



CSLF-T-2009-01

**Minutes of the Technical Group Business Meeting
Washington, DC, USA
16 November 2008**

LIST OF ATTENDEES

Technical Group Delegates

Australia:	Peter Cook, Aleksandra Kalinowski
Canada:	Bill Reynen (Vice Chair), Stefan Bachu
European Commission:	Petre Petrov, Vangelis Tzimas
France:	Pierre Le Thiez, Christian Fouillac
Germany:	Hubert Höwener, Jürgen-Friedrich Hake
Italy:	Giuseppe Girardi, Fabrizio Pisanu
Japan:	Makoto Akai, Chiaki Shinohara
Korea:	Chang-Keun Yi, Chong-Kul Ryu
Mexico:	José Miguel González Santaló
Netherlands:	Harry Schreurs
Norway:	Trygve Riis (Chair), Jostein Dahl Karlsen
Saudi Arabia:	Abdulmuhsen Alsunaid
South Africa:	Elizabeth Marabwa, Jeffrey Kgobane
United Kingdom:	Nick Otter, Rachel Crisp
United States:	Joseph Giove, George Guthrie

CSLF Secretariat

John Panek, Richard Lynch, Scott Miles

Invited Speakers

Victor Der, United States Department of Energy
Antonio Pflüger, International Energy Agency (IEA)
Tim Dixon, IEA Greenhouse Gas R&D Programme (IEA GHG)
Steve Whittaker, Petroleum Technology Research Centre, Canada
Robert Gentile, Leonardo Technologies, United States
Bob Dahowski, Pacific Northwest National Laboratory, United States

Observers

Bill Koppe, Australia
John Bradshaw, Australia
Dennis Van Puyvelde, Australia
Rick Causebrook, Australia
Clement Yoong, Australia
Emmanuel Giry, Canada
Carolyn Preston, Canada
Dave Ryan, Canada
Bonijoly Didier, France
Bernard Frois, France
Kamel Bennaceur, France
Yann Le Gallo, France
Amir Mohammad Eslami, Iran
Francesco Melis, Italy
Meguru Miki, Japan
Nobumichi Morishita, Japan
Shingo Kazama, Japan
Olav Karstad, Norway
Chris Gross, South Africa
Johann Clur, South Africa
Marthinus Cloete, South Africa
Philip Lloyd, South Africa
Tony SurrIDGE, South Africa
Robert Hershey, United States
Arthur Lee, United States
Phillip Marston, United States
Andrew McCallum, United States
Robert Murray, United States
Jeff Price, United States
Victoria Schlesinger, United States
Judd Swift, United States
Doug Tanner, United States
John Wilkinson, United States
Philip Sharman, United Kingdom
Takahashi Masaki, World Bank
Saiko Yoshijima, World Bank

1. Opening Remarks

The Chair of the Technical Group, Trygve Riis of Norway, called the meeting to order and thanked the organizers of the 9th International Conference on Greenhouse Gas Technologies (GHGT-9) for providing meeting space for the CSLF Technical Group meeting in conjunction with the GHGT-9 meeting. Mr. Riis also thanked the United States and the support staff with the U.S. Department of Energy for their dedication and hard work in preparing for the meeting and welcomed all the observers.

2. Host Welcome

Victor Der, Principal Deputy Assistant Secretary for Fossil Energy at the United States Department of Energy, welcomed all attendees to Washington. Dr. Der also thanked the GHGT-9 conference organizers for its support of the CSLF Technical Group meeting. Dr. Der provided a prologue to the meeting by emphasizing the importance of the CSLF Technology Roadmap, stating that it was a key document and that there had been much progress at the recent meeting in Australia, which he had attended, for updating the Roadmap.

3. Introduction of Delegates and Observers

Technical Group delegates and observers present for the session introduced themselves. Fifteen of the twenty-two CSLF Members were represented at this meeting, including representatives from Australia, Canada, the European Commission, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, Norway, Saudi Arabia, South Africa, the United Kingdom, and the United States. There were 40 observers attending the meeting, representing ten countries and several international organizations. During the introduction of the delegates, Philip Sharman stepped down as a delegate for the United Kingdom and was replaced for this meeting by Rachel Crisp.

4. Adoption of Agenda

The Agenda was adopted with no changes.

5. Review and Approval of Minutes of Cape Town Meeting

The Technical Group minutes from the April 2008 meeting in Cape Town, South Africa were reviewed and approved as final with no changes.

6. Review of Cape Town Meeting Action Items

John Panek of the CSLF Secretariat reviewed the status of action items resulting from the Cape Town Technical Group meeting.

The following action items have been completed:

- Secretariat: Posted the Phase III report of the Storage Capacity Estimation Task Force to the CSLF website.
- Secretariat: Sent follow-up e-mails to non-responders for the CSLF stakeholder and project sponsor surveys. Project sponsors were polled about their interest in moving projects forward. Stakeholders were asked to share their reasons for putting forth projects or their reasons against submitting

projects for CSLF recognition. The results were included in a document written by the Secretariat for this meeting and were presented to the CSLF Projects Interaction and Review Team (PIRT) at its meeting earlier on November 16th.

The following action items are ongoing, in progress, or deferred:

- Secretariat: Pending selection of the Storage Capacity Coefficients project proposal by the IEA GHG, request access for CSLF delegates for the project's final report. (Note: The status of the Storage Capacity Coefficients project is described in Item 9 below.)
- PIRT: Prepare the schedule for the update to the CSLF Technology Roadmap. (Note: The status of the Roadmap is described in Item 8 below.)
- Secretariat and PIRT: Prepare detailed status report on CSLF projects for the next meeting. (Note: A progress report on this activity was written by the Secretariat for this meeting.)
- Australia, Italy, Netherlands, United Kingdom, United States, and IEA GHG: Identify points of contact from each Working Group member. (Note: The status of this activity is described in Item 11 below.)
- Secretariat: Circulate a Risk Assessment Task Force request form to the Technical Group delegates for response by the end of June. (Note: The Secretariat circulated the Task Force's request form to delegates and received only a few responses, which were forwarded to the Task Force Chair. The status of this activity is described in Item 11 below.)

7. Discussion of Opportunities to Collaborate with the IEA

The G8, at its 2005 Gleneagles meeting, requested that the CSLF and IEA work together on developing a set of recommendations on near-term opportunities for CO₂ capture and storage (CCS). Three workshops were held in 2006 and 2007 in Calgary, Canada; San Francisco, USA; and Oslo, Norway. A report was issued and recommendations were delivered to the G8 at its July 2008 meeting in Japan, where the G8 accepted these recommendations and requested a plan for implementation with both the CSLF and IEA playing a role.

The Chair invited Antonio Pflüger of the IEA to present a briefing on IEA CCS activities. Dr. Pflüger reviewed several key recent activities, including the joint IEA/CSLF statement to the G8 in Japan. At that meeting the G8 ministers and energy ministers of China, Korea, and India affirmed their strong support of CCS and the initiation of 20 large-scale CCS projects by 2020.

Dr. Pflüger mentioned that in June 2007, a "Legal Aspects of Storing CO₂" report was published by the IEA to assist in development of legal and regulatory frameworks. However, more work remains in this area. The International CCS Regulators Network was launched May 2008 in Paris and includes 100 experts. Since then, two telephone conferences have taken place (in July and October 2008). Key areas yet to be explored include jurisdiction establishment among agencies, classification of CO₂, transportation, public health protection and environment, and monitoring. More conferences are being planned, with participation by invitation only via a sign-up page at the IEA website.

The question remains whether adequate information exchange on regulations exists or if more is needed. A synthesizing document to streamline regulations might be helpful. Another international workshop is needed on regulations followed by documentation of results, and the IEA is looking for a country to host such a meeting. CSLF Members will be contacted as more information becomes available.

Dr. Pflüger also briefed attendees on the technical study on CO₂ capture-ready plants sponsored by the IEA GHG. The study was prepared by leading manufacturers and academia in the United Kingdom and reviewed by technology holders in the United States, United Kingdom and the Netherlands, as well as the IEA Secretariat. Additional discussion on what constitutes “capture readiness” is still needed, however.

One other IEA publication now available is the *IEA World Energy Outlook 2008*, which includes several scenarios on atmospheric CO₂ stabilization. The main conclusion of the 450 parts per million stabilization scenario was that an equivalent of 310 gigawatts worth of coal-fired power plants must to be equipped with CCS. This represents around 620 standard sized coal-fired power plants. CCS was broadly addressed in the *World Energy Outlook*. A high level CCS Summit is planned in 2009 (United Kingdom, Australia, and Norway have already committed) to create a platform for making major new commitments and informing the public, focusing on funding near term demonstrations and announcements by government and industry.

Dr. Pflüger said the IEA plans to come up with a more detailed roadmap in 2009. He stressed the importance of technology roadmaps as they underlie and steer modeling. Technology roadmaps are also used by many countries as an energy policy tool with the goal of accelerating technology development. Roadmaps encompass technology, policy, legal, financial, market, and organizational requirements and are useful for making modeling and actions consistent, accelerating actions, and tracking progress. A roadmapping workshop was held in Paris in early November 2008. The IEA will send a synthesis document to meeting attendees for review and comment and will later expand to a larger CCS network. A second meeting will take place in early February 2009. The final draft review is scheduled for April 2009 and publication in June 2009.

Dr. Pflüger stated that the IEA’s priorities for advancing deployment of CCS include:

- Holding demonstrations and bridging financial gap.
- Taking concerted international action.
- Creating a value for CO₂ for commercialization of CCS.
- Establishing legal and regulatory frameworks.
- Communicating with public.
- Building infrastructure.
- Considering requirements for retrofit with CO₂ capture.

Dr. Pflüger stressed that the CSLF must strengthen its message because other groups incorrectly believe CCS will only have a minor impact on reducing emissions. He stated that the CSLF should concentrate on aiding development of international co-operative activities that build on existing networks and industry to further develop and implement key technologies.

Recommendations for IEA/CSLF future growth include:

- Assess above action implementations and conduct workshops on ongoing basis.
- Prepare a report on international collaboration efforts.
- Prepare regionally focused assessments of CO₂ storage potentials and possibly match them to stationary sources.
- Share findings.
- Contribute to other events.
- Develop national legal and regulatory frameworks.

There were several questions and comments from meeting attendees. Jostein Dahl Karlsen of Norway complimented the IEA on its roadmapping work and agreed that this presents opportunities for further collaboration between the CSLF and the IEA. Nick Otter of the United Kingdom inquired as to which recommendations to the G8 the IEA was planning to address. Dr. Pflüger replied that the report is clear on key conclusions. Efforts are under way to establish legal/regulatory frameworks, raise education/awareness, and create a public presence. He stated that the report was purposely written to show clear conclusions in a step-by-step manner, but as a practical matter, the most prominent issues should be addressed first. He also suggested that the CSLF could set up a small workshop to discuss and go through each proposed task one by one.

Stefan Bachu of Canada suggested, concerning the G8 recommendation for at least 20 large-scale demonstration projects, that the CSLF and/or the IEA could help collect, maintain, and distribute information about these projects. Bernard Frois of France suggested that the CSLF needs to identify the best projects and convince governments that they are necessary.

Dr. Pflüger said there is support for a meeting between the IEA and the CSLF and that he will propose a date and location. The purpose of this meeting would be to review current CSLF and IEA activities, identify gaps, and coordinate efforts to minimize any overlap. Makoto Akai of Japan emphasized that promptness of the meeting is key. John Panek stated that the Secretariat would welcome receipt of a letter from the IEA to the Policy Group Chair concerning the proposed meeting, and it will be circulated it to all CSLF delegates.

8. CSLF Technology Roadmap: Next Steps

The Chair of the PIRT, Nick Otter, provided a progress report on ongoing activities to update the CSLF Technology Roadmap. On 23-24 September, the PIRT convened a meeting in Canberra, Australia, to work on the Roadmap update. At that meeting, a timetable was established for completion of the update:

- 16 November 2008: Review of Progress at CSLF Technical Group meeting in Washington.
- 5 December 2008: Updated Technology Roadmap to be issued.
- 19 December 2008: Need technical points of contact for each CSLF Member.
- 9 January 2009: Deadline for comments.

- 4-5 February 2009: PIRT Technology Roadmap review meeting scheduled in Paris, France.
- February/April: Robust draft required.
- April 2009: Subsequent review/agreement by Technical Group.
- May 2009: Submission of updated Technology Roadmap to the CSLF Policy Group for review and endorsement.

Mr. Otter stated that the Roadmap needs to align with both the CSLF Strategic Plan and the IEA Technology Roadmap. The structure of the Roadmap is not changing substantially – this will be more of an update than a rewrite. Modules 0 and 1 are in good shape. Module 2 requires a major rewrite including “now and then” maps of CCS activities. Modules 3 and 4 are mostly complete but still need to be edited.

Peter Cook of Australia commented that the time period covered by the Roadmap isn't discussed until page 25 and that the timing needs to be presented earlier in the document. He also commented that economics need to be further embedded into the Roadmap and be all encompassing, not just dealing with the capture side. Economics need to drive the Roadmap. Mr. Otter replied that Dr. Cook's comments will be incorporated.

Rachel Crisp of the United Kingdom and Jostein Dahl Karlsen both commented on the importance of sharing outlines for the Roadmap so all parties have a common destination.

9. IEA GHG Update

Tim Dixon of the IEA GHG provided an update on its activities. To date, twenty countries are in the IEA GHG as members and nineteen organizations are in as sponsors. Three studies have been published on CO₂ capture since the last CSLF Technical Group meeting in April 2008. Nineteen projects are underway including “What Have We Learnt to Date?” which is drawing upon knowledge gained from large-scale CCS projects.

Another of these projects is the Storage Capacity Coefficients project proposed by the CSLF earlier in 2008, which has been accepted by the IEA GHG Executive Committee for funding. This project will build upon work done by the CSLF Storage Capacity Estimation Task Force. The University of North Dakota's Energy and Environmental Research Center (EERC) is under contract to support this effort and the U.S. Department of Energy is also providing support. The report will be made available to the CSLF Technical Group when the work is completed.

New projects just approved are in the areas of quantification techniques for CO₂ leakage, incorporating future technology improvements in CO₂ capture plants, injection strategies for CO₂ storage sites, and water usage of power plants with CO₂ capture. Mr. Dixon stated that there are ongoing opportunities for proposals, as the IEA GHG Executive Committee meets every six months. The deadline for proposals for the next Executive Committee meeting is January.

The Chair issued a call for proposals and encouraged people to send any proposals to the Secretariat.

10. Discussion of Projects for Potential CSLF Recognition

The Chair noted that there is a troublesome downward trend in the past few years in the number of projects coming before the CSLF for recognition. There will be a Ministerial meeting of the CSLF next year and one of the deliverables should be a new set of projects proposed for recognition that are greater in number than just one or two.

Vice Chair Bill Reynen of Canada provided some historical context for the issue of fewer new projects. There were a large number of projects recognized in the initial years of the CSLF but there has of late been a downward trend of projects proposed for recognition as the CSLF has sought to avoid duplication and select projects which fill existing gaps in the project portfolio. Mr. Reynen suggested that the CSLF should set a target of ten new projects proposed for CSLF recognition at the 2009 Ministerial meeting and called for a new working group to address this issue.

Nick Otter offered the view that any potential projects need to relate to the Technology Roadmap. He agreed on the need for new working group to study attracting new projects for the Ministerial meeting and stated that the PIRT is overextended with current assignments and so is not the appropriate choice to take on this assignment. Mr. Reynen accepted the call to lead this new working group and delegates from the United States, the United Kingdom, and the Netherlands also volunteered to join.

11. Committee Reports

Project Interaction and Review Team (PIRT)

Nick Otter provided an update on the activities of the PIRT, including outcomes from its meeting earlier on November 16th. Much of the PIRT's activities were covered in the earlier Technology Roadmap presentation as that is a key focus of the PIRT. Other major activities are interaction with IEA GHG and research and technical programs from Europe. Mr. Otter introduced the PIRT members and formally welcomed France as a PIRT member. Besides the previously-described review of activities related to the Technology Roadmap, the earlier PIRT meeting also included a summary of feedback received by the Secretariat on the project recognition survey. Mr. Otter also welcomed the initiative suggested by Mr. Reynen for attracting new projects.

Mr. Otter felt that the United Kingdom should retain leadership of the PIRT until work on updating the Roadmap is complete, as a change in leadership at this point would slow down the PIRT's work. The next meeting of the PIRT will be 4-5 February 2009 in Paris, to continue Roadmap update activities. Another PIRT meeting will be held on the morning of the next Technical Group meeting.

Risk Assessment Task Force

George Guthrie of the United States provided a status report on the activities of the Risk Assessment Task Force. Task Force members include Australia, Canada, France, India, Japan, the Netherlands, Norway, the United Kingdom, the United States, and the IEA GHG. The Task Force's mission is to examine risk-assessment standards, procedures, and research activities relevant to and associated with the injection and long-term storage of CO₂. These include CO₂ near-term (injection) processes (such as fracturing, fault reactivation, and induced seismicity) and long-term processes

related to impacts of CO₂ storage, including health, safety, and environmental risks, potential impact on natural resources (such as groundwater and mineral resources), and return of CO₂ to the atmosphere.

Dr. Guthrie stated that the Task Force expects to have a report of its Phase I work as a room document for the next Technical Group meeting. Sections of this report reviewing the methodologies, literature, and terminology for risk assessment as applied to geologic storage of CO₂ have already been revised and integrated, and an appendix has been added on terminology. A full draft of this report will be circulated to Task Force members for review in December.

The Task Force has expanded a preliminary assessment of ongoing and emerging research activities and input has been received from Australia, Canada, France, Japan, United States and the IEA GHG. The Secretariat, acting on behalf of the Task Force, circulated a form to Technical Group members requesting input on risk assessment activities in their countries, with a focus on risk assessment projects rather than organizations. To date, there has been only a limited response and any final input on projects should be submitted to Secretariat as soon as possible.

Working Group on Student Body Initiative

Aleksandra Kalinowski of Australia gave a brief presentation of the activities of this working group. The idea to form a student body of the CSLF was proposed in January 2008 at the Al Khobar meeting and a decision was made at the April Cape Town meeting to form a working group for implementation. Australia, Italy, Mexico, the Netherlands, the United Kingdom, the United States, and the IEA GHG are participating in this working group.

Ms. Kalinowski stated that henceforward, the name for this working group will be the Technical Outreach/Study Body Initiative Working Group. The objective is to encourage international interaction between students engaged in the study of CCS and to give them a resource for interaction, which could include networking, discussing research, and communicating with researchers in other institutions. The short-term goals of the working group are to increase the technical capacity in CCS, encourage student/researcher collaboration, and assemble a directory of student and researcher international activities. The working group is looking at having a career center where students can post resumes and companies can post openings for internships and jobs. A mentor program is also a possibility. The working group aims to complete its much or all of its work by the next Technical Group meeting, but an issue yet to be resolved is how or where these kinds of student forums can be hosted.

Several delegates complimented the working group on its goals and applauded the working group's activities. Amir Mohammad Eslami, an observer from Iran, inquired if the working group was open to stakeholders. Iran has many students and researchers studying CCS and enhanced oil recovery (EOR). He is an advisor to CCS students and offered his assistance to the working group. Ms. Kalinowski stated that any support and assistance would be most welcome.

12. Updates on CSLF-Recognized Projects

IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project

Steve Whittaker, Senior Project Manager, Petroleum Technology Research Centre, Canada presented a status update on the CSLF-recognized Weyburn-Midale project.

The project is located in the Williston Basin in Southeastern Saskatchewan, Canada, and is the world's largest full-scale, field study of CO₂ storage associated with commercial EOR operations. The CO₂, of greater than 95% purity, is produced by the Great Plains Synfuels Plant at Beulah, North Dakota, in the United States, and is transported by pipeline to the Williston Basin by pipeline. This US\$80 million project is currently in its final phase, which began in 2005 and is scheduled to end in 2011. To date, about 12 million tons of CO₂ have been injected into the field, 10 million in the Weyburn field (operated by Encana) and 2 million in the adjacent Midale field (operated by Apache). The project expects to store about 40 million tons in the reservoir by 2035. The incremental benefit to this project is production of 20,000 barrels of oil per day.

Results from the first phase of the project demonstrated that Weyburn is an effective geological "container" for CO₂. The primary carbonate and secondary shale seals are highly effective and there is hydraulic separation between adjacent aquifers. Initial results indicate over 98% of the initial CO₂ in place will remain stored for hundreds of years. About 9% of the CO₂ will migrate laterally and about 18% will move downwards. A small fraction will move up the old wellbores. Wellbore integrity is a key interest of technical studies. Further work is required and the development of risk management practices is needed.

Objectives of the final phase are to develop a best practices manual which will guide all aspects of future CO₂ EOR-Storage projects and ensure integration across technical and policy research. The final phase includes the following components:

Technical Components

- Site Characterization
- Monitoring and Verification
- Wellbore Integrity
- Performance Assessment

Policy Components

- Regulatory Issues
- Regulatory issues
- Public Communication and Outreach
- Fiscal Policy Issues

The Weyburn-Midale field contains about 1 billion barrels of oil in place. The field size is about 110 square miles. Projections are for the field to store 40 million tons of CO₂, equivalent to the removal of 8 million cars from the road for a year.

Currently about 33 tasks that have been reviewed and initiated under the four major technical themes:

- Geological Integrity
- Wellbore Integrity
- Geophysical and Geochemical Monitoring
- Risk Assessment

Jostein Dahl Karlsen inquired as to the total amount of stored CO₂ to be stored by 2035 and if the project will become a continuous storage project after it ceases being an EOR project. Mr. Whittaker replied that the amount of stored CO₂ and the status of the project will depend on the future prices of oil and pure CO₂. He mentioned that the 40 million ton figure for total CO₂ stored will most likely be on the low end of

projections. In 2035, if there is no more oil to be extracted from the field, it will probably become a storage project. If the price of pure CO₂ remains high, some will likely be extracted and sold. However, this would likely be minimal because the CO₂ will be dissolved in the water in the field.

Aquistore

Mr. Whittaker also briefly discussed another project of possible interest to the CSLF. Aquistore is a US\$100 million deep store aquifer project which began in July 2008 and is scheduled to run through July 2013. CO₂ for the project is coming from a refinery that recently expanded production. The extra CO₂ from the increased production, 500 tons per day, is being transported by pipeline and injected into a deep saline aquifer. The project has a comprehensive measurement, monitoring and verification (MMV) program.

The objectives of the project are to demonstrate that CO₂ deep saline aquifer storage is a safe, workable solution for emissions reductions; to develop a transportable, integrated suite of technologies for carbon storage in a saline aquifer; and to establish an environment for creating linkages between financial institutions developing domestic trading schemes, an appropriate regulatory environment, industrial commercialization, and public acceptance. The work plan for the project includes the following elements:

- Task 1: Site Selection
- Task 2: Geological and Hydrogeological Detailed Site Characterization
- Task 3: Seismic Monitoring and Site Characterization
- Task 4: Groundwater Sampling and Analysis
- Task 5: Fluid Sampling and Analysis
- Task 6: Aquifer Mineralogy
- Task 7: Monitoring Wells
- Task 8: Reactive Transport Numerical Simulations
- Task 9: Risk Assessment and Risk Management Framework
- Task 10: Commercialization/ Economic Analysis

Regional Opportunities for CO₂ Capture and Storage in China

Robert Gentile of the United States provided a brief history of the CSLF-recognized China Sources and Sinks project. This project is sponsored by Leonardo Technologies and Battelle under the auspices of the U.S.-China Energy and Environment Technology Center led by Tulane University. The objectives were to look, with their Chinese partners, for opportunities for carbon sequestration in China. The project looked at CO₂ sources and sinks and matching transportation and cost curves.

Robert Dahowski of the United States gave the technical presentation on this project. The project objectives were:

- Develop the first ever bottom-up cost assessment of the potential to utilize carbon dioxide capture and storage (CCS) across the Chinese economy.
- Assess the potential and costs for CCS technologies to deploy across regions of China.
- Inventory large anthropogenic CO₂ point sources from power plants and other industrial sources.

- Identify potential candidate geologic CO₂ storage reservoirs/basins which could be used for the safe, long-term storage of CO₂.
- Examine the economics of CCS and develop cost curves for CO₂ transport and storage via optimized source-reservoir matching.

Key findings to date are:

- More than 1,620 large stationary CO₂ point sources were identified, with total emissions of more than 3,890 million tons of CO₂ per year.
- 91% of these large CO₂ point sources have a candidate CO₂ storage reservoir within 100 miles (161 kilometers).
- There is an estimated CO₂ storage capacity on the order of 2,300 gigatons of CO₂ in on-shore basins in China.
- There is strong potential for CCS technologies to offer significant emissions reductions in China at costs less than \$10 per ton CO₂ for transport and storage.
- Deep saline formations offer significant storage potential and 90% of the CO₂ stored in this analysis is injected into one of these.

The project partners cataloged existing CO₂ point sources and deep saline formations, deep unmineable coal seams, and depleted oil and gas fields as candidate CO₂ storage reservoirs. Project data was integrated into a GIS modeling framework to enable integrated spatial and economic analyses. The partners built a CO₂ cost curve describing CCS potential versus cost and examined regional opportunities, economics, and technical constraints.

In developing the cost curves for CO₂ transport and storage the project sponsors applied a cost-minimizing optimization process that was developed and used previously for a North American study. Cost assumptions were updated based on more recent published cost estimates.

- Net Storage Cost = Cost of Transport (via pipeline from plant gate) + Cost of Injection (site characterization, capital, operating, & MMV) - Revenue from Value-Added Hydrocarbon Recovery

The cost curve methodology computes thousands of source-reservoir cost pairs for these point sources and candidate storage reservoirs, i.e., many CO₂ point sources will have many candidate storage options available within a reasonable distance.

Possible next steps are to:

- Continue U.S. / China collaboration.
- Expand and refine CO₂ point source inventory.
- Further CO₂ storage reservoir evaluations and data collection.
- Assess and refine costs and methodology.
- Incorporate capture and compression costs.
- Examine more closely the economics of offshore storage.
- Look at challenges / potential technical and economic barriers to CCS deployment.
- Start identifying potential candidates for more detailed evaluation / demonstration project.

Mr. Karlsen asked what was behind the cost curves and if the information sheds light on early opportunities in China. Mr. Dahowski responded that the low costs do speak to initial opportunities. However, some of these low costs might be overstated. The study suggests there are opportunities for early use of sequestration, but there are timing components to EOR operations and coal seams operations. Many oil fields and coal seams need to move closer to maturation before CO₂ injection can begin. Further investigation is needed to better understand where the early opportunities exist.

Jürgen-Friedrich Hake of Germany asked about the level of involvement by Chinese institutions. Mr. Dahowski replied that the Chinese Academy of Sciences and the Institute of Rock and Soil Mechanics were very active partners in the project. They helped considerably with data collection, geology estimates, their expertise, and with their governmental connections.

CO2CRC Otway Project

Aleksandra Kalinowski briefed the Technical Group on the CSLF-recognized CO2CRC Otway project, located in southwestern Victoria in Australia. This project features injection of CO₂ produced from a natural accumulation into a nearby depleted gas field. International project partners include Australia, Canada, the United States, Korea, and New Zealand. Injection of CO₂ began in April 2008 and has totaled about 30,000 tonnes to date. A range of monitoring techniques is being deployed around the site, and there is now evidence that CO₂ is starting to reach the monitoring well as planned, which is important to validating the models. Injection will continue for several more months more, until the total amount of injected CO₂ reaches about 50,000-100,000 tonnes. The project is developing plans for a second stage, which will inject CO₂ into a saline aquifer at a depth of 1,500 meters.

13. Upcoming Meetings

There was consensus that next Technical Group meeting will be 1-2 April 2009 in Oslo, Norway. Committee meetings will be held the morning of April 1st with the Technical Group meeting commencing in the afternoon.

The CSLF Ministerial meeting will be 16-18 November 2009 in London. The Policy Group has organized a Task Force for planning the Ministerial meeting and has requested input into the agenda from the Technical Group. The updated CSLF Technology Roadmap and a slate of new projects proposed for CSLF recognition will be ready for inclusion in that meeting. The Policy Group has requested suggestions for potential speakers for the Plenary Session.

Bernard Frois suggested that a group be formed to decide on the messages that the Technical Group would like to promote. Once this has been settled on, a list of potential speakers could be assembled. Dr. Frois stated that the Technical Group needs to have a clear message to present to the Ministers, as their time is limited and we must maximize our impact. Rachel Crisp spoke on behalf of the host country, the United Kingdom, in saying that a clear set of deliverables is needed. A new Technology Roadmap and a slate of new projects for CSLF recognition would make attractive deliverables. The host is looking at a format to celebrate all twenty CSLF recognized projects. Ms. Crisp also mentioned that at the CSLF Cape Town meeting, there was a commitment made to set aside half of a day for stakeholders.

Jürgen-Friedrich Hake voiced a concern about the timing of the unveiling of the CSLF Technology Roadmap. The IEA plans to release their roadmap in June and so care must be taken so that the CSLF Technology Roadmap is delivered with some impact and is not simply seen as following the IEA roadmap.

14. New Business

Bill Reynen introduced the concept of a strategic review of the CSLF Technical Group ahead of the CSLF Ministerial meeting scheduled for 16-18 November 2009. Such a review was discussed for the CSLF Policy Group at its meeting in Cape Town. Mr. Reynen suggested that now that the CSLF is halfway through its mandate, timing is ripe to review the CSLF's activities in advance of the Ministerial meeting. He proposed this idea for consideration at the next Technical Group meeting and for the formation of an ad hoc group to consider the idea.

However, Rachel Crisp, Policy Group Vice Chair, mentioned that the Policy Group has a Task Force in place, headed by Ian Hayhow of Canada, that is formulating a plan for the CSLF's activities for the next five years. The output from this Task Force will be a key deliverable at the Ministerial meeting. Nick Otter said that Technical Group is coordinating with this Task Force so that the Technology Roadmap is in harmony with the Task Force's plan for the next five years.

15. Review of New Action Items

New action items resulting from this meeting were reviewed and are listed below.

Action Items arising from Washington Technical Group Meeting

Item	Lead	Action
1	Secretariat	Forward to delegates the invitation letter on Technology Roadmap collaboration with the IEA. Letter will be sent to Policy Group Chair and it should be circulated to all Policy and Technical Group delegates.
2	PIRT	Convene meeting on 4-5 February 2009 in Paris to continue update activities for CSLF Technology Roadmap.
3	Canada (lead), Netherlands, United Kingdom, and United States.	Form new working group to locate potential projects for CSLF recognition.
4	Delegates	Provide PIRT chair with one point of contact for each CSLF Member who will distribute Technology Roadmap modules for comment.
5	PIRT	Assemble technical points of contact from CSLF Members.