



## Minutes of the Technical Group Meeting

Riyadh, Saudi Arabia  
Monday, 02 November 2015

### LIST OF ATTENDEES

#### Chair

Trygve Riis (Norway)

#### Delegates

Australia: Andrew Barrett (*Acting Vice Chair*), Max Watson  
Canada: Eddy Chui (*Vice Chair*), Michael Monea  
China: Xian Zhang  
European Commission: Jeroen Schuppers  
France: Didier Bonijoly, David Savary, Bernard Frois  
Italy: Sergio Persoglia  
Japan: Ryoza Tanaka, Takeshi Kawabata  
Korea: Chang Keun Yi, Chong Kul Ryu  
Norway: William Christensen, Lars Ingolf Eide  
Saudi Arabia: Khalid Abuleif, Ali Al-Meshari  
South Africa: Tony Surridge (*Vice Chair*)  
United Arab Emirates: Arafat Saleh Al-Yafei  
United Kingdom: Philip Sharman, Brian Allison  
United States: Mark Ackiewicz, Stephanie Duran

#### Representatives of Allied Organizations

Global CCS Institute: Andrew Purvis  
IEAGHG: Tim Dixon

#### CSLF Secretariat

Richard Lynch, Adam Wong, Jarad Daniels

#### Invited Speakers

Australia: Max Watson, Program Manager – CO<sub>2</sub> Storage, CO2CRC  
France: Isabelle Czernichowski-Lauriol, CGS Europe Coordinator,  
BRGM  
Germany: Frank Ennenbach, Director – R&D and Technology  
Environmental Control Solutions, Alstom  
Korea: Chang Keun Yi, Director – Climate Change Research  
Division, Korea Institute of Energy Research (KIER)  
Saudi Arabia: Khalid Abuleif, Sustainability Advisor to the Minister,  
Ministry of Petroleum and Mineral Resources  
Ali Al-Meshari, Manager – EXPEC Advanced Research  
Center, Saudi Aramco

Saudi Arabia:	Tidjani Niass, Chief Technologist – Carbon Management Division, Saudi Aramco Atieh Abu Raqabah, General Manager – Corporate Sustainability, Saudi Arabia Basic Industries Corp. (SABIC)
United States:	Nigel Jenvey, Chairman, CO <sub>2</sub> Capture Project

### **Observers**

Chinese Taipei:	Vincent S.N. Chen, Yi-Shun Chen, Shoung Ouyang
Czech Republic:	Pavel Kavina
Germany:	Gianluca Di Federico
Korea:	Sangjoo Baek, Byeong Yeol Jeon
Mexico:	Rubén Beltrán-Palafox
Netherlands:	Maurice Hanegraaf, Gerrit van Tongeren
Norway:	Åse Slagtern
Qatar:	Saif Saeed Al-Naimi
Romania:	Mircea Toader
Saudi Arabia:	Saeed Al Alloush, Alla Yousef Al-Amrey, Saleh Al-Ansari, Abdullah Al-Ghabi, Abdelrahman Al-Gwaiz, Mohammed Al-Hamed, Waleed Al-Harbi, Awwad Al-Harhi, Abdullah Al-Hemdi, Adel Al-Khalifah, Sulaiman Al-Mayman, Saeed Al-Mehairbi, Abdullah Al-Musa, Hussain Al-Musawa, Ammar Al-Nahwi, Fouad Al Saeedi, Haitham Al-Soudani, Abdulrahman Al-Suhaibani, Abdullah Bogari, Muayad Matar, Hatem Mohiey, Wolfgang Heidug, Renato Hoogeveen, Medhat Nemitallah, Abdullah Tawlah, Muhammad Zahid
Turkey:	M.E. Burpinar, Nuri Kunt
United Arab Emirates:	Mohammed Al-Hamed, Hussain Al-Musawa, Khaled Al-Yagoubi
United States:	Ed Dodge, Scott McDonald, Tip Meckel, Shishir Tamotia
GCCSI:	Victor Der

## **1. Chairman's Welcome and Opening Remarks**

The Chairman of the Technical Group, Trygve Riis, called the meeting to order and welcomed the delegates and observers to Riyadh. Mr. Riis mentioning that this is an important meeting because there will be decisions on future Technical Group activities. A working group led by the United States has developed a prioritized list of proposed new activities.

Mr. Riis also mentioned that the current meeting is, as usual, very content-rich, with many presentations of interest to attendees. This includes presentations from five projects which have been nominated for CSLF recognition. Mr. Riis closed his remarks by mentioning that he will make a presentation during the Ministerial Conference later in the week that will provide key messages and recommendations from the Technical Group.

## **2. Meeting Host's Welcome**

Khalid Abuleif, Sustainability Advisor to Saudi Arabia's Minister of Petroleum and Mineral Resources, welcomed the meeting attendees to Riyadh. Mr. Abuleif stated that the 6<sup>th</sup> CSLF Ministerial was a very significant event for Saudi Arabia, as it is the largest and highest profile meeting ever in this part of the world about carbon capture and storage (CCS) and would be a prolog to the Conference of Parties (COP) climate talks in Paris.

### 3. Introduction of Delegates

Technical Group delegates present for the meeting introduced themselves. Fourteen of the twenty-three CSLF Members were represented. Observers from thirteen countries were also present.

### 4. Adoption of Agenda

The Agenda was adopted with the addition of a presentation by the Dry Solid Sorbent CO<sub>2</sub> Capture Project, which was nominated by Korea for CSLF recognition. This project had been a late addition to the previous day's PIRT meeting where it had been considered and sent forward to the Technical Group with a recommendation for its review and endorsement.

### 5. Approval of Minutes from Regina Meeting

The Minutes from the June 2015 Technical Group Meeting were approved with no changes.

### 6. Report from CSLF Secretariat

Richard Lynch provided a report from the CSLF Secretariat which covered the status of action items from the June 2015 meeting in Canada and some of the highlights from that meeting. This was a five-day event, including a site visit to SaskPower's Boundary Dam CCS Project and CO<sub>2</sub> Capture Test Facility.

Mr. Lynch stated that there were seven Action Items from the June 2015 meeting, six of which are now complete. Still in progress is an activity assigned to the Secretariat to create a new section of the CSLF website for tracking progress on 2<sup>nd</sup> and 3<sup>rd</sup> generation CO<sub>2</sub> capture technologies. In addition to these Action Items, consensus was reached by the Technical Group on the following items:

- The Jingbian CCS Project is recommended by the Technical Group to the Policy Group for CSLF recognition. (*note: The project received CSLF recognition at the Policy Group's meeting two days later.*)
- The Technical Group will form a working group to develop additional Action Plan activities.
- The Technical Group will revise the CSLF Technology Roadmap (TRM) Interim Report, incorporating new information about the current status of technology for the identified ten technology needs areas.

Mr. Lynch also stated that four documents had been prepared as deliverables by the Technical Group for the Ministerial Conference, all of which are included in a special briefing book for the Ministers:

- TRM Interim Report (the Executive Summary from the full report, which reviews progress toward implementation for ten technology areas identified by the 2013 TRM);
- Report on Development of 2<sup>nd</sup> and 3<sup>rd</sup> Generation CO<sub>2</sub> Capture Technologies (the Executive Summary from the full report);
- Key Messages from the CSLF "Lessons Learned from Large-Scale CCS" Workshop (which was held as part of the Regina meeting); and

- Messages and Recommendations from the CSLF Technical Group (including takeaways from task forces and other Technical Group activities).

Mr. Lynch ended his presentation by noting that Mr. Riis is departing the CSLF after a very successful seven years as Technical Group Chairman. Mr. Lynch stated that it had been an a privilege to have worked alongside Mr. Riis as Secretariat and, in honor of the occasion, presented Mr. Riis with a CSLF Recognition Award. The meeting attendees added their best wishes with a round of applause.

## **7. Overview of CCS Activities in Saudi Arabia**

Ali Al-Meshari, Manager of Saudi Aramco's EXPEC Advanced Research Center and Carbon Management Overall Coordinator for Saudi Arabia, gave a detailed presentation that described ongoing CCS activities in Saudi Arabia. The overall message was that technology development and deployment is a viable option to address climate change.

Dr. Al-Meshari stated that Saudi Arabia's program for CCS includes small-scale R&D being done at research centers and universities, where topics include CO<sub>2</sub> utilization, enhanced oil recovery (CO<sub>2</sub>-EOR), CO<sub>2</sub> storage, CO<sub>2</sub> capture, and advanced materials. Larger-scale activities, sponsored by Saudi Aramco and SABIC, range from pilots and prototypes all the way up to large scale demonstrations. Five main areas of interest are CO<sub>2</sub>-EOR, CO<sub>2</sub> sequestration, CO<sub>2</sub> capture from fixed sources (including oxy-fuel combustion), CO<sub>2</sub> capture from mobile sources (being demonstrated by two prototype vehicles), and industrial applications.

Dr. Al-Meshari closed his presentation by stating that Saudi Arabia already has a CSLF-recognized project (the Uthmaniyah EOR Project) and two others (a large oxy-fuel pilot project and a large-scale CO<sub>2</sub> utilization project) have been nominated for CSLF recognition at the current meeting. These prototype projects are important components in Saudi Arabia's overall carbon management plan.

## **8. Update on the CO<sub>2</sub> GeoNet and CGS Europe Projects**

Isabelle Czernichowski-Lauriol, former CO<sub>2</sub> GeoNet President and current CGS Europe Coordinator, gave a presentation that described both of these CSLF-recognized projects. CO<sub>2</sub> GeoNet was initiated in 2004 as a Network of Excellence under the European Union's Sixth Framework Programme for Research and Technological Development (FP6). Founding members included 13 research institutes located in seven European countries. In 2008, CO<sub>2</sub> GeoNet transformed from being a project into being an Association (under French law) and as an independent and multidisciplinary organization, it has taken on a key role in building trust on CO<sub>2</sub> geological storage and supporting wide-scale CCS implementation. The CO<sub>2</sub> GeoNet Association is now the European scientific authority dealing with all aspects of geological storage of CO<sub>2</sub> and its activities have included joint research, scientific advice, training, and information / communication.

Concerning the CGS Europe Project, Dr. Czernichowski-Lauriol stated that the objectives of the project were to build a credible, independent and representative pan-European scientific body of expertise on CO<sub>2</sub> storage. To that end, the project has attracted a total of 24 partners representing 34 research institutes in 28 countries. The project ended in 2013, and in its three-year duration it has created and provided an information pathway which will help lead toward future large-scale implementation of CO<sub>2</sub> geological storage in Europe. Dr. Czernichowski-Lauriol closed her presentation by mentioning that since the end of the CGS Europe Project, many of its partners have continued to collaborate by

joining the CO<sub>2</sub> GeoNet Association, and as a result, CO<sub>2</sub> GeoNet is now a reference source for stakeholders throughout the world.

## 9. Overview of Alstom's Oxyfuel Development Program

Frank Ennenbach, Director of R&D and Technology in Alstom Power's Environmental Control Solutions division, gave an overview presentation about Alstom's oxy-combustion technology activities. Alstom views oxy-combustion as a robust and flexible technology that works with all types of boilers and fuels. It can be used for large commercial units up to about 1,000 MW<sub>e</sub>, including those with ultra-supercritical steam cycles. Oxy-combustion is cost competitive with other CO<sub>2</sub> capture technologies and has the advantage of not introducing new chemicals (such as amine sorbents) into a power plant.

Mr. Ennenbach stated that Alstom has been developing oxy-combustion technology since the 1990s, and has operated a 15 MW<sub>th</sub> pilot plant in the United States. The technology is now ready for commercial-scale demonstration, which is anticipated at the United Kingdom's White Rose Project where a new 448 MW<sub>e</sub> facility, currently in design, would treat 100% of the flue gas and have a 90% CO<sub>2</sub> capture rate. The CO<sub>2</sub> would be transported by pipeline to an offshore deep saline formation storage site.

Mr. Ennenbach also stated that Alstom and Saudi Aramco are collaborating on a large-scale pilot for testing oxy-combustion with heavy residue oil. Development has included a feasibility study for scale-up to commercial scale and also a three-week combustion test of the use of heavy residue fuel at Alstom's pilot plant in the United States. The large-scale pilot has been nominated for CSLF recognition, with a separate presentation on it later in the meeting.

## 10. Update from the IEA Greenhouse Gas R&D Programme (IEAGHG)

Tim Dixon gave a presentation about the IEAGHG and its continuing collaboration with the CSLF's Technical Group. The IEAGHG was founded in 1991 with the mission to provide information about the role of technology in reducing greenhouse gas emissions from use of fossil fuels. The focus is on CCS, and the goal of the organization is to produce information that is objective, trustworthy, and independent, while also being policy relevant but not policy prescriptive. The "flagship" activities of the IEAGHG are the technical studies and reports it publishes on all aspects of CCS, the eight international research networks about various topics related to CCS, and the biennial GHGT conferences, the next one in November 2016 in Lausanne, Switzerland.

Mr. Dixon mentioned that since 2008 the IEAGHG and CSLF Technical Group have enjoyed a mutually beneficial relationship which allows each organization to cooperatively participate in the other's activities. This has included mutual representation of each at CSLF Technical Group and IEAGHG Executive Committee (ExCo) meetings, and also the opportunity for the Technical Group to propose studies to be undertaken by the IEAGHG. These, along with proposals from IEAGHG ExCo members, go through a selection process at semiannual ExCo meetings. So far there have been four IEAGHG studies that originated from the CSLF Technical Group: "Development of Storage Coefficients for CO<sub>2</sub> Storage in Deep Saline Formations" (March 2010), "Geological Storage of CO<sub>2</sub> in Basalts" (September 2011), "Potential Implications of Gas Production from Shales and Coal for CO<sub>2</sub> Geological Storage" (November 2013), and "Life Cycle Assessment of Carbon Capture, Utilization and Storage (CCUS) – Benchmarking". This

benchmarking study will actually be a workshop with a resulting report, the workshop taking place in the early part of 2016.

Mr. Dixon closed his presentation by mentioning that a special issue of the *International Journal of Greenhouse Gas Control* has been published in association with the IEAGHG, and contains 17 technical papers on CCS. One of them, “Review of CO<sub>2</sub> Storage Efficiency in Deep Saline Aquifers” by Stefan Bachu, is actually the final report of the Technical Group Task Force on Review of CO<sub>2</sub> Storage Efficiency in Deep Saline Aquifers. Mr. Dixon was requested to determine a way to allow access to journal paper that is the task force’s final report via the CSLF website.

## **11. Report from the CSLF Projects Interaction and Review Team (PIRT)**

The Acting PIRT Chair, Andrew Barrett, gave a short presentation that summarized the previous day’s meeting. Mr. Barrett stated that the PIRT had evaluated five projects which had been nominated for CSLF recognition and had recommended all five for consideration by the Technical Group:

- CO<sub>2</sub> Capture Project, Phase 4
- CO<sub>2</sub>CRC Otway Project, Stage 2
- Oxy-Combustion of Heavy Liquid Fuels Project
- Carbon Capture and Utilization Project / CO<sub>2</sub> Network Project
- Dry Solid Sorbent CO<sub>2</sub> Capture Project

Mr. Barrett also briefly summarized other outcomes from the PIRT meeting. Concerning future technology workshops, there was support for a workshop themed on lessons learned from completed CSLF-recognized projects. Concerning whether there should be a TRM update for 2016, three main possibilities were considered: a full re-write of the 2013 TRM, another TRM Interim Report of some kind, or doing nothing. The preferred option was not to do either a new TRM or an Interim Report, and instead use next year to formulate a process and structure for future TRM update activities. After ensuing discussion, there was agreement by the Technical Group for this approach and a new working group was formed to determine the future of the TRM process. The working group will be chaired by Australia, and will also include representation by Norway, South Africa, the United Kingdom, the United States, the IEAGHG, and the CSLF Secretariat. The working group was asked to present its recommendations at the next Technical Group meeting.

## **12. Review and Approval of Project Proposed for CSLF-Recognition:**

### **Dry Solid Sorbent CO<sub>2</sub> Capture Project**

*(nominated by Korea and the United Kingdom)*

Chang Keun Yi, representing project sponsor KIER, gave a presentation about its CO<sub>2</sub> capture project. This is a pilot-scale project, located in southern Korea, which is demonstrating capture of CO<sub>2</sub> from a 10 MW<sub>e</sub> power plant flue gas slipstream, using a potassium carbonate-based solid sorbent. The overall goal is to demonstrate the feasibility of dry solid sorbent capture while improving the economics (target: US\$40 per tonne CO<sub>2</sub> captured). The project will extend through most of the year 2017. There will be 180 days continuous operation each year with capture of approx. 200 tonnes CO<sub>2</sub> per day at more than 95% CO<sub>2</sub> purity.

After a brief discussion, there was consensus to recommend to the Policy Group that the project receive CSLF recognition.

**13. Review and Approval of Project Proposed for CSLF-Recognition:  
CO<sub>2</sub> Capture Project, Phase 4**

*(nominated by the United Kingdom, Canada, and the United States)*

Nigel Jenvey, the Chairman of the CO<sub>2</sub> Capture Project, gave a presentation that described the 4<sup>th</sup> phase of the project. This is a multi-discipline project whose goal is to further increase understanding of existing, emerging, and breakthrough CO<sub>2</sub> capture technologies applied to oil and gas application scenarios (now including separation from natural gas), along with verification of safe and secure storage of CO<sub>2</sub> in the subsurface (now including utilization for enhanced oil recovery). The overall goal is to advance the technologies which will underpin the deployment of industrial-scale CO<sub>2</sub> capture and storage. Phase 4 of the project will extend through the year 2018 and includes four work streams: storage monitoring and verification; capture; policy & incentives; and communications.

After a brief discussion, there was consensus to recommend to the Policy Group that the project receive CSLF recognition.

**14. Review and Approval of Project Proposed for CSLF-Recognition:  
CO<sub>2</sub>CRC Otway Project, Stage 2**

*(nominated by Australia and the United States)*

Max Watson, representing project sponsor CO<sub>2</sub>CRC, presented the 2<sup>nd</sup> stage of a multi-stage CO<sub>2</sub> storage program at the Otway Project, located in southwestern Victoria, Australia. The goal is to increase the knowledge base for CO<sub>2</sub> storage in geologic deep saline formations through seismic visualization of injected CO<sub>2</sub> migration and stabilization. Stage 2 of the overall project will extend into the year 2020 and will include sequestration of approx. 15,000 tonnes of CO<sub>2</sub>. The injected plume will be observed from injection through to stabilization, to assist in the calibrating and validation of reservoir modeling's predictive capability. An anticipated outcome from the project will be improvement on methodologies for the characterization, injection and monitoring of CO<sub>2</sub> storage in deep saline formations.

After a brief discussion, there was consensus to recommend to the Policy Group that the project receive CSLF recognition.

**15. Review and Approval of Project Proposed for CSLF-Recognition:  
Oxy-Combustion of Heavy Liquid Fuels Project**

*(nominated by Saudi Arabia and the United States)*

Tidjani Niass, representing project sponsor Saudi Aramco, gave a presentation about its oxy-combustion project. This is a large pilot project (approx. 30-60 MW<sub>th</sub> in scale), located in Dhahran, Saudi Arabia whose goals are to investigate the performance of oxy-fuel combustion technology when firing difficult-to-burn liquid fuels such as asphalt, and to assess the operation and performance of the CO<sub>2</sub> capture unit of the project. The project will build on knowledge from a 15 MW<sub>th</sub> oxy-combustion small pilot that was operated in the United States by Alstom. An anticipated outcome from the project will be identifying and overcoming scale-up and bottleneck issues as a step toward future commercialization of the technology.

After a brief discussion, there was consensus to recommend to the Policy Group that the project receive CSLF recognition.

**16. Review and Approval of Project Proposed for CSLF-Recognition:  
Carbon Capture and Utilization Project / CO<sub>2</sub> Network Project**  
(nominated by Saudi Arabia and South Africa)

Atieh Abu Raqabah, representing project sponsor SABIC, gave a presentation about its carbon capture and utilization project. This is a large-scale CO<sub>2</sub> utilization project, including approx. 25 kilometers of pipeline infrastructure, which captures and purifies CO<sub>2</sub> from an existing ethylene glycol production facility located in Jubail, Saudi Arabia. More than 1,500 tonnes of CO<sub>2</sub> per day will be captured and transported via pipeline, for utilization mainly as a feedstock for production of methanol, urea, oxy-alcohols, and polycarbonates. Food-grade CO<sub>2</sub> is also a product, and the CO<sub>2</sub> pipeline network can be further expanded as opportunities present themselves.

After a brief discussion, there was consensus to recommend to the Policy Group that the project receive CSLF recognition.

**17. Report from Task Force on Technical Barriers and R&D Opportunities for  
Offshore, Sub-Seabed Storage of CO<sub>2</sub>**

Task Force Chair Mark Ackiewicz gave a brief update on the task force and its final report. The task force was established at the March 2014 meeting with the mandate to identify technical barriers and R&D needs / opportunities for sub-seabed storage of CO<sub>2</sub>. Mr. Ackiewicz stated that the task force had previously developed a draft of its final report for the June 2015 CSLF meeting in Regina. In all, the task force had 31 team members / contributors from seven countries and one multilateral organization, representing government agencies, universities, research laboratories, industry, and non-governmental organizations.

Mr. Ackiewicz provided information about the report's structure, which includes sections on all aspects of sub-seabed CO<sub>2</sub> storage such as resource assessments, CO<sub>2</sub> transport aspects, wellbore management, risk analysis, monitoring tools, and regulatory requirements. There are six main recommendations:

- Knowledge-sharing. Increase knowledge-sharing to define potential areas for international collaboration on offshore CO<sub>2</sub> storage. Need to leverage opportunities early and often.
- Storage Capacity Assessments. Much more information is needed in this area. Pre-qualify storage locations and basin evaluation. To facilitate doing this, make use of knowledge-sharing through international collaboration.
- Transport infrastructure. Offshore CO<sub>2</sub> transport is potentially expensive, but less subject to issues related to pipeline routing. Optimize current practices and infrastructure by taking advantage of pilot and demonstration projects.
- Offshore CO<sub>2</sub>-EOR. Recent advances in subsea separation and processing could extend the current level of utilization of sea bottom equipment to also include the handling of CO<sub>2</sub> streams. Explore opportunities to leverage existing infrastructure and field tests, which could lead to a mechanism to catalyze and facilitate offshore storage opportunities and infrastructure.
- Understanding of CO<sub>2</sub> Impacts on the Subsea Environment. A significant body of research exists, but there are many challenges to efficient monitoring, particularly

to identify and correct non-natural change. Need to better understand buffering potential of sediments and the impact of longer-term exposures. More modeling is needed. Leverage existing work.

- Monitoring Technology Development. Technology exists, but there is room for improvement. The quantification of CO<sub>2</sub> within a reservoir still remains a challenge. Need better real-time data retrieval and navigation. Need further development in integrated in situ sensors.

Mr. Ackiewicz closed his presentation by mentioning some possible next steps. A task force on Offshore CO<sub>2</sub>-EOR would be a good potential new activity area for the Technical Group. Also, the University of Texas Bureau of Economic Geology and the IEAGHG, both of which were task force members, have suggested that a workshop on offshore CO<sub>2</sub> storage would add to the overall knowledge base in this area. The final report from the Task Force will be made available at the CSLF website.

## 18. Decisions on Future Technical Group Action Plan Activities

Mark Ackiewicz, as lead of the working group to identify potential new Action Plan activities, gave a short presentation that described the working group's findings and recommendations. In all, fifteen possible areas of opportunity were investigated and opportunities considered to be of lesser priority were:

- Advanced Manufacturing Techniques Applied to CCS
- Dilute Stream / Direct Air Capture of CO<sub>2</sub>
- Global Residual Oil Zone (ROZ) Analysis and Potential for Combined CO<sub>2</sub> Storage and EOR
- Study / Report on Environmental Analysis Projects throughout the World
- Update on Non-EOR Utilization Options
- Ship Transport of CO<sub>2</sub>
- Definitions, TRL, scales
- Industrial CCS (revisit for application of 2<sup>nd</sup> generation technologies)
- Global Scaling of CCS
- Compact CCS
- Capturing CO<sub>2</sub> from Mobile Applications

Ensuing discussion resulted in the formation of three new task forces, in areas that received the highest priority:

- Offshore CO<sub>2</sub>-EOR (to be chaired by Norway, with Canada, China, the United States, and the IEAGHG also as members)
- Bioenergy with CCS (to be chaired by the United States, with Italy, Norway, and the IEAGHG also as members)
- Improved Pore Space Utilisation (to be co-chaired by Australia and the United Kingdom, with France, Japan, the United Arab Emirates, and the IEAGHG also as members)

The suggested timelines for these new task forces are as follows: At the next Mid-Year Meeting (anticipated in June 2016), each task force should do a presentation on its overall plan and any activities. At the next Annual Meeting (anticipated in October 2016), each task force should have a written progress report or interim report of some kind. At the

2017 Mid-Year Meeting, each task force should have a draft of its final report, with a finished final report ready by the time of the 2017 Annual Meeting.

The Technical Group temporarily postponed a decision on forming a new task forces in one other high-priority area, Geo-steering / Pressure Management Techniques. There was also some interest in investigating the Industrial CCS area, but not enough yet to merit a new task force. These two areas will be taken up again at the next Technical Group meeting.

## **19. Update from Joint Task Force on the Development of 2<sup>nd</sup> and 3<sup>rd</sup> Generation CCS Technologies**

Lars Ingolf Eide provided a status update on the Joint Policy Group-Technical Group Task Force on “Supporting Development of 2<sup>nd</sup> and 3<sup>rd</sup> Generation CCS Technologies”. This task force has been established with Norway as the lead for the Technical Group and Canada the lead for the Policy Group. The technical mandate of the task force includes:

- Mapping/identifying 2<sup>nd</sup> and 3<sup>rd</sup> generation technologies under consideration in CSLF member countries, especially those that may mature in the 2020-2030 timeframe;
- Identifying major challenges facing development of these next generation technologies; and
- Using existing networks such as the International CCS Test Centre Network to map potential for testing these next generation technologies at existing test facilities.

Mr. Eide stated that a draft final report has been prepared which summarizes existing information in the area of 2<sup>nd</sup> and 3<sup>rd</sup> generation CO<sub>2</sub> capture technologies, and that the report has been organized to provide descriptions of the technologies and their development pathways as well as information on existing CCS test centers where some of these technologies could be scaled-up. Mr. Eide stated that the report does not address the economics for use of these technologies but does indicate technology readiness levels. Also, details concerning overall process development, integration, and materials development has been excluded.

Mr. Eide provided several recommendations for follow-up by the CSLF. These include finding ways to implement mechanisms that will allow technology developers and test facility operators to cooperate in mutually beneficial and cost-effective ways. Also, the CSLF could work to increase the opportunities for project developers to participate in extended visits to other demonstration projects and test centers, and the CSLF could work toward developing a consistent terminology for new CO<sub>2</sub> capture technologies, as both the technology maturity and scale of operation (i.e., pilot vs. demonstration) currently have imprecise boundaries.

At the conclusion of Mr. Eide’s presentation, there was agreement that the Secretariat will circulate a copy of the final report to all Technical Group delegates, and that the delegates will provide any comments, additions and corrections regarding the test facilities section of the report to Mr. Eide. The Secretariat will make a finalized version of the report available at the CSLF website.

## **20. Update on International CO<sub>2</sub> Capture Test Centre Network**

Lars Ingolf Eide gave a short presentation on the status of the International CO<sub>2</sub> Capture Test Centre Network (ITCN), which was officially launched in 2013 to accelerate CCS

technology development. Mr. Eide stated that the network's main function is to facilitate knowledge sharing of operational experience and non-confidential information, and that analysis and problem solving (and *not* data collection) is the network's focus. Criteria for a test facility's membership in the network is that the facility must be operating on real flue gases (i.e., be connected to a power plant or industrial plant), it must have the intent of being neutral in any technology decisions, and it must be willing to share information and receive visitors.

Mr. Eide stated that the knowledge-sharing aspects of the ITCN has been manifested in three workshops, in Mongstad, Norway in May 2014 (which was focused on amine-based post-combustion capture), in Austin, Texas, USA, in October 2014 (which was an exchange of experiences on how best to measure and model amine emissions), and in Wilhelmshaven, Germany in April 2015 (which was focused on aerosols and mist formations). A report from the first workshop, on lessons learned from measurement of amine and amine degradation products, is in preparation.

Mr. Eide stated that ITCN activities in 2016 will be aimed at increasing insight and awareness of different technologies for relevant stakeholders in order to reduce risks and increase investments in CCS technology. The ITCN may also broaden its membership base to include universities and small test centers. It will also establish relationships with other test networks, as well as explore business focus areas for future collaborations.

## **21. Election of Technical Group Chair and Vice Chairs**

Richard Lynch presided over this item of the agenda. Mr. Lynch stated that according to the CSLF Terms of Reference and Procedures, CSLF Chairs and Vice Chairs are elected every three years. The previous election for the Technical Group was in 2012 at the CSLF Annual Meeting in Perth, Australia.

By consensus, Norway was re-elected as Chair, and Australia, Canada, and South Africa were re-elected as Vice Chairs.

## **22. Update on Future CSLF Meetings**

Richard Lynch provided a short summary of upcoming CSLF events. Concerning the 2016 CSLF meetings, Mr. Lynch stated that there was nothing yet to report concerning the mid-year meeting but Japan may be willing to host the year-end meeting. Takashi Kawabata was called on for additional comments and welcomed the opportunity to bring the CSLF to Japan in October 2016. Mr. Kawabata stated that a budgetary request for the meeting has been made, so Japan's hosting of the 2016 CSLF Annual Meeting should be considered tentative at this point with a final decision expected by the end of the year.

## **23. Open Discussion and New Business**

No additional new activities were proposed. Tony Surridge read a short poem about climate change that he had written for the occasion.

## **24. Review of Consensuses Reached and Action Items**

Consensus was reached on the following items:

- The Dry Solid Sorbent CO<sub>2</sub> Capture Project is recommended by the Technical Group to the Policy Group for CSLF recognition.

- The CO<sub>2</sub> Capture Project – Phase 4 is recommended by the Technical Group to the Policy Group for CSLF recognition.
- The CO<sub>2</sub>CRC Otway Project – Stage 2 is recommended by the Technical Group to the Policy Group for CSLF recognition.
- The Oxy-Combustion of Heavy Liquid Fuels Project is recommended by the Technical Group to the Policy Group for CSLF recognition.
- The Carbon Capture and Utilization Project / CO<sub>2</sub> Network Project is recommended by the Technical Group to the Policy Group for CSLF recognition.
- The Technical Group forms a working group to determine the way forward for future TRM update activities. Members of the working group are Australia (Chair), Norway, South Africa, the United Kingdom, the United States, the IEAGHG, and the CSLF Secretariat.
- The Technical Group forms a new Task Force on Offshore CO<sub>2</sub>-EOR, to be chaired by Norway. Other members are Canada, China, the United States, and the IEAGHG.
- The Technical Group forms a new Task Force on Bioenergy with CCS, to be chaired by the United States. Other members are Italy, Norway, and the IEAGHG.
- The Technical Group forms a new Task Force on Improved Pore Space Utilisation, to be co-chaired by Australia and the United Kingdom. Other members are France, Japan, the United Arab Emirates, and the IEAGHG.
- The Technical Group is temporarily postponing decisions on forming new task forces in the areas of Geo-steering / Pressure Management Techniques and Industrial CCS. These will be taken up again at the next meeting.

Action items from the meeting are as follows:

Item	Lead	Action
1	Technical Group Chair	Provide the Technical Group's recommendation to the Policy Group that five new projects be recognized by the CSLF. <i>(Note: this was done at the November 3<sup>rd</sup> Policy Group meeting.)</i>
2	IEAGHG	Determine a way to allow access to journal paper that is the Task Force on Review of CO <sub>2</sub> Storage Efficiency in Deep Saline Aquifers final report via the CSLF website.
3	Working Group on TRM	Make recommendations on the future of the TRM process at the next Technical Group meeting.
4	Secretariat	Make final report from the Task Force on Technical Barriers and R&D Opportunities for Offshore, Sub-Seabed Storage of CO <sub>2</sub> available at CSLF website.
5a	Secretariat	Circulate a copy of the final report from the Task Force on Supporting Development of 2 <sup>nd</sup> and 3 <sup>rd</sup> Generation CCS Technologies to all Technical Group delegates.

Item	Lead	Action
5b	Delegates	Provide comments on the test facilities section of the task force report.
5c	Secretariat	Make a finalized version of the task force report available at the CSLF website.

## 25. Closing Remarks / Adjourn

In adjourning the meeting, Trygve Riis thanked the meeting hosts, especially Hamoud AlOtaibi who was the CSLF's main point of contact. Mr. Riis thanked the Secretariat for its support, thanked the delegates for their active participation, and introduced the new Technical Group Chair, Åse Slagtern. Mrs. Slagtern has many years of experience associated with CCS; she is currently involved with Norway's CLIMIT research program on CCS and is Vice Chair of the IEAGHG's Executive Committee. William Christensen, on behalf of Norway and the CSLF, thanked Mr. Riis for his seven years of strong leadership for the Technical Group and welcomed Mrs. Slagtern as the new Chair.