Dalton, USA; David Denton, USA; Jeff Jarrett, USA; Jack Parkes, USA; Andrew Paterson, USA; Maria Pineda, USA)
2. Purpose of Task Force
Investigate incentives and investments for CCS in both developing and developed countries, which will allow the CSLF a new means of engaging financial and multinational entities.
3. Milestones
<ul style="list-style-type: none"> ▪ Creation of Task Force (June 2009) ▪ Completion of report sponsored by Asian Development Bank for analyzing key policy issues and barriers to CCS (2010) ▪ Completion of report on “Framework of Risks and Rewards for Commercial Deployment of Projects with CCS” (2010) ▪ Engage financial community (2009 and beyond)
4. Status
<ul style="list-style-type: none"> ▪ Task Force meetings held in June 2009 (San Francisco) and October 2009 (London). ▪ Report on analyzing key policy issues and barriers is underway. ▪ Executive Summary for report on “Framework of Risks and Rewards for Commercial Deployment of Projects with CCS” is complete, and full report is still in progress. ▪ Financing CCS Task Force held one-day business case roundtables in London on January 27th and Washington on April 6th to engage the financial and investor community on critical policies and incentives needed to finance and implement the initial wave of industrial-scale facilities with CCS. Results of these Roundtables were used as input for the process of addressing the financial gap for early large-scale CCS projects.

Project Interaction and Review Team (PIRT)
CSLF Task Force Strategic Implementation Report
April 2010

1. PIRT Members

The PIRT consists of:

- A core group comprising Members of the Technical Group, or as nominated by a CSLF Member country. Current membership consists of representatives from:

Australia	Clinton Foster (Chair)
Canada	Stefan Bachu
Denmark	Flemming Ole Rasmussen
European Commission	Jeroen Schuppers
France	Pierre Le Thiez
Germany	Jürgen-Friedrich Hake
Netherlands	Harry Schreurs
Norway	Trygve Riis
Saudi Arabia	Khalid Abuleif
UK	Philip Sharman
USA	George Guthrie

During the period of this report the PIRT chairmanship resides with Australia.

- An *ad hoc* group of Stakeholders comprising representatives from CSLF-recognized projects.

2. Purpose of PIRT

The PIRT has the following functions:

- Assess projects proposed for recognition by the CSLF in accordance the project selection criteria developed by the Technical Group and approved by the Policy Group. Based on this assessment make recommendations to the Technical Group on whether a project should be accepted for recognition by the CSLF.
- Review the CSLF project portfolio and identify synergies, complementarities and gaps, providing feed back to the Technical Group
- Provide input for further revisions of the CSLF Technology Roadmap (TRM).
- Identify technical, economic, environmental and other issues where it would be appropriate to have CSLF recognized projects.
- Foster enhanced international collaboration for CSLF projects, both within individual projects (e.g. expanding partnership to entities from other CSLF Members) and between different projects addressing similar issues.
- Ensure a framework for periodically reporting to the Technical Group on the progress within CSLF projects.
- Organize periodic events to facilitate the exchange of experience and views on issues of common interest among CSLF projects and provide feedback to the CSLF.
- Perform other such tasks which may be assigned to it by the CSLF Technical Group.

3. Milestones

Near term (next 6 months)

- Populate technology gaps matrix and technology readiness level.
- Develop plan for attracting new projects using input from new project questions
- Develop plan for implementing a projects workshop
- Prepare summaries of completed projects for web

- Update TRM (October 2010)
- Develop and submit project proposals to IEA GHG for study of storage of carbon dioxide in unconventional geological media (examples basalts, shales); project scope may include analysis of resource conflict
- Assist in the formation of Taskforce “Assessing the progress of closing the gaps”

Long term (next >18 months)

- Complete periodic assessments of gaps and upgrades of the TRM
- Promote awareness of activities among the CSLF members and stakeholders
- Project engagement workshops, events, networks
- Collaboration with other organizations

4. Status

- The TRM was updated and delivered at the London Ministerial meeting. Subsequent meetings of the PIRT in Canberra (1-3 February 2010) and Pau (15 March 2010) agreed on a strategy for updating the TRM (see Milestones above for details).
- Actions arising from the Canberra and Pau meetings to ensure consistency with the CSLF Strategic Plan and to create alignment where possible with other international and global actions of CCS (such as the IEA, the IEA GHG, and the Global CCS Institute), included:
 - Revision and update of the PIRT Terms of Reference
 - Updating of the CSLF Project Submission Form
 - Development of a new plan for analysis of CSLF-recognized projects in relation to technology gaps (see below)
 - Development of a strategy for engaging CSLF-recognized projects and attracting new projects
 - Review and recognition of the importance of current collaborations and opportunities for new collaboration.
- At the London Ministerial meeting, 30 projects were recognized by the CSLF. The Canberra and Pau PIRT meetings resolved to develop a comprehensive plan for analyzing projects in relation to addressing technology gaps, both for projects that have already been recognized by the CSLF and for projects that are proposed for recognition. A preliminary version of a technology gaps analysis matrix “report card” on CSLF-recognized projects was prepared by Geoscience Australia for the PIRT. The matrix will assist the PIRT in identifying projects that would address the remaining gaps. Importantly, entries for all CSLF-recognized projects need to be individually verified *by the project managers*. There was agreement that the CSLF Secretariat should prepare and send out, to each recognized project for verification, an individual gap analysis worksheet based on this preliminary matrix.
- In conjunction with the gaps assessment, it was agreed that CSLF existing and future projects needed to be evaluated against a technology readiness scale, using the following levels: laboratory / bench scale, sub-scale pilot, full-scale demonstration, and first-of-a-kind commercial. Enabling Technologies and Applied Research will also be identified.
- The next PIRT meeting will review and report on progress.

Working Group on Safety and Integrity
CSLF Task Force Strategic Implementation Report
April 2010

1. Task Force Members

- France (Chair: Didier Bonijoly)
- Canada
- IEA GHG
- Japan
- Netherlands
- South Africa
- United States

2. Purpose of the Working Group

The main objective of the working group was to summarize the State of the Art on existing safety and integrity performance criteria which could be used by operators, governments, population to control that abnormal event which could lead stored CO₂ to move towards the surface, would present no significant impact on environment and human health.

The report focus was (1) on technical requests necessary for the establishment of performance and safety standards and (2) it reports the various regulation approaches to be used to guaranty safety and integrity for storage sites:

1. Technical requirements for performance-based standards for storage site safety and integrity
 - 1.1. Which performance objective for a CO₂ storage site?
 - 1.2. Which evaluation criteria for assessing safety and integrity of a CO₂ storage site?
 - 1.3. Exposure assessment
 - 1.4. Which techniques and capabilities for monitoring CO₂ storage performance and safety?
2. Regulation requirements for performance-based standards for storage site safety and integrity
 - 2.1. EU approach
 - 2.2. International regulatory review
3. Conclusion

3. Milestones

- April 2009 – the Technical Group launches the Working Group during the meeting in Oslo, Norway
- October 2009 – First meeting of the Working Group – comments on the draft report – proposal to merge the Working Group with the Risk Assessment Task Force
- March 2010 – Final draft completed for review by the Working Group and Risk Assessment Task Force – decision to merge the Working Group with the Risk Assessment Task Force

4. Status

- Completed report to be sent to Risk Assessment Task Force members for review

Formation of New Task Force for Assessing Progress on Closing the Gaps

Task Force Chair – Clinton Foster, Australia, Vice Chair Technical Group

Background

Following meetings of the PIRT in Canberra (February 1-3, 2010) and in Pau (March 15, 2010), the Technical Group accepted a recommendation that a new Task Force be formed to assess the progress on the gaps that affect the deployment of CCS.

Four Working Groups (WG) agreed

- **Capture WG** to be chaired by the US, current participants include: Italy, Korea, and South Africa. Lead George Guthrie.
- **Transport and Infrastructure WG** to be chaired by the Netherlands, current participants include Norway; Australia will make available the recent findings from its National Carbon Storage Taskforce. Lead Harry Schreurs.
- **Storage WG** to be chaired by Canada, current participants include: China, Italy, Japan, and US. Lead Stefan Bachu.
- **Integration WG** to be chaired by the Global CCS Institute. Lead Bill Koppe.

Discussion and an Invitation to Join WG

The work of the new Task Force complements an ongoing activity of the PIRT to assess the level of CCS readiness of the existing 30 CSLF projects.

The Working Groups have been formed to focus on the progress of each of the key elements that will affect the deployment of CCS. The output of the Task Force is to provide periodic updates; and the structure and participation of many of the CSLF members will ensure that recent developments and achievements are reported on. The Task Force Chair is responsible for reporting to the CSLF Technical Group.

There is an ongoing need for a source of factual and updated information on *Capture* through *Integration*. This is particularly so for policy makers and the public who are aware of key issues but in general do not know if progress is being made. As a result the same project examples are often used, which may lead to the perception that progress has stalled.

Each WG will assess how the existing CSLF projects address the recognized gaps, and monitor other projects that address the same gap. For example, the progress of project and country storage assessments and the methodologies and techniques being applied. The IEA GHG was invited, through the Technical Group meeting, to participate within the Task Force, and the CSLF Secretariat and the WG Chairs will also encourage other CCS bodies to participate.

The CSLF Secretariat will coordinate responses from CSLF delegates and other organizations who wish to join a Working Group.

CANMET Energy R&D Oxyfuel Combustion for CO₂ Capture
CSLF Project Status Report
April 2010

1. Project Location
CanmetENERGY, Ottawa, Canada
2. Project Lead
Dr. Kourosh Zanganeh, Zero-Emission Technologies Group, Clean Electric Power Generation CanmetENERGY, 1 Haanel Drive, Ottawa, Ontario K1A 1M1 Tel: (613) 996-3916; Fax: (613) 992-9335 Email: kzangane@nrcan.gc.ca
3. Project Objectives
<ul style="list-style-type: none"> • To research and develop advanced near-zero emission technologies, including CO₂ capture systems, for fossil fuel plants. • To develop next-generation oxy-fuel combustion and burner technologies and improve the overall performance and economics of these systems. • To assess CO₂ capture and compression processes, phase changes, and the impact of impurities on the performance of CO₂ capture systems using pilot scale facilities. • To research and develop advanced zero-emission cycles. • To develop novel integrated multi-pollutant control processes for NO_x, SO_x, Hg, and particulate with optimization, integration and low-grade heat recovery.
4. Recent Milestones
<ul style="list-style-type: none"> • Developed and tested new ultra-low NO_x oxy-combustion burners with sub-bituminous and lignite coals. • Developed and tested a new multi-function oxy-fuel/steam burner with lignite coal and with zero flue gas recycles. • Developed and tested multi-pollutant control strategies and processes. • Validated at the pilot scale that Fe salts were capable of oxidizing Hg and achieved a 75% Hg oxidation with an optimal pH between 1 and 3 on bench-scale tests. • Enhanced computational fluid dynamic (CFD) modeling capability to simulating oxy-combustion flame characteristics. • Developed, constructed, and tested a first-of-a-kind fully integrated pilot scale CO₂ capture and compression unit. • Developed new advanced gas turbine and high-efficiency fuel cell-based power generation cycles. • Developed performance and economic models and simulators for advanced supercritical oxy-coal plants with integrated CO₂ capture and air separation unit.
5. Status
<ul style="list-style-type: none"> • CANMET CO₂ R&D Consortium research program started in 1994 and is currently soliciting member participation for a Phase 10 program. • Phase 10 work program under consideration will include projects relating to: <ol style="list-style-type: none"> a) modeling and economic analysis of supercritical coal-fired plants with CO₂ capture;

- b) performance testing of an advanced CO₂ recovery module;
 - c) development of global control strategies for the CO₂ Capture and Compression Unit;
 - d) development of multi-pollutant control processes for removal of SO_x, NO_x, and Hg emissions using the CO₂CCU;
 - e) testing of a novel hot sieving electrostatic precipitator;
 - f) development of efficient processes for advanced post-combustion capture of CO₂;
 - g) development of models and optimization tools for mitigating GHG emissions from oil sands and upgrading facilities; and
 - h) assessing oxy-firing of bio-based fuels with CO₂ capture
- Consortium technical reports and presentations are confidential.
 - New members are welcome to join the program by paying a nominal membership fee and accepting the terms and conditions of the Consortium agreement.

CCS Northern Netherlands Project
CSLF Project Status Report
 April 2010

1. Project Location
Groningen Province, Netherlands
2. Project Lead
Desmond de Vries (ddevries@provinciegroningen.nl)
3. Project Objectives
This project will implement a large-scale regional plan for capture, transport and storage of CO ₂ around the Eemsharbor complex in Groningen province in the northern part of the Netherlands. The project will capture CO ₂ from existing and planned power plants, transport the CO ₂ to the storage location, and store the CO ₂ 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 CO ₂ 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.
4. Recent Milestones
For the CCS project in the Northern Netherlands, a CCS foundation is being formed. This foundation (the participants are: EBN, Energy Valley, Gasunie, Groningen Seaports, NAM, NOM, Nuon en RWE) aims to enlarge the chance of a successful CCS project in the region by preparing the realization of CO ₂ transport and storage. The Foundation is now established and is named “Borg”. This is a reference to a typical type of stronghouse that are found in the north and also means “secure(d)” in Dutch language.
5. Status
The Dutch cabinet has fallen in march this year. Consequence of this is that irreversible decisions will be postponed until a new government has been elected (probably in September a new government will be in place). This will for example mean no permits can be approved by the minister. Until now we experience no problems, but it can mean some delay for our activities in the northern Netherlands. Meanwhile we continue to prepare for entering a proposal for the NER programme. Therefore the process has started to select a storage location and a transport route.

CCS Rotterdam Project
CSLF Project Status Report
 April 2010

1. Project Location
Rotterdam, Netherlands
2. Project Lead
Maarten de Hoog (maarten.dehoog@dcmr.nl) Hans Knippels (hans.knippels@dcmr.nl)
3. Project Objectives
<ul style="list-style-type: none"> • Development of CCS in the greater Rotterdam area (Port of Rotterdam) • 2015 annual storage of 5 Mton CO₂ • 2025 annual storage of 20 Mton CO₂
4. Recent Milestones
<ul style="list-style-type: none"> • September 2009, annual progress report on CCS, “CO₂ Capture Transport and Storage in Rotterdam” available on www.rotterdamclimateinitiative.nl: <ul style="list-style-type: none"> ○ Validation of technical feasibility and cost of CCS by key Rotterdam industrial facilities ○ Technical and cost scenario’s of a CO₂ pipeline and storage scenario’s ○ Shipping of CO₂ ○ Comprehensive financial analysis. Financial risk and commercial structure considerations ○ Policy considerations and roadmap ○ Ensuring the implementation of CCS, memo for discussion ○ Including roadmap for large scale CCS in Rotterdam Stakeholders involved are: <ul style="list-style-type: none"> ○ Capture: Eon, Electrabel, Shell/Essent, Air Products, Air Liquide, C-gen, AVR, 3 other companies ○ Transport and storage: Port of Rotterdam Authority, GdF Suez, EBN, TAQA, Gasunie, OCAP, Wintershall and Stedin ○ Shipping and storage : Anthony Veder, Gasunie, GdF Suez and VOPAK ○ Technical validation: Foster Wheeler. Financial analysis and cost validation: Climate Change Capital • EU-EEPR funding for the EON/Electrabel project. CCS demonstration plant of 250 MW size at the new EON coal fired power plant. Final financial arrangement to be made in April 2010.
5. Status
<ul style="list-style-type: none"> • Advise for building blocks for a national transport and storage masterplan by Gasunie and EBN to minister of economic affairs due April 2010. • Start tender for due diligence of three possible CO₂ storage locations on Dutch Continental Shelf. • Further development of the shipping business case, signing of joined (LOC = Letter of cooperation) agreement, Athony Veder, Gasunie, VOPAK and Air Liquide for development of CO₂ terminal.

- Evaluation of communication process regarding CO₂ storage in gas fields underneath Barendrecht, public perception.
- Discussion with industry and regulators on the need of additional safeguards for the implementation of CCS (Ensuring CCS).
- Requirements Dutch government regarding NER-applications due April 2010

CO2CRC Otway Project
CSLF Project Status Report
April 2010

1. Project Location
Southwestern Victoria, Australia
2. Project Lead
Sandeep Sharma, CO2CRC, Kensington WA 6151, Australia, <ul style="list-style-type: none">- Ph: 08 6436 8736- Mob: 0412 515 494- E-mail: ssharma@co2crc.com.au
3. Project Objectives
The Otway project has been designed to demonstrate geological storage and monitoring of CO ₂ under Australian conditions. It aims to provide technical information on geosequestration processes, technologies and monitoring and verification regimes that will help to inform public policy and industry decision-makers and assurance to the community.
4. Recent Milestones
<ul style="list-style-type: none">▪ Over 65,400 tonnes of CO₂ have been injected between April 08 and Sept 09.▪ In January a concurrent 3D surface seismic and a 3D VSP was acquired. This data is currently being interpreted for TL affects.▪ Geochemical sampling using U-Tube is continuing and an understanding of the plume movement is being built up.▪ Multiple site visits by local and international visitors.
5. Status
<ul style="list-style-type: none">▪ U tube sampling of reservoir data to continue.▪ Injection is currently paused pending analysis of the repeat seismic survey acquired in January 2010.▪ Otway Stage 2 progressing and the new well CRC-2 was drilled in Feb 10 targeting the Paaratte saline aquifer.▪ Community is continuously updated on forward plans through public meetings with the next one planned on April 29.

CO₂ GeoNet
CSLF Project Status Report
 June 2010

1. Project Location
Western Europe
2. Project Lead
<ul style="list-style-type: none"> ▪ Coordinator: Dr. Nick Riley (British Geological Survey) <ul style="list-style-type: none"> - E-mail: njr@bgs.ac.uk ▪ Network Manager: Isabelle Czernichowski-Lauriol (BRGM) ▪ Secretariat: Sergio Persoglia (OGS) ▪ Contact: info@co2geonet.com
3. Project Objectives
<ul style="list-style-type: none"> ▪ Focus is R&D into geological storage of CO₂ and strengthening the European Research Area. ▪ Form a durable integration of the original 13 partners over 5 years, involve more partners. ▪ Provide the underpinning science capability and knowledge to help enable deployment of large scale CO₂ storage in Europe as quickly as possible ▪ Collaborate internationally ▪ Be a source of impartial scientific information on CO₂ geological storage for stakeholders ▪ Train existing and new researchers ▪ Develop and share research infrastructure
4. Recent Milestones
<ul style="list-style-type: none"> ▪ In April 2008 formed a legal entity, “CO₂GeoNet Association”- this will enable new strategic partners to join and existing partners to continue working together. ▪ In March 2009, the CO₂GeoNet project supported by EC under FP6 has been successfully completed. ▪ Since then, the Association has continued the mutual integration and joint research programming, acting as a virtual institute involving more than 300 researchers from 7 European nations. ▪ CO₂GeoNet is in the negotiation phase for “CGS Europe – Pan-European coordination action on CO₂ Geological Storage”, a new EC coordination and support action under FP7, aimed at pooling together the expertise of the key institutes for CO₂ storage in each relevant European Member State and Associated Country.
5. Status
<ul style="list-style-type: none"> ▪ The CO₂GeoNet researchers have prepared basic answers to several frequently asked questions, as to how CO₂ geological storage can be carried out, under what circumstances it is possible, and what the criteria are for its safe and efficient implementation. These are in the CO₂GeoNet’s new brochure available in Danish, Dutch, French, German, Hungarian, Italian, Norwegian, Polish, Romanian,(and soon in Chinese, Russian and other languages), at www.co2geonet.eu ▪ Latest results of research presented at Annual Stakeholder workshop held April 2009. Among these, development of a low-cost seismic alert system to be used on storage sites, development of a benthic chamber for off-shore impact assessment and biological monitoring, impact studies on terrestrial ecosystems and groundwater, use of remote sensing techniques to monitor leakages over large areas, studies on interactions aqueous

fluids-CO₂-rock-cement.

- Co-organization of two courses in spring 2009 on CCS and “Modeling chemical reactivity during CO₂ geological storage”.
- Co-organisation of the 1st IEA GHG CO₂ storage modeling workshop, Orleans, February 09.
- Organisation of the ESF Research Conference “CO₂ Geological Storage: Latest progress”, Obergurgl, Austria, 22-27 November 2009. The conference was built around 24 invited talks of 45 min duration each, given by international experts, and gathered 90 participants from the whole world including EU countries, Israel, Russia, Australia, Brazil, USA, Canada and China.
- Studies performed for IEA-GHG on various aspects of CO₂ geological storage.
- Participation as partner to proposals and contracts supported by EC under FP6 and 7.
- Scientific advice on development of monitoring plans for CCS demo projects.
- Professional training course in Orleans.
- Contribution to CCOP Training Course on CO₂ Storage, Thailand, June 2009.
- Contribution to IEA GHG Summer School in Australia, August 2009.
- Participation to COP-15 in Copenhagen, December 2009.
- Fifth Open Forum at San Servolo, Venice, May 2010. The focus has been to develop strategic international collaboration between CO₂GeoNet and major national, European and international initiatives and networks. Among the participants, DG Energy, DG Climate Action, CSLF Technical Group, ZEP, EERA CCS Programme, ECCSEL, Bellona, GCCSI, industrial stakeholders, research centers involved in CCS projects in Eastern Europe, Spain, Germany, Japan, Canada, China.
- e-mail: info@co2geonet.com
- CO₂ GeoNet website: <http://www.co2geonet.com>

CO₂ SINK
CSLF Project Status Report
 April 2010

1. Project Location
Ketzin, State of Brandenburg, Germany
2. Project Lead
GeoForschungsZentrum Potsdam, German Research Centre for Geosciences (GFZ) Telegrafenberg, D-14473 Potsdam; http://www.gfz-potsdam.de Coordinator: Dr.-Ing. Hilke Würdemann Tel: +49.331.288-1516; Fax: +49.331.288-1529; e-mail: wuerdemann@gfz-potsdam.de Project website: http://www.co2sink.org
3. Project Objectives
<ul style="list-style-type: none"> ▪ Developing a basis for geologic storage of CO₂ into a saline aquifer ▪ Establishing the first European in-situ laboratory for onshore storage of CO₂ ▪ Creating a field laboratory with one injection well and two observation wells ▪ Characterization of flow and reaction processes in geologic storage, including detailed analysis of samples of rocks, fluids and microorganisms from the underground reservoir ▪ Intensive monitoring of the injected CO₂ using a broad range of geophysical (time-lapse seismic, electrical and thermal), geochemical and microbiological techniques ▪ Development and benchmarking of numerical models ▪ Definition and testing of risk-assessment strategies
4. Recent Milestones
<ul style="list-style-type: none"> ▪ Feb./May 2007: Spud-in of the CO₂SINK injection and observation wells ▪ June 13, 2007: Opening of the Ketzin Field Lab, CO₂ Storage Site and Info Centre ▪ Sept. 8, 2007: One injection and two observation wells drilled and cemented (smart wells with electrical and fibre-optical permanent sensors behind casing) ▪ Feb. 8, 2008: Injection facility installed and tested ▪ Feb. 29, 2008: Hydraulic testing successful ▪ June 18, 2008: Final <i>lifting</i> of injection and observation wells; slug injection ▪ June 24, 2008: Commissioning of injection facility, start of injection test phase ▪ June 30, 2008: Start of CO₂ injection ▪ Nov. 17, 2008: Presentation of the CO₂SINK Status Report to GHGT-9, Washington ▪ April 21, 2009: Presentation of the CO₂SINK Status Report to EGU Vienna ▪ September 28, 2009: Presentation of the CO₂SINK Status Report to ERF Amsterdam ▪ November 26, 2009: CO₂SINK Status Report to ESF Obergurgl
5. Status
<ul style="list-style-type: none"> ▪ 6-years lifetime 04/2004 - 03/2010 ▪ July 2008: start injection of up to 60,000 tonnes CO₂ ▪ July 15, 2008: arrival of CO₂ at first observation well ▪ March 2009: arrival of CO₂ at second observation well ▪ April 2009: 11,500 tonnes of CO₂ injected till now ▪ November 2009: 25,500 tonnes of CO₂ injected ▪ End of March 2010: 32.758 tonnes of CO₂ injected

- March 31, 2010: end of project
- CO₂-Injection in Ketzin still ongoing (CORTIS project)
- Follow-up projects at the Ketzin site: CO₂MAN and CO₂CARE

Completed subprojects:

- Storage site development
- Baseline Storage Site Modeling
- GeoEngineering: drilling, coring, pre-injection logging
- Rock/fluid interactions laboratory experimentation
- Economic/ecological analysis and safety concepts
- CO₂ supply, transport, intermediate storage, conditioning and injection
- Geophysical and geochemical borehole and surface MMV of CO₂ storage
- Project coordination and public outreach
- Preparation (permitting and operation) of CO₂ wellbore abandonment and post-injection MMV

CO₂ Storage in Limburg Coal and Sandstone Layers
CSLF Project Status Report
April 2010

1. Project Location
Geleen, Netherlands
2. Project Leads
Harrie Duisters (harrie.duisters@dsm.com)
3. Project Objectives
<ul style="list-style-type: none">• Pilot project: Store 10,000 tons of CO₂ in the Sandstone layers underneath an ammonia plant• When pilot is successful: Store 2 million tons of CO₂ in the Sandstone layers and combine with ECBM
4. Recent Milestones
<ul style="list-style-type: none">• Finished the conceptual engineering phase of the pilot project with cost estimate• Discussed the environmental permitting procedure with the Dutch Authorities• Established a communication team to get maximum public acceptance for the project• Established a steering team for the project consisting of high level representatives of authorities (local aldermen, province deputy, ministry representative) and DSM Agro
5. Status
<ul style="list-style-type: none">• Project is put on hold because of poor economics. The conceptual engineering shows that already the small pilot project is very expensive and the subsidy money is not covering the costs. Also for the large project the economics show no feasible scenario.• New discussions will have to be held with the Dutch Authorities on these financial problems.

Demonstration of an Oxyfuel Combustion System
CSLF Project Status Report
March 2010

1. Project Location
Renfrew, Scotland, U.K.
2. Project Lead
Sang Hyeun Kim (skim2@doosanbabcock.com)
3. Project Objectives
<p>The specific objectives of the project are:</p> <ul style="list-style-type: none">• to demonstrate the successful performance of a full-scale (40MWt) oxyfuel burner firing at conditions pertinent to the application of an oxyfuel combustion process in a utility power generating plant;• to demonstrate the performance of an oxyfuel burner with respect to combustion efficiency, NO_x, flame shape, and heat transfer characteristics;• to demonstrate the operational envelope of an oxyfuel burner with respect to flame stability, turndown, start-up, shutdown, and the transition between air- and oxyfuel-firing,• to demonstrate the safe operation of an oxyfuel combustion process under realistic operating conditions;• to generate sufficient performance data from the oxyfuel combustion process to inform future investment decisions; and• To demonstrate the level of technology readiness of the oxyfuel combustion process.
4. Recent Milestones
<ul style="list-style-type: none">• Completion of first phase oxycoal burner tests• Completion of full oxycoal burner tests (40MWt)
5. Status
<ul style="list-style-type: none">• Test matrix was generated in consultation with the partners.• Parametric testing for oxycoal burner is being carried out from January 2010.• Oxycoal burner parametric test will be finished and a report will be issued by June 30th,

*European CO₂ Technology Centre Mongstad Project
CSLF Project Status Report
April 2010*

1. Project Location
Mongstad, Norway
2. Project Lead
Tore Amundsen; Managing Director. tam@tcmda.no
3. Project Objectives
<ul style="list-style-type: none"> • Develop technologies for CO₂-capture capable of wide national and international deployment • Reduce cost and technical, environmental and financial risks related to large scale CO₂-capture • Test, verify and demonstrate CO₂-capture technology owned and marketed by Vendors • Encourage the development of a market for such technology
4. Recent Milestones
<ul style="list-style-type: none"> • Admin complex building closed, internal construction and installations ongoing • Alstom Chilled Ammonia concrete absorber tower slipforming complete • Prefabrication of piperacks and modules for Aker Amine plant ongoing • Electrical substation building closed • Seawater intake ready for installation • Overall progress March 2010 approximately 30% and on schedule
5. Status
<ul style="list-style-type: none"> • Investment (\$ 905 million) approved in June 2009 • Construction underway (30% progress) • Operating organization established and preparing for operations

Fort Nelson Carbon Capture and Storage Project
CSLF Project Status Report
 April 2010

1. Project Location
Fort Nelson, British Columbia, Canada
2. Project Leads
Al Laundry (alaundry@spectraenergy.com) Ed Steadman (esteadman@undeerc.org)
3. Project Objectives
<p>The primary objective of the Fort Nelson carbon capture and storage (CCS) project is to verify and validate the concept of utilizing North America's large number of saline formations for large-scale injection, proposed to be in the 1.3 to 2 Mt per year range, of anthropogenic CO₂ for permanent storage. Specific goals include the following:</p> <ul style="list-style-type: none"> • Cost-effective risk management, simulation, and monitoring, verification, and accounting (MVA) strategies for large-scale CO₂ storage in deep saline formations. • Testing and refinement of reservoir modeling intended to predict and estimate CO₂ injectivity (the potential for placing CO₂ into the reservoir) and to confirm the practical CO₂ storage capacity for this site, areal extent and mobility of the supercritical CO₂ plume in the reservoir, and improved methodologies to ensure that site characterization and MVA results better support risk management objectives and modeling efforts. • Testing strategies to predict the effects of CO₂ on the integrity of overlying sealing formations, including the testing and modeling of key geomechanical and geochemical parameters.
4. Recent Milestones
<ul style="list-style-type: none"> • In early January, 2010, Spectra completed a "slant drill" operation conducted off the well that was drilled last year. This re-entry of the borehole in the target reservoir and lower part of the cap rock extends approximately 80 meters away from the old borehole. A variety of tests (well logging, leak-off tests and water injection tests) were conducted on the well to further understand the injection target. In addition further ground water well samples were also collected for baseline monitoring. • Continued running predictive modeling simulations. • Continued work on geochemical reaction modeling • Continued laboratory experiments on rock-cutting samples from selected portions of core as part of an ongoing series of geomechanical and geochemistry experimental activities. These activities include the use of x-ray diffraction and scanning electron microscope techniques.
5. Status
<ul style="list-style-type: none"> • Planning and preparation for 2011 winter drilling season are ongoing • All items above are under evaluation and will be revised based upon the results of newly drilled wells and/or newly obtained data sets from the existing test well.

Geologic CO₂ Storage Assurance at In Salah, Algeria
CSLF Project Status Report
May 2010

1. Project Location
In Salah, Algeria, Africa
2. Project Lead
Iain W. Wright, wrightiw@bp.com BP Alternative Energy, Chertsey Road, Sunbury, Middlesex TW16 7LN, UK
3. Project Objectives
<ul style="list-style-type: none"> ▪ 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. ▪ Demonstrate to stakeholders that industrial-scale geological storage of CO₂ is a viable GHG mitigation option. ▪ Set precedents for the regulation and verification of the geological storage of CO₂, allowing eligibility for GHG credits
4. Recent Milestones
<ul style="list-style-type: none"> ▪ Processing and interpretation of the 2009 seismic continues. Current conclusions are that CO₂ remains securely stored within the storage complex as expected. ▪ INSAR program continues to exceed expectations of resolution and reliability. ▪ Monitoring well KB-5 now fully decommissioned. ▪ High-resolution tilt-meters installed over the southern CO₂ plume. These will be used to benchmark the tilts seen from satellite. ▪ A project website is available at: www.insalahco2.org ▪ An integrated session of 6 technical papers was presented at US DOE NETL's CCS conference in Pittsburgh
5. Status
<ul style="list-style-type: none"> ▪ Storing ~1mmtpa CO₂ in a deep saline aquifer (1900 deep, 2m thick, 10mD permeability). ▪ A second project phase is now being scoped out and agreed with partners and co-funders. ▪ A coordinated roll-out of project lessons-learned in Phase 1 is planned for the IEA's GHGT-10 Conference in September 2010.

Heartland Area Redwater Project (HARP)
CSLF Project Status Report
 April 2010

1. Project Location
Redwater, Alberta, Canada
2. Project Lead
William Sawchuk (wsawchuk@arcresources.com)
3. Project Objectives
<ul style="list-style-type: none"> ▪ Develop a low-cost, secure and long-term CO₂ storage site in the close vicinity of major CO₂ emitters in the Heartland Industrial Area of Alberta, Canada, that will attain a storage rate of at least 1 Mt CO₂/year by 2015 ▪ Develop a characterization and monitoring program that is suited for onshore continental conditions specific to the northern plains of North America (geology, farmland area, four climatic seasons, etc.) ▪ Support development of a regulatory framework for CCS in Alberta, including tenure of the pore space, long-term liability as well as regulatory permitting and follow-up ▪ Achieve synergies with a CO₂-EOR operation being developed by the operator in the oil leg of the same carbonate reef
4. Recent Milestones
<ul style="list-style-type: none"> • Phase II of the project started in August 2009 and has the aim of drilling and testing an exploratory well for the collection of specific data about rock mineralogy, flow and geomechanical properties of the injection aquifer, overlying caprock and other relevant units in the sedimentary succession. Achievements to date include: <ul style="list-style-type: none"> ◦ Selected the site of the exploratory well ◦ Met with local land owners, communities and counties ◦ Met with representatives of government agencies regarding the permitting process for and tenure of pore space ◦ Geological analysis and characterization of the entire sedimentary succession from the Precambrian crystalline basement to the ground surface in an area of approximately 24 × 30 square miles around the prospective storage site ◦ Hydrogeological analysis and characterization of the aquifers and aquitards in the entire sedimentary succession from the Precambrian crystalline basement to the top of the bedrock ◦ Completed an assessment of the natural seismicity in the area ◦ Executed funding agreements with government and joint-industry participants
5. Status
<ul style="list-style-type: none"> ▪ The Redwater reef (approx. 600 km² in size, up to 275 m in thickness, and 1000 m deep at its shallowest) and the Ireton shale caprock have been characterized ▪ The geology and hydrogeology of entire sedimentary succession in an area of 24 × 30 square miles around the site has been analyzed and characterized ▪ The exploratory well drilling, testing and sampling program has been completed ▪ Drilling of exploratory well postponed to Q3 2010 due to a landowner concern ▪ Preparing applications to the regulatory agencies for a well drilling license and authorization to inject CO₂ into saline pore space

IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project

Final Phase

CSLF Project Status Report

April 2010

1. Project Location
Weyburn and Midale Units, Weyburn area, southeast Saskatchewan, Canada
2. Project Lead
<ul style="list-style-type: none">▪ Floyd Wist (Saskatchewan Energy and Resources), Chair, Leading Sponsors Executive Committee (LSEC)▪ Frank Mourits (Natural Resources Canada), Project Integrator and Coordinator Policy Component▪ Steve Whittaker (Petroleum Technology Research Centre), Senior Project Manager, Technical / Research Component
3. Project Objectives
<ul style="list-style-type: none">▪ Develop a comprehensive Best Practices Manual for CO₂ geological storage, which will guide all aspects of future CO₂-EOR storage projects.▪ Building on the successes of the First Phase, focus the technical research component on site characterization, wellbore integrity, monitoring and verification, and performance (risk) assessment.▪ Focus the policy component on public communications and outreach, regulatory issues and the business environment.▪ Ensure integration across technical research and policy components.
4. Recent Milestones
<ul style="list-style-type: none">▪ February 2009 – NRCan increased its project funding by \$2 million.▪ March 2009 – Public Communications and Outreach work program and budget approved by LSEC. Work on CCS website and outreach activities commenced.▪ June 2009 – Project Integration and Sponsors Meeting (PRISM-4), Regina, Saskatchewan.▪ June 2009 – an expert workshop was held in Calgary as part of the ongoing Risk Assessment work.▪ October 2009 – a workshop was held in Ottawa with researchers involved in modeling tasks.▪ January 2010 – Project Integration and Sponsors’ Meeting (PRISM-5), Ottawa, Ontario.▪ March 2010 – Completion of a study that clarifies the regulatory framework governing injection and storage of CO₂ in Saskatchewan (second major deliverable under the Regulatory Theme).
5. Status
<ul style="list-style-type: none">▪ 30 active research projects in four Themes are underway as of January 2010.▪ The static geological model is being updated on an ongoing basis to incorporate additional data being developed from the research activities.▪ A preliminary model for determining the long-term fate of CO₂ has been developed.▪ A proposal for an expanded Wellbore Integrity research program was submitted in late 2009 to NRCan and U.S. DOE and accepted for additional funding in Jan/Feb 2010.

Negotiations with field operators are underway to obtain access to in-field wellbores for integrity testing.

- A shallow groundwater survey was completed fall 2009. This survey complements similar surveys performed since the inception of the project in 2000.
- Three reservoir fluid sampling monitoring surveys were completed in October 2008, May 2009 and October 2009.
- Passive seismic surveys have indicated very minimal response to CO₂ injection.
- Work is continuing to calibrate time-lapse 3D seismic for CO₂ saturations.
- Stochastic modeling is underway to utilize both geophysical and geochemical databases.
- The Risk Assessment process is integrating stakeholder community members, technical expert opinions and initiating biosphere discussions.
- Major work items under the Regulatory Theme have been completed. The Theme Lead will maintain a watching brief to keep the completed studies up-to-date. Presentations on these studies to government agencies, conferences and other events are being made on request.
- Under the Public Communications and Outreach Theme, the new ccs101.ca website has been completed and will be launched at the 9th Carbon Capture and Sequestration Conference in Pittsburgh (May 10-13, 2010). CCS booklets and associated educational materials have been distributed at conferences and conventions to over 1,000 science teachers in Canada and US. Further outreach activities are being developed for 2010-2011.
- All research will be completed by March 31, 2011.
- The project's key deliverable, a Best Practice Manual, will be completed by September 30, 2011.

Regional Carbon Sequestration Partnerships (RCSP) Project
CSLF Project Status Report
April 2010

1. Project Location
Various locations in United States and Canada
2. Project Lead
National Regional Carbon Sequestration Partnership (RCSP) Initiative Managed by the U.S. Department of Energy National Energy Technology Laboratory (NETL) <ul style="list-style-type: none"> ▪ Sean Plasynski, Sequestration Technology Manager (sean.plasynski@netl.doe.gov) ▪ John Litynski, Sequestration Division Director (john.litynski@netl.doe.gov) ▪ Traci Rodosta, Regional Partnerships Coordinator (traci.rodosta@netl.doe.gov)
3. Project Objectives
<ul style="list-style-type: none"> ▪ Coordinate this government/industry effort of seven RCSPs tasked with determining the most suitable technologies, regulations, and infrastructure needs for carbon capture, transport, and storage across areas of the United States and Canada. ▪ Develop the infrastructure necessary for the future deployment and commercialization of carbon capture and storage (CCS) as a critical strategy mitigation of greenhouse gas emissions and climate change. ▪ Implement the RCSP program in three phases: <ul style="list-style-type: none"> – Characterization Phase (2003 – 2005): The partnerships completed the initial characterization of their regions’ potential to store CO₂ in different geologic formations. – Validation Phase (2005 – 2010): The partnerships are validating the most promising regional sequestration opportunities through a series of small-scale field tests. This phase builds upon Characterization Phase accomplishments and begins field testing of geologic and terrestrial sequestration technologies to provide the technical foundation for Development Phase activities. – Development Phase (2008 – 2017): The partnerships will implement large-scale field testing involving at least one million tons of CO₂ per project to confirm that CO₂ injection and storage can be achieved safely, permanently, and economically. These tests will include one to three years of site characterization; one to three years of injection; and two or more years of post-injection monitoring, verification, and accounting (MVA).
4. Recent Milestones
<ul style="list-style-type: none"> ▪ Validation Phase was initiated in 2005 and is scheduled for completion in 2010. A total of 16 out of 21 small scale field tests have been completed, three are in progress and the remaining two should be completed in 2010. Below are the results from the completed tests. <p>Completed Saline Formation CO₂ injection field tests:</p> <p><u>Midwest Geological Sequestration Consortium (MGSC)</u></p> <ul style="list-style-type: none"> – Illinois Basin – injection site was merged with Phase III site, characterization well was drilled in Phase II. <p><u>Midwest Regional Carbon Sequestration Partnership (MRCSP)</u></p> <ul style="list-style-type: none"> – Michigan Basin – two injection tests totaling 60,000 metric tonnes in the Bass Islands Dolomites completed in July 2009

- Cincinnati Arch – injection of approximately 1,000 metric tonnes in the Mt. Simon was completed in September 2009
- Appalachian Basin – injection was completed in September 2008 targeting the Oriskany and Clinton Sandstones

Southeast Regional Carbon Sequestration Partnership (SECARB)

- Mississippi Gulf Coast – injection of approximately 2,740 metric tonnes into the Lower Tuscaloosa Formation at Plant Daniel in late 2008.

West Coast Regional Carbon Sequestration Partnership (WESTCARB)

- Colorado Plateau – evaluation completed in Naco and Martin Sandstones in December 2009

Completed Enhanced Oil or Gas Recovery and CO₂ storage:

Midwest Geological Sequestration Consortium (MGSC)

- Illinois Basin – Huff'n Puff test in the Weller Sandstone was completed in March 2007 in Fayette County, Illinois; approximately 39 metric tonnes of CO₂ were injected and 93 barrels of oil produced.

Plains CO₂ Reduction Partnership (PCOR)

- Williston Basin – Huff'n Puff in the Duperow Formation was completed in June 2009 in Williams County, North Dakota; approximately 400 metric tonnes were injected producing through September 17th approximately 242 barrels of oil and 1,991 million cubic feet of natural gas
- Zama Oil Field – acid gas (CO₂ and H₂S) injection was completed December 2006 in the Middle Devonian Keg River Formation at the Alberta, Canada, site in which 25,400 metric tonnes of CO₂ has been injected, producing more than 25,000 barrels of oil

Southeast Regional Carbon Sequestration Partnership (SECARB)

- Cranfield Oil Field – initial injection of 500,000 metric tonnes into the Tuscaloosa Formation was completed in July 2008 for enhanced oil recovery, project transitioned into Development Phase and to date more than one million tons of CO₂ has been injected.

Southwest Regional Partnership on Carbon Sequestration (SWP)

- Aneth Oil Field – as of December 2009, approximately 630,000 metric tonnes have been injected into the Deep Creek and Ismay Formations within the Paradox Basin for EOR operations
- SACROC – injection of approximately 86,000 metric tonnes were injected into the Horseshoe Atoll and Pennsylvania Reef/Bank Play in the Permian Basin

Completed Enhanced Coalbed Methane (ECBM) CO₂ tests:

Midwest Geological Sequestration Consortium (MGSC)

- Illinois Basin – the 91 metric tonne injection was completed in July 2008 into the Pennsylvanian Carbondale Formation at 2-3 tons per day, methane gas was produced as a result

Plains CO₂ Reduction Partnership (PCOR)

- Williston Basin – injection of 80 metric tonnes into the Harmon Coal in the Fort Union Formation

Southwest Regional Partnership on Carbon Sequestration (SWP)

- San Juan Basin – to date approximately 16,700 metric tonnes has been injected into the coals in the Upper Cretaceous Fruitland Formation, and methane has been subsequently produced. Desalination of produced water is being used for irrigating stressed riparian areas near the injection site as

part of the SWP Validation Phase terrestrial project.

Southeast Regional Carbon Sequestration Partnership (SECARB)

- Central Appalachian Basin – injection of 907 metric tonnes into coals in the Pocahontas and Lee Formations was completed in early 2009
 - **Terrestrial Sequestration Projects:** Eleven successful terrestrial sequestration projects have been ongoing during the Validation Phase, and some projects will continue through 2010. Project categorization includes agriculture soils, soil reclamation, afforestation, accounting/aggregation and wetlands reclamation.
- Development Phase activities began in 2008 and will continue for approximately 10 years. There are seven to nine large-volume injection tests initiating between 2009 – 2011. These injection tests are being conducted primarily in saline formations with one test being conducted in an oil bearing formation.

Partnership Development Project Status:

Big Sky Regional Carbon Sequestration Partnership (Big Sky)

- The Partnership is currently conducting final site determination activities.

Midwest Geological Sequestration Consortium (MGSC)

- The Partnership will conduct a large scale saline formation test in the Illinois Basin that will inject 365,000 metric tonnes of CO₂ per year into the Mt. Simon Sandstone for three years totaling one million tons. The source of the CO₂ will be the Archer Daniels Midland Company (ADM), ethanol production facility in Decatur, Illinois. It is scheduled to begin injection in the 2010/2011 timeframe.

Midwest Regional Carbon Sequestration Partnership (MRCSP)

- Due to business decisions, it was decided to relocate the initial site from Greenville, Ohio. The Partnership is currently conducting final site determination activities.

Plains CO₂ Reduction Partnership (PCOR)

- The Partnership will be conducting two large-volume geologic CO₂ storage projects, one saline and one EOR. The Williston Basin project in North Dakota will couple EOR and CO₂ storage of over one million metric tonnes into a deep carbonate formation that is also a major saline formation. The second demonstration, the Fort Nelson project, will capture over one million metric tonnes of CO₂ per year from one of the largest gas-processing plants in North America, compress it, and transport the CO₂ via pipeline to the injection site, most likely a Devonian-age Elk Point carbonate rock formation located near the gas processing plant.

Southeast Regional Carbon Sequestration Partnership (SECARB)

- The Partnership will be conducting two injection tests at two locations to assess different CO₂ streams. The first test, or Early Test, began injection in April 2009 and will inject one and a half million tons of CO₂ over 18 months into the Lower Tuscaloosa Formation. CO₂ is from a naturally occurring source, Jackson Dome, and will be delivered by Denbury Resources' CO₂ pipeline. The second test, or Anthropogenic Test, will inject 100,000 to 250,000 metric tonnes of CO₂ per year for four years into the Paluxy Formation. The CO₂ will be supplied from flue gas produced at Alabama Power's Plant Barry located near the injection site.

Southwest Regional Partnership on Carbon Sequestration (SWP)

- The Partnership will conduct a large scale saline injection test into deep

Jurassic-, Triassic-, and Permian-aged sandstone in the Farnham Dome of Utah. The simultaneous injection of CO₂ into two formations will total 3 million metric tonnes of CO₂ over a four-year period. The CO₂ will come from both a natural CO₂ source in the Jurassic-aged Nugget Sandstone, and a second source from a coalbed methane production field northwest of Price, Utah.

West Coast Regional Carbon Sequestration Partnership (WESTCARB)

- Due to business decisions, it was decided to relocate the site. The Partnership is currently conducting final site determination activities.
- NETL is continuing ongoing collaboration with Interstate Oil and Gas Compact Commission (IOGCC), through SECARB, to evaluate potential for subsurface geological storage of CO₂, in Federal waters, Gulf of Mexico (GOM), utilizing existing infrastructure, such as wells and pipelines and addressing regulatory, legal and technical issues.
- The Regional Carbon Sequestration Partnerships', "Public Outreach and Education for Carbon Storage Projects Best Practices Manual" was completed and released online December 2009.

5. Status

- The RCSPs span 43 states and 4 Canadian provinces and include agency participation from six member countries of the CSLF.
- 16 of the 21 geologic and 11 terrestrial field tests have been completed in the Validation Phase with the remaining 5 geologic tests being completed in 2010.
- The Development Phase is underway starting 2008, with the first four awards announced in late 2007 and three more large-scale awards announced in 2008.
- The 2008 Regional Carbon Sequestration Partnerships Program Review Proceedings, which include more detailed descriptions of status, are at:
<http://www.netl.doe.gov/publications/proceedings/09/rcsp/index.html>

6. Links to RCSP Programmatic Information

- Carbon Sequestration webpage on the NETL website:
http://www.netl.doe.gov/technologies/carbon_seq/index.html
- Carbon Sequestration Newsletter (distributed monthly):
http://www.netl.doe.gov/technologies/carbon_seq/refshelf/subscribe.html
- Carbon Sequestration Technology Roadmap and Program Plan 2007:
http://www.netl.doe.gov/technologies/carbon_seq/refshelf/project%20portfolio/2007/2007Roadmap.pdf
- Carbon Sequestration Atlas of the United States and Canada:
http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasII/
- An Introduction to Carbon Capture and Sequestration (video):
mms://prod-mmedia.netl.doe.gov/carbon_sequestration_sept.wmv
- Carbon Sequestration Program Environmental Reference Document:
http://www.netl.doe.gov/technologies/carbon_seq/refshelf/nepa/index.html
- Carbon Sequestration Project Portfolio:
http://www.netl.doe.gov/technologies/carbon_seq/refshelf/project%20portfolio/2009/
- Regional Carbon Sequestration Partnerships Phase I Accomplishments, see:
http://www.netl.doe.gov/technologies/carbon_seq/partnerships/phase1/workproducts_table.html

Zama Acid Gas Enhanced Oil Recovery, CO₂ Sequestration, and Monitoring Project
CSLF Project Status Report
April 2010

1. Project Location
Zama City, Alberta, Canada
2. Project Leads
<ul style="list-style-type: none">• Ed Steadman, Energy & Environmental Research Center, Grand Forks, North Dakota, USA<ul style="list-style-type: none">– E-mail: esteadman@undeerc.org• Steven Smith, Energy & Environmental Research Center, Grand Forks, North Dakota, USA<ul style="list-style-type: none">– E-mail: ssmith@undeerc.org• Bill Jackson, Apache Canada Ltd, Calgary, Alberta, Canada<ul style="list-style-type: none">– E-mail: bill.jackson@apachecorp.com
3. Project Objectives
To validate the sequestration of CO ₂ -rich acid gas in a depleted oil reservoir
4. Recent Milestones
Planning of the following work at Zama has been initiated: <ul style="list-style-type: none">• Laboratory-based wellbore integrity studies• Static and dynamic modeling• Acid gas-phase behavior• Continued monitoring, verification, and accounting activities
5. Status
<ul style="list-style-type: none">• Injection is ongoing. Over 40,000 tons of acid gas has been injected to date.• Approximately 25,000 incremental barrels of oil have been produced to date.

ZeroGen Project
CSLF Project Status Report
 April 2010

1. Project Location
Emerald, Queensland, Australia
2. Project Lead
Tony Tarr (tony.tarr@zerogen.com.au) Chris Greig (chris.greig@zerogen.com.au)
3. Project Objectives
<p>ZeroGen is part of the national and international collaborative effort to accelerate the deployment of low emission technologies.</p> <ul style="list-style-type: none"> • Established by the Queensland Government to facilitate the development and accelerated deployment of low emissions coal technology to preserve the State's competitive position in power generation and continued mining, use and exports of its extensive coal resources. • Provide 520MW (gross) IGCC power plant with CCS of up to 90% capture or 3 million tonnes CO₂ per annum.
4. Recent Milestones
<ul style="list-style-type: none"> • Extensive prefeasibility study nearing completion. Report to be finalised by end June 2010. • Study funded by State Government, Federal Government, ACA Low Emissions Technologies Pty Ltd, Mitsubishi Corporation and Mitsubishi Heavy Industries. • MHI agreed to provide EPC wrap for IGCC and carbon capture. • Test injection of >400 tonnes CO₂ completed in Northern Denison Trough near Emerald. • One of 4 projects shortlisted for funding by federal government under its Clean Energy Initiative - a \$2 billion CCS Flagships Program. • State Coordinator General declares ZeroGen a project of significance for which an Environmental Impact Study is required. • State Government issued tenders in April for geosequestration tenements covering 66,000 square kilometers in Surat, Galilee, Bowen and Adavale Basins in Queensland. • ZeroGen's CO₂ storage exploration extended to two projects in Northern Denison Trough and Surat Basin.
5. Status
<ul style="list-style-type: none"> • Power plant site selection Q2 2010 • Environmental Impact Study commenced Q1 2010 • Feasibility study to commence Q4 2010 • Construction to begin 2012 • Operations commence before end of 2015