



## Minutes of the Technical Group Meeting Chatou, France

Monday-Tuesday, 04-05 November 2019

### LIST OF ATTENDEES

**Chair** Åse Slagtern (Norway)

### **Delegates**

Australia: Max Watson  
Canada: Eddy Chui (*Vice Chair*), Mike Monea  
European Commission: Wolfgang Schneider  
France: Didier Bonijoly, Dominique Copin, David Savary  
Italy: Paolo Deiana  
Japan: Ryoza Tanaka (*Vice Chair*), Jiro Tanaka  
Korea: Jeom-In Baek, Yi Kyun Kwon  
Netherlands: Paul Ramsak  
Norway: Lars Ingolf Eide, Espen Bernhard Kjærgård  
Poland: Krzysztof Makowski  
Romania: Sorin Anghel, Constantin Sava  
Saudi Arabia: Hamoud AlOtaibi, Ammar Alshehri, Pieter Smeets  
United States: Mark Ackiewicz

### **Representatives of Allied Organizations**

CO<sub>2</sub>GeoNet Association: Ceri Vincent  
Global CCS Institute: Alex Townsend  
IEAGHG: Tim Dixon, Mónica García Ortega

**CSLF Secretariat** Richard Lynch

### **Invited Speakers**

European Commission: Wolfgang Schneider (*D-G for Research & Innovation*)  
France: Pascal Charles (*EDF*)  
Joseph Hajjar (*Ministère de la Transition Écologique / DGEC*)  
Aïcha El Khamlichi (*ADEME*)  
Netherlands: Peter Arends (*Porthos Project*)  
Tom Mikunda (*TNO*)  
Norway: Peder Eliasson (*SINTEF*)  
Stig Svenningsen (*Ministry of Petroleum and Energy*)  
Poland: Krzysztof Makowski (*Ministry of Energy*)  
Romania: Constantin Sava (*GeoEcoMar*)  
United Kingdom: Iain Macdonald (*Shell*)  
United States: Mark Ackiewicz (*Department of Energy*)  
Frank Morton (*National Carbon Capture Center*)

## **Observers**

Australia:	Owen Davis ( <i>Woodside Energy</i> ) Solomon Faka ( <i>Woodside Energy</i> )
France:	Paul Bonnetblanc ( <i>Ministère de la Transition Écologique / DGEC</i> ) Valerie Czop ( <i>EDF</i> ) Morvan Favennec ( <i>TechnipFMC</i> ) Bernard Frois ( <i>CEA</i> ) Juho Lipponen ( <i>Clean Energy Ministerial CCUS Initiative</i> ) Gauthier Perdu ( <i>TechnipFMC</i> )
Germany:	Jürgen-Fr. Hake ( <i>Sustainable Energy Solutions</i> )
Japan:	Akihiro Nakamura ( <i>RITE</i> )
Korea:	Se Won Chang ( <i>Kongju National University</i> )
Norway:	Eva Halland ( <i>Norwegian Petroleum Directorate</i> ) Svein Ingar Semb ( <i>Gassnova</i> )
Saudi Arabia:	Feraih Alenazey ( <i>KACST</i> ) Faris Almansour ( <i>KACST</i> )
United States	Ramón Gil-Egui ( <i>University of Texas / Bureau of Economic Geology</i> ) Charles Gorecki ( <i>University of North Dakota EERC</i> )

## **Monday Session**

### **1. Welcome and Opening Remarks**

The Chair of the Technical Group, Åse Slagtern, called the meeting to order, welcomed CSLF delegates and stakeholders to Chatou. Ms. Slagtern mentioned that as was the case for the April meeting in the United States, this would also be a two-day Technical Group meeting. A one day workshop on Hydrogen Production and Carbon Capture, Utilization and Storage (CCUS) would take place on Wednesday and a half-day workshop on CCUS for Energy Intensive Industries on Thursday. For the Technical Group meeting there is plenty of content on many topics of interest related to CCUS. This includes presentations by the International Test Center Network, the Mission Innovation CCUS Workshop, and the Oil and Gas Climate Initiative (OGCI). Additionally, there are presentations about several European projects and initiatives, including France's policy plans for a carbon-neutral society. And also scheduled are updates from all of the Technical Group's task forces as well as the Technical Group's three allied organizations: the CO<sub>2</sub>GeoNet Association, the Global CCS Institute (GCCSI), and the IEA Greenhouse Gas R&D Programme (IEAGHG). Ms. Slagtern also called attention to the downloadable documents book that had been prepared by the Secretariat for this meeting which contains documents relevant to items on the agenda.

### **2. Building Safety Briefing**

Valerie Czop, representing meeting host EDF, provided a short building safety briefing including location of all emergency exits.

### **3. Introduction of Delegates**

Technical Group delegates and stakeholders present for the meeting introduced themselves. Thirteen of the twenty-six CSLF Members were represented. Stakeholder observers from eight countries were also present, as were representatives from the three allied organizations.

#### **4. Adoption of Agenda**

The Agenda was adopted with no changes. (*Note: Subsequently, the agenda was slightly changed. Item 10 actually preceded Item 9 because of a temporary technical difficulty with the Item 9 presentation.*)

#### **5. Approval of Minutes from April 2019 Meeting**

The Minutes from the April 2019 Technical Group Meeting were approved with no changes.

#### **6. Report from CSLF Secretariat**

Richard Lynch provided an update from the CSLF Secretariat which reviewed highlights from the April 2019 Technical Group Mid-Year Meeting in Champaign, Illinois, USA. This was a two-day event, consisting of the Technical Group meeting and a site visit to the Illinois Industrial Carbon Capture and Storage (CCS) Project. The Technical Group meeting was held in conjunction with the annual meeting of the Midwest Geological Sequestration Consortium. Presentations from the Technical Group meeting are online at the CSLF website.

Mr. Lynch reported that there were several notable highlights and outcomes from the meeting:

- The SECARB Early Test at Cranfield Project, sited in Mississippi, USA, received a CSLF Global Achievement Award.
- The Improved Pore Space Utilisation Task Force, which was co-chaired by Australia and the United Kingdom, has completed its activities and has disbanded.
- The CCS for Energy Intensive Industries Task Force, chaired by France, indicated that it would complete its final report in time for the next Technical Group meeting.
- The Non-EHR Utilization Options Task Force, chaired by the United States, indicated that it would present a summary report and recommended next steps at the next Technical Group meeting.
- The CO<sub>2</sub> Hubs and Infrastructure Task Force, chaired by Norway, has completed its preliminary “Phase 0” activities. The task force will remain in existence and present updates annually.
- Australia’s delegation will investigate the feasibility of a CO<sub>2</sub> Storage Reservoir Management future activity and report back to the Technical Group.
- A new task force, co-chaired by Australia and the United Kingdom, was formed to explore engagement with the academic community and will report back to the Technical Group with recommendations on what should happen next.
- The Policy Group was requested to provide details on the status of the CSLF’s stakeholder engagement initiative.
- The Technical Group’s Ad Hoc Committee for Task Force Maximization and Knowledge Sharing will continue its activities for the foreseeable future and make annual reports on the four priority recommendation areas from the 2017 CSLF Technology Roadmap (TRM):
  - “Facilitate CCS Infrastructure Development”
  - “Leveraging Existing Large-Scale Projects”

- “Drive Down Costs along the Entire CCUS Chain through Research, Development and Demonstrations (RD&D)”
- “Facilitate Innovative Business Models for CCS Projects”
- The Ad Hoc Committee added “Progress toward CO<sub>2</sub> Utilization” as a 5<sup>th</sup> priority recommendation area.
- Five Working Groups were formed under the Ad Hoc Committee to follow progress in each of the respective five priority recommendation areas. The working group leads were instructed to develop their own methodologies and decide the overall ‘stoplight’ ratings (i.e., ‘red’, ‘yellow’, and ‘green’, where green indicates significant progress and red indicates a lack of progress) for these priority areas.

Mr. Lynch also noted three specific action items from the meeting:

- The PIRT Chair will develop a proposal on how the PIRT could function going forward.
- The Secretariat will send out a reminder email to Technical Group delegates requesting comments on the draft Project Engagement Survey Form.
- The Technical Group Executive Committee (ExCo) will inquire to the Policy Group to see if mutual interest exists for joint activities on the topic of Business Models.

Mr. Lynch concluded his presentation by stating that these actions have all been done.

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

Tim Dixon, Programme Manager for the IEAGHG, gave a presentation about the organization and its continuing collaboration with the CSLF’s Technical Group. The IEAGHG was founded in 1991 as an independent technical organization with the mission to provide information about the role of technology in reducing greenhouse gas emissions from use of fossil fuels. The IEAGHG was organized under the auspices of the International Energy Agency (IEA) as part of the IEA’s Energy Technology Network (ETN) but is functionally and legally autonomous. The IEAGHG currently consists of 36 members representing 15 countries plus the Organization of Petroleum Exporting Countries (OPEC), the European Commission (EC), and the IEA’s Coal Industry Advisory Board (CIAB). These members set the strategic direction and technical programme for the organization.

Mr. Dixon stated that the IEAGHG’s focus is on CCS (specifically the role that technology can play in reducing greenhouse gas emissions from the power and industrial sectors), 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 (more than 330 reports published on all aspects of CCS), the six international research networks about various topics related to CCS, and the biennial GHGT conferences (the most recent one in Melbourne, Australia in October 2018 and the next one in Abu Dhabi, UAE in October 2020). Other IEAGHG activities include its biennial post-combustion capture conferences (the most recent one in Kyoto, Japan in September 2019), its annual International CCS Summer School (the next one in Bandung, Indonesia in July 2020), peer reviews with other organizations, activity in international framework/standards-setting organizations (such as the UNFCCC, the ISO TC265, and the London Convention and Protocol), and collaboration with other organizations

(including the CSLF). The IEAGHG has also held CCS side events at the past five COPs. The COP24 side event was titled “Can CCS decarbonize industry in developed and developing countries?” and had 150 attendees. Concerning the London Convention and Protocol, Mr. Dixon reported its CO<sub>2</sub> export amendment that was originally adopted in 2009 has now come into effect. This happened due to a ‘Provisional Amendment’, adopted at the organization’s annual meeting in October 2019, whose development and proposal had been led by Norway. The IEAGHG had also played an active role in support prior to and inside the negotiations for this important amendment which paves the way for multinational CO<sub>2</sub> infrastructure hubs.

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 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 seven IEAGHG studies that originated from the CSLF Technical Group or related activities, including reports on three International Workshops on Offshore Geologic CO<sub>2</sub> Storage.

Mr. Dixon concluded his presentation by showing lists of reports recently published, reports in progress to be published, studies underway, studies awaiting start, and webinar series. Mr. Dixon also briefly described IEAGHG’s research networks and other upcoming/recent events.

## **8. Update from the Global CCS Institute**

Alex Townsend, Senior Consultant – Economics for the Global Carbon Capture and Storage Institute (GCCSI), gave a short update on the organization. The GCCSI currently consists of 62 members and has offices in seven countries, with an overall mission of accelerating the deployment and commercial viability of CCS globally.

Mr. Townsend mentioned that services of the GCCSI include research on key aspects of CCS deployment (including publication of an annual “Global Status of CCS” document, the next one scheduled for a December 2019 launch), advice and capacity building (through tailored workshops, conferences, and presentations to groups such as the CSLF), and communications / advocacy (to build awareness of CCS and its role in achieving climate targets and reducing emissions). A key 2019 event was the conference “Delivering Net-Zero: Mobilising Finance for CCS Deployment” which was held in London two weeks after the Technical Group meeting.

One of the slides in Mr. Townsend’s presentation summarized the global status of carbon capture deployment. As of October 2019 there are 19 large-scale CCS facilities currently operating, four others under construction, and another 28 in development. This represents an increase of eight projects (all of them in development) since the previous Technical Group meeting in April.

Mr. Townsend concluded his presentation by briefly summarizing the GCCSI’s advocacy activities. These include consultation responses, op-eds, discussions with journalists, and publication of a newsletter. The GCCSI will have a presence at the COP25 United Nations climate change conference in Spain in December.

## **9. Update on OGCI's CCUS Kickstarter Activities**

Iain Macdonald, Principal Carbon Relations Advisor – OGCI for Shell Global Solutions International, gave a short update on the OGCI's CCUS Kickstarter activities. The OGCI was launched in September 2014 at the United Nations Climate Week event and currently consists of 13 members which account for more than 30% of global oil and gas production. OGCI programs are intended to accelerate development of a low-carbon economy and support Paris Agreement climate goals, and include exploring reduction on the energy value chain, acceleration of low-carbon solutions, and enabling a circular carbon model (which emphasizes reduction of net greenhouse gas emissions as well as capture and storage or re-use of CO<sub>2</sub>). Dr. Macdonald stated that CCUS deployment is currently being hampered by several hard-to-overcome obstacles: Only a few countries have policies in place which incentivize and regulate aspects of CCUS. There is a perceived lack of trust in CCUS by the general public, which looks on CCUS as one means for the oil and gas companies to preserve business as usual. And there are financial barriers which exist in part because unclear legal and regulatory intentions throughout much of the world have increased the perceived risk/reward ratio to the point where private investment has not been readily forthcoming – higher risk equates to a higher cost of investment capital from global financial institutions.

Dr. Macdonald stated that OGCI's CCUS Kickstarter activities are intended to facilitate large-scale commercial investment in CCUS by enabling multiple low-carbon industrial hubs, in particular by investigating barriers to hub development in countries where CCUS is under consideration as a climate mitigation strategy. In particular, five such hubs could emerge by the year 2030: the Teesside Project in the United Kingdom, the open-source Northern Lights Project in Norway, the Porthos Project in the Netherlands, the area around Xinjiang in China, and the Gulf of Mexico along the Texas-Louisiana coast in the United States. Potential impacts of these five hubs could range from 3 million tons up to as much as 200 million tons of CO<sub>2</sub> stored annually.

Dr. Macdonald closed his presentation by mentioning that the OGCI has been vigorously engaging with external stakeholders. Prime among these is the Clean Energy Ministerial (CEM) CCUS Task Force, but there are also many universities and other NGOs as well as important international organizations such as the GCCSI, the United Nations Framework Convention on Climate Change, The United Nations Economic Commission for Europe, and the World Economic Forum.

## **10. Update from the International Test Center Network (ITCN)**

Frank Morton, representing the National Carbon Capture Center (NCCC) in the United States, gave a short presentation about the ITCN and its collaborative activities. Mr. Morton stated that the ITCN was launched in 2013 to accelerate CCS technology development, and currently has member organizations in Australia, Canada, China, Germany, Japan, Korea, Norway, the United Kingdom, and the United States. The ITCN's main function is to facilitate knowledge sharing of operational experience and non-confidential information for CO<sub>2</sub> capture technologies, in terms of facility operations, facility funding, safety, and analytical techniques. Among the objectives of the ITCN are increasing insight and awareness of different technologies that may reduce risks and increase investments in CO<sub>2</sub> capture technologies and enhancing public awareness and acceptance of the technologies involved. There are several specific goals:

- Increase the value of public and private CCS research and technology investments through increased sharing of lessons learned and results from parallel activities.

- Identify one technical focus area per year and publish a summary report. Previously these focus areas have been amine carry-over, support of the CSLF-recognized Capture Simulation for Industry Impact (CCSI<sup>2</sup>) initiative, open access technology, and alternative baselines to MEA solvent for CO<sub>2</sub> capture. Future focus areas could include reclaiming optimization, process intensification, international standardization, CCUS flexible operation, and CO<sub>2</sub> capture in the industrial sector (especially steelmaking).
- Continue emphasis on technical and non-technical collaboration, including determining new areas for such collaborations.
- Collaborate on partnerships for scale-up of technology and responses to funding opportunities.

Mr. Morton then provided ITCN's 'stoplight' evaluation and ratings for five recommendations from the 2017 TRM specific to CO<sub>2</sub> capture:

- "Government and Industry should work together toward reducing the cost of currently-available commercial CO<sub>2</sub> capture technologies for power and industry by at least 30%, while at the same time minimizing environmental impacts." This received a 'yellow' rating. There is growing confidence that cost and performance improvements are real from extensive testing at small pilot scale. But sharing of results from large test facilities is needed.
- "Government and Industry should work together toward establishing a network for knowledge-sharing among full-scale facilities." This received a 'yellow' rating. The ITCN is working to establish relationships with projects that are scaling-up in various parts of the world, as well as the organizations which are planning scale-ups.
- "Government and Industry should work together toward resolving issues regarding industrial CO<sub>2</sub> capture and bio-CCS, and further develop technologies for applications and implementation in pilot plants and demonstrations." This received a 'yellow' rating. There are far-reaching improvements under development by the CCUS R&D community and there are also commercial designs that are being advanced, but more and larger projects are needed.
- "Government and Industry should work together toward increasing possibilities for testing at large- and demonstration-scale by facilitating planning and construction of more test facilities for technologies that are not solvent-based." This received a 'red' rating. Large-scale projects are needed, even though it is more cost-effective to test low technology readiness level (TRL) non-solvent technologies at smaller scale first.
- "Government and Industry should work together toward funding and encouraging RD&D activities for new and promising capture technologies." This received a 'green' rating. There is growing optimism for R&D support for promising technologies.

Mr. Morton closed the presentation by listing companies and organizations which are interested in testing their technologies at relatively small-scale at the NCCC test site. Capture technologies would include solvents, membranes, and sorbents. CCUS technologies would include production of ethylene using CO<sub>2</sub> and ethane, upcycled CO<sub>2</sub>-negative concrete, and algae capture of CO<sub>2</sub> to produce value-added products.

## 11. CSLF Projects Interaction and Review Team (PIRT) Future Options

The PIRT Chair, Martine Woolf, was unable to attend the meeting but had prepared a presentation that was given by Technical Group Chair Åse Slagtern. The PIRT's most significant function has been as the initial reviewer in the CSLF project recognition process, recommending to the Technical Group whether or not any projects proposed for CSLF recognition should be approved. However, no projects have been proposed for recognition recently. The 2017 TRM also assigns the PIRT the responsibility to "monitor progress in CCS in relation to priority actions" but in actuality that has instead become the mandate of the Ad Hoc Committee. At the previous Technical Group meeting, there had been an extended discussion on how (or if) the PIRT should continue to function going forward. There had not been a consensus on how to proceed but Dr. Woolf was given a mandate to develop a concept on what the PIRT's future could be. Subsequent to the meeting and after a review of the discussion, Dr. Woolf proposed three different options: 'Reactivate', 'On Demand', and 'Abolish'.

For the 'Reactivate' option, the CSLF would continue to recognize projects through the PIRT, but with a streamlined process. For this option, it would be necessary to rearticulate objectives and benefits of the CSLF project recognition process, align criteria for project recognition with the TRM, ensure value proposition for projects seeking recognition, and define a strategy for seeking new project nominations. The 'pros' for this approach are that the CSLF would continue to have recognized projects as an experience base. The 'cons' are that the process for project recognition can be relatively work intensive and that project recognition may be a potentially inefficient way to achieve the envisaged outcomes of the TRM.

For the 'On Demand' option, the CSLF would no longer recognize projects with the PIRT only functioning as needed for specific project-related tasks. Under this concept the PIRT would have a Chair, but no fixed membership. This option would require the PIRT to have a new Terms of Reference. CSLF members would support the PIRT, as necessary, by facilitating contact with projects located in their countries. The 'pros' for this approach are that the PIRT would become an efficient and effective targeted activity, with a reduced workload for PIRT members. The 'cons' are the loss of an existing CSLF function (i.e., project recognition) and the uncertainty on whether the PIRT could be resourced if stood up at short notice.

For the 'Abolish' option, the PIRT would no longer exist as a formal body and the CSLF would no longer be recognizing projects. All project-related activities would instead be undertaken, as needed, by other task forces. The 'pros' for this approach are that targeted activity is inherently more efficient and effective than having the PIRT as a 'standing' body. The 'cons' are the same as for the 'On Demand' approach with an additional potential disadvantage of less engagement of CSLF members.

Following the presentation, a lengthy discussion ensued. There was unanimous consensus to reject the 'Abolish' option. Also, the CSLF's project recognition function was supported by many delegates and stakeholders as being of great importance, as the input that the CSLF receives from recognized projects is valuable. Mark Ackiewicz offered that having recognized projects is important to the CSLF because it helps to shine a spotlight on projects that are making progress, and this benefits both the projects and the CSLF. Sponsors of CSLF-recognized projects who were present at the meeting provided short testimonials of the worth of project recognition. Jiro Tanaka stated that the Tomakomai Project has become more active internationally following CSLF recognition. Ceri Vincent stated that the added visibility for the CO<sub>2</sub>GeoNet Association and its

CSLF-recognized projects has been valuable. And Max Watson stated that CO2CRC, which sponsors the Otway Project, sees the benefit of international exposure through the CSLF.

In the end, there was agreement that the PIRT should remain as a standing committee but that there should be changes to make it more focused and more efficient. In particular, there needs to be a much better articulation and clarity on the overall benefits of CSLF project recognition, for both the projects and the CSLF. And there also should be thought given to whether or not the CSLF should accept the nomination of any CCUS project, or narrow the focus toward only the projects which advance the priority recommendations from the TRM. Also, other types of project engagement and interaction for the PIRT, in addition to the recognition process, should be better defined as to how they would proceed and/or what kinds of information would be requested. There was agreement that the PIRT Chair and Technical Group Chair would review all discussions and suggestions concerning the PIRT's future and provide a recommended plan forward at the next Technical Group meeting.

## **12. Clean Energy Ministerial (CEM) CCUS Initiative Update**

Stig Svenningsen, speaking as a Co-Chair of the CEM CCUS Initiative (CEM-CCUS), gave a short presentation which provided a background and activities of the organization. CEM-CCUS is currently comprised of 11 member governments: Norway, Saudi Arabia, the United States, and the United Kingdom as lead countries, and Canada, China, Japan, Mexico, the Netherlands, South Africa, and the United Arab Emirates as other participating CEM members. In addition, the European Commission is an observer and there are links to other organizations (including the CSLF). Industry (including the oil and gas community) and financial institutions (including multilateral development banks) are also involved. Key objectives of CEM-CCUS include:

- Expanding the spectrum of clean energy technologies actively considered under CEM to include CCUS;
- Creating a sustained platform for the private sector, governments and the investment community to engage and accelerate CCUS deployment;
- Facilitating identification of both near and longer-term investment opportunities to improve the business case for CCUS; and
- Disseminating emerging CCUS policy, regulatory and investment best practices as part of integrated clean energy systems.

Mr. Svenningsen stated that at the May 2019 CEM meeting in Canada, CEM-CCUS held a well-attended side event which emphasized the following points:

- 80% of primary energy is from fossil fuels, and this has not changed in the past 30 years.
- CCUS technology is available and has been for several decades.
- Public-private collaboration is critical to drive more action.
- Banks are interested in investing in CCUS, but need good projects driven by government incentives.

Mr. Svenningsen reported that the CEM-CCUS had recently agreed to a collaboration with the OGCI. The focus will be on accelerating CCUS projects with emphasis on key hubs and clusters. The five 'kickstarters' (as described in the OGCI presentation) would

be a starting point. This collaboration would be flexible and specific to each country and region and would be open to other industries and sectors to join.

Mr. Svenningsen also reported that CEM-CCUS is working to establish a “Finance Sector Lead Group for CCUS” activity whose aim is to gain a more systemic relationship and to provide input and advice on government policy conducive to investment. Specific objectives include: creating a platform for the financial sector to discuss CCUS investment challenges and opportunities and to gain insights from governments and industry on experience; bringing views and comments from the financial sector to governments and industry regarding government policy approaches and CCUS as an investment proposition; and helping accelerate the financing of CCUS clusters and key projects. Targeted participants include multilateral development banks, commercial banks, institutional investors, and finance-sector associations.

Lastly, Mr. Svenningsen provided some details on CSLF policy-related activities that have now been assumed by CEM-CCUS. Mr. Svenningsen stated that academic engagement now appears to be an activity better suited to the Technical Group, but that CEM-CCUS can contribute if necessary. Stakeholder engagement is currently dormant but could be included as an item in the next CEM-CCUS meeting. As for Business Models, CEM-CCUS has circulated templates drafted by the Technical Group’s working group (led by China) and will continue to seek input. And on the topic of Capacity Building, Mr. Svenningsen stated that the CSLF’s remaining Capacity Building funds have been earmarked toward leveraging the participation of emerging economy countries in CEM-CCUS. Mr. Svenningsen closed his presentation by stating that the next CEM-CCUS meeting will be in January in Abu Dhabi and invited the Technical Group to make a ‘readout’ presentation there.

During ensuing discussion it was noted that CEM-CCUS appears to have largely supplanted the CSLF Policy Group in both form and function. Moreover, concern was expressed by several delegates that there has been no indication that the Technical Group’s recommendations to CEM Ministers (as expressed by its “Message from CSLF Technical Group to CEM and CSLF Ministers” document that was prepared in advance of the May 2019 CEM meeting) have been advocated by CEM-CCUS. Mr. Svenningsen responded that while the Policy Group no longer holds separate meetings, it is closely aligned with CEM-CCUS. Countries that gather at CEM-CCUS meetings always deal with Policy Group items as part of the meeting. Mr. Svenningsen also stated that the recommendations from the CSLF Technical Group had been included in the background materials to the Vancouver meetings and that CEM-CCUS would follow-up regarding the concerns voiced by delegates. CEM-CCUS’s Secretariat, Juho Lipponen, stated that he would provide the Technical Group the work program of CEM-CCUS. Mr. Svenningsen then stated that henceforward, one or more CEM-CCUS co-chairs would attend and participate in Technical Group meetings. As for the upcoming CEM-CCUS meeting in Abu Dhabi, there was agreement that the Technical Group Chair would give a ‘readout’ presentation there.

### **13. Conclusions and Recommendations from the CCUS for Energy Intensive Industries (EII) Task Force Final Report**

Task Force Co-Chair Dominique Copin made a short presentation which summarized the main conclusions and recommendations from the now disbanded task force. The task force had been established at the October 2016 meeting in Tokyo with a mandate to investigate the opportunities and issues for CCUS in the industrial sector and show what

the role of CCUS could be as a lower-carbon strategy for CO<sub>2</sub>-emitting industries. The focus of the task force had been to show how CCUS in EIIIs will contribute to the double target of economic growth and climate change mitigation.

Mr. Copin stated that the task force has now published its final report. Main conclusions are:

- The benefits of CCUS for EIIIs far outweigh its costs.
- CCUS complements rather than competes with other low-carbon solutions.
- The development of CCUS in EIIIs will require strong commitment from various stakeholders, including governments, the oil and gas sector, end use consumers, CCUS organizations, and the EIIIs themselves.
- CO<sub>2</sub> utilization can play an important role for business development and for raising the level of acceptability, but it will not be enough.
- R&D must be accelerated in order to decrease costs.

Mr. Copin then provided a summary of the report's recommendations. Some of these are:

- RD&D is needed to further reduce energy consumption for CO<sub>2</sub> capture.
- Further RD&D is needed to help reduce combustion-related CO<sub>2</sub> emissions from EIIIs through CCUS.
- Developing shared transport infrastructures is imperative.
- Cooperation between stakeholders, especially between EIIIs, is essential.
- Support of business model development for CCUS at EIIIs is needed to help lower uncertainties.
- Non-EII stakeholders should bring in their expertise in CO<sub>2</sub> transport and storage.
- Advocacy is needed to the main relevant stakeholders on the paramount importance of developing CCUS in EIIIs in order to address the challenge of climate change mitigation.

Mr. Copin ended his presentation by mentioning that the major contributors to the task force's final report were CSLF delegations from France, Norway and Canada as well as sectorial business organizations and companies. The final report is now available at the CSLF website.

#### **14. Report from the Non-Enhanced Hydrocarbon Recovery (EHR) Utilization Options Task Force**

Task Force Chair Mark Ackiewicz gave a brief update on the task force, which had been established at the April 2018 meeting in Venice. Besides the United States as Chair, membership also includes delegates from Australia, Brazil, China, Canada, France, the Netherlands, and Saudi Arabia, as well as representation by the IEAGHG. This task force was created in support of a Key Action recommended by the Technical Group to CSLF Ministers: "Explore new utilization concepts beyond CO<sub>2</sub> Enhanced Oil Recovery (CO<sub>2</sub>-EOR) that have the potential to add commercial value". Mr. Ackiewicz noted that a previous task force related to this topic (which had then included EHR such as enhanced oil recovery [CO<sub>2</sub>-EOR] and enhanced gas recovery [CO<sub>2</sub>-EGR]) had existed between 2011 and 2013 and had issued two reports before disbanding. Key messages from these two reports were that:

- There are many CO<sub>2</sub> utilization options.
- CO<sub>2</sub>-EOR is the most near-term utilization option.

- Non-EOR CO<sub>2</sub> utilization options are at varying degrees of commercial readiness and technical maturity.
- Early R&D or pilot-scale activities should focus on addressing techno-economic challenges, verifying performance, and supporting smaller-scale tests of first generation technologies and designs.
- More detailed technical, economic, and environmental analyses should be conducted.

Mr. Ackiewicz reported that following the disbanding of that task force there have been many other kinds of activities on this topic, including incentives and policy changes of various kinds (including the United States ‘45Q’ tax credit which now includes other utilization options such as conversion of CO<sub>2</sub> into fuels, chemicals, and other useful products). Mr. Ackiewicz also noted that there have been more recent reports by academia, government, and independent organizations such as the IEAGHG. There have also been, and continue to be, conferences entirely focused on CO<sub>2</sub> utilization or having that topic for one or more sessions. And, to date, there has been one CSLF-recognized project on CO<sub>2</sub> utilization: the Carbon Capture and Utilization / CO<sub>2</sub> Network Project located in Jubail, Saudi Arabia and sponsored by SABIC, where up to 1,500 tonnes per day of CO<sub>2</sub> is being captured and transported via pipeline to industrial sites where it is used as feedstock for production of methanol, urea, oxy-alcohols, and polycarbonates.

Mr. Ackiewicz stated that the main goal of the task force is to add value and not re-invent: the task force has been checking on the status of non-EHR CO<sub>2</sub> utilization by reviewing the reports, projects, conferences, activities, and projects of various kinds, and government initiatives that have occurred since the closure of the previous task force. Another task force activity will be to assess government activities in this area via information to be provided by CSLF delegates. The task force is developing a summary report and recommended next steps of the task force which will be presented at one of next year’s Technical Group meetings.

Mr. Ackiewicz closed his presentation by providing non-inclusive CO<sub>2</sub> utilization summary which showed that there are more than 60 facilities in operation or in construction, including 18 commercial/operation pilot facilities. The majority of these are for algae/biological products and mineralization/building materials technologies, but several are for chemicals and fuels production. Mr. Ackiewicz ended by mentioning that the task force would not be doing more than a summary report as its end product, but a future CSLF workshop on this topic is a possibility.

## **15. Feasibility of CO<sub>2</sub> Storage Reservoir Management Activities**

Max Watson gave a short presentation on this topic, which had been proposed as a follow-on to the now-disbanded Improved Pore Space Utilisation (IPSU) Task Force which he had co-chaired. Dr. Watson stated that the objective of the IPSU Task Force had been specifically to investigate the current status of techniques that have the potential to improve how well the capacity of reservoirs for CO<sub>2</sub> storage are utilized. Reservoir management from a risk basis (including reservoir pressure relief, CO<sub>2</sub> plume steering, and other pressure management techniques), well engineering (including reservoir access for optimized sweep, flow control, and other well engineering practices), and barriers to flow (physical, chemical, and biological), had not been part of the IPSU Task Force mandate, yet Dr. Watson noted that these topics have had limited investigation in CCS literature.

Dr. Watson provided information which reinforced that storage reservoir management is a key topic of interest. The OGCI's recent multinational CO<sub>2</sub> storage resource assessment activity has illustrated the near-term action required for continued safe CO<sub>2</sub> storage operations while enhancing storage capacity through improved reservoir management and efficiency. Large commercial-scale CO<sub>2</sub> storage projects such as Gorgon may include reservoir management activities commonly related to pressure management of the storage reservoir. Additionally, there are reservoir management R&D activities being investigated, such as the GeoCquest Project which has demonstrated at bench scale the role of heterogeneity in inhibiting CO<sub>2</sub> plume migration and improving the trapping processes. GeoCquest and CO<sub>2</sub>CRC are currently considering conducting an investigation at CO<sub>2</sub>CRC's International Otway Test Centre to validate heterogeneous reservoir trapping processes at a field scale.

Dr. Watson indicated that a reasonable way forward would be for the Technical Group to leverage these international activities: engage commercial CCS projects to learn more about their storage reservoir management methodologies; and engage R&D organizations, via the CSLF academic engagement initiative and by other means, to learn more about their projects and to help promote their efforts to CSLF delegates and stakeholders.

Dr. Watson concluded his presentation by recommending that the Technical Group continue to follow this topic and note any updates at future Technical Group meetings. To that end, there was consensus to form a new "passive" task force on this topic, to be chaired by Australia, which would keep track of ongoing and new storage reservoir management activities worldwide provide updates to the Technical Group if and when new outcomes arise.

## **16. Outcomes from the October 2019 "Capturing the Value of CCUS" Workshop**

Dominique Copin provided a brief summary of the workshop, which had been attended by approximately 70 people. The workshop was multinational, with attendees from the United States, China, Japan, Brazil, and the Middle East as well as from France and other parts of Europe. The workshop was also broadly multi-sector in terms of outside interest, with attendees representing oil and gas companies, heavy industries such as cement production, insurance and financial sector companies, academia, NGOs, and governments. In particular, insurance company representation was seen to be a very positive thing as it indicates the growing importance of CCUS as a possible means for achieving climate objectives outlined in the Paris Agreement of 2016.

Mr. Copin provided some outcomes of the workshop, perhaps the most important being that it is imperative for any organizations involved with CCUS to develop stronger relationships with both the insurance sector and the financial sector. Insurability affects the cost of borrowing money, which can have a large effect on whether or not a project is do-able. Another outcome was that there was strong support for the idea that CCUS should be implemented as soon as possible, rather than wait for the economics to further improve. Supply-side support mechanisms, such as the "45Q" tax credits that have been enacted in the United States, can become a means to make projects economically feasible. Also, keeping lines of communication open amongst all the different kinds of organizations which are interested in CCUS is perhaps a bigger issue than might be expected. Effective communications cover the breadth of academia to NGO to government to finance / insurance; all of these have specialized vocabularies and maintaining communications about CCUS on a level that all can easily understand is a necessary first step. Mr. Copin ended his presentation by stating that a written summary

of the workshop is in preparation, and that the Intergovernmental Panel on Climate Change will be informed of workshop outcomes.

## **17. Adjourn for the Evening**

Technical Group Chair Åse Slagtern thanked EDF for hosting the meeting and Sébastien Corbeil of EDF for his assistance concerning meeting logistics, thanked Lars Ingolf Eide for taking charge of the meeting room computer, praised the delegates and stakeholders for their interactiveness, and adjourned the meeting for the evening.

## Friday Session

### **18. Welcome Back**

Technical Group Chair Åse Slagtern expressed her appreciation to France's delegation for the excellent dinner at the historic Maison Fournaise restaurant. She then welcomed attendees to Day 2 of the meeting and called the meeting to order.

### **19. Building Safety Briefing**

Valerie Czop, representing meeting host EDF, provided another short building safety briefing including location of all emergency exits.

### **20. Overview of EDF and its CCUS Activities**

Pascal Charles, Generation Programmes Director for meeting host EDF, gave a short presentation about EDF and its CCUS activities. The EDF Chatou campus, located on the Île des Impressionnistes, is a long-established R&D site with ongoing work related to energy and the environment. Overall, EDF is the predominant electricity producer in France, serving nearly 40 million customer sites. Operational figures as of the end of 2018 show 126.5 gigawatts of installed capacity (22.4 gigawatts of which are fossil-fired) and 584 terawatts of electricity output.

Mr. Charles stated that EDF's objectives over the next decade are threefold: creating new, competitive decentralized solutions including personalized energy services and smart grids; achieving a new balance for the generation mix by accelerating development of renewables and extending the lifespan of existing nuclear power plants; and expanding into new geographical areas by developing low-carbon solutions in emerging markets. In particular, low-carbon electricity is a strategic focus for EDF. Mr. Charles stated that this mostly means that EDF will be reducing its fossil-fired power generation but it is also very much interested in CCUS, as there has been a significant rise in CO<sub>2</sub> prices in Europe. As for CCUS, EDF is mainly focused on CO<sub>2</sub> capture and is involved in several European Union projects. EDF is also a member of the Electric Power Research Institute's CCS program and is a member (and Secretariat) of France's Club CO<sub>2</sub> as well as Chair of the French mirror commission for standardization on CCS (ISO TC265).

Mr. Charles ended his presentation by briefly describing the CO<sub>2</sub> Capture Pilot Plant that had scaled-up an advanced amine capture process by Alstom. The pilot plant was located on a slipstream at EDF's Le Havre coal-fueled power plant. The capture rate was one ton per hour, and a total of 1,900 tons of CO<sub>2</sub> were captured from July 2013 to March 2014. Overall, a 90% capture rate was consistently demonstrated, there was good thermal and chemical stability of the solvent, and there were low ammonia and gaseous amine emissions.

## 21. Update from the CO<sub>2</sub>GeoNet Association

Ceri Vincent, President of the CO<sub>2</sub>GeoNet Association, gave a short presentation about the organization and its activities. CO<sub>2</sub>GeoNet is a pan-European research association that has the mission of supporting the safe and efficient deployment of CO<sub>2</sub> geological storage. The organization was created as a European Union FP6 Network of Excellence in 2004 and transformed into an Association under French law in 2008. Ms. Vincent stated that the overall mission of the CO<sub>2</sub>GeoNet Association is to be the independent scientific voice of Europe on CO<sub>2</sub> geologic storage in order to build trust in the technologies involved and to support wide-scale CCS implementation. Membership comprises 30 research institutes from 21 countries, and CO<sub>2</sub>GeoNet uses the multidisciplinary expertise of its members to advance the science supporting CCS. There are currently four categories of activities: joint research, scientific advice, training, and knowledge sharing.

Ms. Vincent stated that the CO<sub>2</sub>GeoNet Association is also overseeing the ongoing CSLF-recognized ENOS project, whose objective is to provide crucial advances which will help foster onshore geologic CO<sub>2</sub> storage in Europe. The project has 29 partners from 17 countries as well as five field laboratories / pilot sites. Components of the project include accelerating the development and deployment of CCS in Europe, ensuring safe and environmentally sound onshore CO<sub>2</sub> storage, de-risking storage site characterization in order to provide bankable capacity assessments, monitoring leakage risks for the protection of the environment and groundwater, linking the technical work to the perspective of local population, and providing a framework for sharing and mutual learning with international sites. Ms. Vincent also stated that beginning in February 2020, the ENOS project is partnering with the Sapienza University of Rome to offer a Masters of Science degree in CO<sub>2</sub> storage.

Ms. Vincent reported some of the highlights from the 2019 CO<sub>2</sub>GeoNet Open Forum, which was held in Venice in May. Key messages were that CCS is an opportunity for economic growth and job creation, and that clear and consistent long-term policy and regulatory measures are needed to provide a predictable business landscape which will attract investment. There was a CO<sub>2</sub>GeoNet-CSLF workshop on the topics of seismicity, injectivity and monitoring CO<sub>2</sub> storage sites, with presenters representing projects in the United States, Canada, Norway, Japan, Iceland, and Algeria. The emphasis was on sharing of lessons learned, not just for the science of CO<sub>2</sub> storage but also on practical aspects.

Ms. Vincent concluded her presentation by summarizing some of CO<sub>2</sub>GeoNet's activities since the previous Technical Group meeting. One of these was outreach during the 11<sup>th</sup> World Conference of Scientific Journalists, which took place in Lausanne in July. A joint CO<sub>2</sub>GeoNet activity is to engage with civil society and the media, and to that end it sponsored a booth at the conference which was intended to better inform journalists about CCS. The organization is also planning to have a presence at the COP25 United Nations Climate Change Conference in Madrid in December where it may sponsor both a booth and a side event.

During ensuing discussion there was agreement that the Technical Group will co-host a workshop at the next CO<sub>2</sub>GeoNet Open Forum (May 2020). This includes helping to develop themes. (Delegates from the United States, France, and Italy will be involved in this activity.)

## 22. Status Report from the Ad Hoc Committee

Lars Ingolf Eide gave a detailed presentation which summarized the committee's activities. This group was created at the April 2018 Technical Group meeting in Venice with a mandate to monitor progress on the overall goals from the 2017 TRM:

- Long-term isolation from the atmosphere of at least 400 megatonnes (Mt) of CO<sub>2</sub> per year by 2025 (or have permanently captured and stored 1,800 Mt CO<sub>2</sub>);
- Long-term isolation from the atmosphere of at least 2,400 Mt of CO<sub>2</sub> per year by 2035 (or have permanently captured and stored 16,000 Mt CO<sub>2</sub>);

The committee is also monitoring progress toward addressing five priority recommendations:

- Facilitate CCS infrastructure development;
- Leverage existing large-scale projects to promote knowledge-exchange opportunities;
- Drive down costs along the entire CCS chain through RD&D; and
- Facilitate innovative business models for CCS projects.
- Facilitate implementation of CO<sub>2</sub> utilization.

The overall objective is to identify and recommend corrective actions in areas where progress is slow and to report findings to CSLF Ministers. To that end, five working groups were formed under the committee to follow progress in each of the respective priority recommendation areas and also to identify and recommend corrective action in areas where progress has been slow. A 'stoplight' rating system was devised where 'Green' indicates that there has been good progress toward reaching the target; 'Yellow' indicates that there is room for improvement and that progress is insufficient to reach the target unless new actions are initiated; and 'Red' indicates that strong actions are required as there has been poor progress and the target will not be reached.

Mr. Eide reported that during the previous Technical Group meeting in Champaign it was decided that the five working group leads were free to develop their own methodologies and decide the overall 'stoplight' ratings. The CCS Infrastructure Development group is being led by Norway with participation/assistance from Australia, Canada, the Netherlands, and the United Kingdom. The Leverage Existing Large-Scale Projects group is being led by the PIRT with participation from Australia, Canada, and the IEAGHG. The RD&D to Drive Down Costs group is being led by Canada with participation from Australia, Saudi Arabia, the CO<sub>2</sub>GeoNet Association, and the IEAGHG. The Innovative Business Models for CCS Projects group is being led by China with participation from Canada, Norway, Saudi Arabia, and the United States. And the Facilitate Implementation of CO<sub>2</sub> Utilization group is being led by the United States with participation from Canada and Saudi Arabia.

Mr. Eide stated that, overall, the 2025 result target for long-term isolation had received a 'Red' rating. There needs to be a ten-fold increase in annual storage capacity over the next six years to meet the target, but only one new project (the Gorgon Project in Australia) has come online since March 2019. All other projects currently in advanced or early development will not add sufficient capacity by 2025 to meet the target.

Mr. Eide then provided some initial results from the five working groups:

- "Facilitate CCS infrastructure development" received a 'Red' rating. Only one CCUS network project is anticipated to start up in the near future and it will only

increase storage capacity by 2 Mt CO<sub>2</sub>. No new projects had passed the Final Investment Decision gate in 2019. However, there continues to be interest in hubs, clusters and infrastructure and a few projects have received funding for parts of their infrastructure chain (though mainly for studies to confirm feasibility).

- “Leverage existing large-scale projects” received a ‘Green’ rating. There has been active leveraging through CSLF meetings, by the International CCS Knowledge Centre, and in various conferences and reports. As an example, a report by the International CCS Knowledge Centre indicates that a second-generation CO<sub>2</sub> capture facility at the Shand power plant in southern Saskatchewan, Canada, will be able to reduce capture cost on a per-tonne basis by 67% as compared to the nearby first-generation Boundary Dam Project.
- “Drive down costs along the entire CCS chain through RD&D” received a ‘Yellow’ rating. There is much good research going on that progresses CCUS technologies but no breakthrough technologies reported or identified at high technology readiness levels have convincing evidence of significant cost reductions. Some of the encouraging signs are that the ITCN is expanding, there has been progress in oxyfuel process development and demonstration, commercial designs of next-generation technologies are moving forward, and funding is available for small projects.
- “Facilitate innovative business models for CCS projects” received a ‘Yellow’ rating. There is an initiative taken by China through the CEM CCUS to map business models and incentive policies in its member countries. Additionally, there have been some market-based frameworks for CCUS developed for the power sector as well as other related activities by both the Government of the United Kingdom and the GCCSI. However, progress on development of business models (except for those influenced by the ‘45Q’ tax credits in the United States) has been lacking (perhaps due to absence of policy and regulatory environments).
- “Facilitate implementation of CO<sub>2</sub> utilization” received a ‘Yellow’ rating. There are more than 70 known utilization projects that range in size from pilot to full-scale commercial; several of these have been completed while others are under construction. Markets for CO<sub>2</sub> do exist, and there have been financial incentives in some places which encourage CCUS. However, there needs to be much more in the way of business development opportunities / mechanisms / incentives to facilitate greater utilization of anthropogenic CO<sub>2</sub> at commercial scale.

Mr. Eide summarized by stating that there has been no fundamental change in the overall status since the April 2019 meeting in Champaign. The inescapable conclusion is that since only one of the five priority recommendations is showing good progress, the 2025 target will not be reached. As for the 2035 target, it still can be reached but an extensive build-out of CO<sub>2</sub> networks of hubs, clusters, utilization and transport infrastructure is needed. This will require public-private co-funding of cross-industry projects.

Mr. Eide then summarized the role and forward work mode for the Ad Hoc Committee. Of its original four main focal areas, the first step of the task force utilization analysis is complete (CSLF delegates, using a questionnaire, had previously provided information on the use of the TRM and task force reports), the TRM recommendation analysis (as described above) has been done, knowledge-sharing recommendations are part of the TRM recommendation analysis and could be part of the PIRT’s focus, and potential alignment of the Technical Group’s task forces with Policy Group/CEM-CCUS activities as well as outside organizations is something that the Technical Group itself probably

needs to address. Meanwhile, the Ad Hoc Committee has been collaborating with the Technical Group's allied organizations by organizing workshops. Mr. Eide stated that the Ad Hoc Committee should continue its activities for the foreseeable future, as this is a very important Technical Group function.

Mr. Eide concluded his presentation by proposing some 'next steps'. The Technical Group should review and perhaps redefine the mandate for the committee; so far only the recommendations from the 2017 TRM are being addressed, but this could be perhaps broadened to include other issues. Mr. Eide also stated that the Ad Hoc Committee should prepare annual updates and recommendations to the Policy Group/CEM-CCUS in time for its yearly meeting. And finally, the committee should consider a name change since "Ad Hoc Committee" is not very descriptive.

Ensuing discussion emphasized the importance of the committee's work. Tim Dixon, for example, stated that the committee's review process of TRM recommendations is extremely useful. There was also consensus that the committee should decide on a new name in time for the next Technical Group meeting. Also, there was agreement that a decision will be made at the next Technical Group meeting on whether or not to develop and publish a new edition of the TRM.

### **23. Engagement of Academic Community**

Co-Chair Max Watson of the revitalized Academic Task Force gave a short presentation which summarized the CSLF's previous activities toward engagement of the academic community. Dr. Watson stated that during the roll-up to the Technical Group's Champaign meeting in April 2019, there had been discussions between the Technical Group and Policy Group toward transfer of the academic engagement activity to the Technical Group. During the Champaign meeting it was determined that sufficient interest existed within the Technical Group to re-establish a new Academic Task Force. Australia (Max Watson) and the United Kingdom (Brian Allison) became the co-chairs, with Canada (Eddy Chui) also participating.

Dr. Watson stated that the Academic Task Force has existed since 2009, though it was mostly dormant during the years 2010-2014. At the 2015 Mid-Year Meeting in Regina, the CSLF Policy Group re-formed the task force with the United States and Mexico as co-leads. The overall mission was to identify and engage academic programs on CCS throughout the world. A half-day workshop was held at the CSLF's 2016 Mid-Year Meeting in London, which resulted in formation of an Academic Council (comprised of representatives from universities and research institutes) which would advise the CSLF. The workshop also resulted in several recommendations for future Policy Group actions in areas such as international CCS collaborations, international networks, research exchanges, and summer schools. Specific recommendations were to utilize existing resources and linkages to leverage existing connections and foster new connections while avoiding duplication of effort, focusing on best practices, and showcasing talent and technologies. Priority areas were identified as training and academic resources, communications, and capacity building. However, subsequent to the 2016 Workshop, activity in this area faded and there have been no further Policy Group actions. Dr. Watson stated that post-2016, Sallie Greenberg had handled much of the reporting on behalf of the Academic Council, but that limited feedback had been received from the Academic Task Force itself. Following the 2017 CSLF Mid-Year meeting in Abu Dhabi, the Academic Council also mostly went dormant.

Dr. Watson stated that during the roll-up to the Technical Group's Champaign meeting in April, there had been discussions between the Technical Group and Policy Group toward transfer of the academic engagement activity to the Technical Group. During the Champaign meeting it was determined that sufficient interest existed within the Technical Group to re-establish a new Academic Task Force. Australia (Max Watson) and the United Kingdom (Brian Allison) became the co-chairs, with Canada (Eddy Chui) also participating.

Dr. Watson then provided a brief summary of the plan of action. Step 1 would be to re-identify Academic Task Force participants. To that end, at least six Technical Group delegates or representatives from allied organizations would be needed to ensure an effective task force, and the task force is also seeking representation from the Policy Group/CEM-CCUS. Step 2 would be that prior to the 2020 Mid-Year Technical Group meeting, the task force would do a review of previous and possible future task force activities and re-establish the CSLF Academic Council in some form. Step 3 would be to finalize the task force process and goals, and present a task force plan of action at the Technical Group's 2020 Mid-Year meeting. After that, the stage would be set for the Technical Group (through the task force) to begin actively engaging the academic community for the benefit of both the CSLF and the academic community.

Dr. Watson concluded his presentation by providing some initial recommendations from the task force. These include:

- Do a comprehensive review of international R&D programs/organizations in order to leverage existing CSLF-recognized projects and allied organizations within the CSLF, identify and endorse projects that align with task force priorities, and update existing information at the CSLF website.
- Foster connections between R&D programs/organizations in order to help connect commercial CCS needs to the appropriate technology development.
- Focus on priority areas: training and academic resources, communications, and capacity building.

Following the presentation, Saudi Arabia, the IEAGHG, the GCCSI, and the CO<sub>2</sub>GeoNet Association all volunteered to join the task force. Additionally, France and the United States showed interest but could not immediately confirm their participation.

## **24. Update on the Technical Group Activities**

Technical Group Chair Åse Slagtern made a short presentation that summarized existing Technical Group activities and possible new ones. There are now six current/recent actions besides the PIRT. The CCS for Energy Intensive Industries has completed its activities, issued its final report, and has organized a workshop being held during the current Technical Group meeting. The Non-EHR Utilization Options will be continuing its activities into 2020 and may organize a workshop on this topic for a future Technical Group meeting. The CO<sub>2</sub> Hubs and Infrastructure Task Force will be organizing a workshop for the next Technical Group meeting as well as providing annual status reports on this topic. The Academic Task Force has re-formed and is developing a scope of activities. The Hydrogen Production with CCUS Task Force did not continue beyond its initial "Phase 0" activities but has organized a workshop that is being held during the current Technical Group meeting; following the workshop, a summary report will be prepared by the organizers. And the Ad Hoc Committee has organized five working groups to track progress in five priority areas. Besides these, there have been eleven other completed Technical Group actions since 2013.

Ms. Slagtern closed her presentation by stating that there are many other potential topics of interest that the Technical Group could undertake with new task forces, several of which had received high prioritization scores after a working group evaluation, a few years ago, of possible future Technical Group actions. A task force on business models is currently under the lead of the Policy Group/CEM-CCUS and contribution from the Technical Group is still a possibility.

During ensuing discussion there was general agreement that additional Technical Group activities will need to be undertaken, as time goes on, to help maintain the robustness of the organization. However, no new Technical Group task forces were formed.

## **25. Overview of France's CCUS Activities**

Aïcha El Khamlichi, CCUS Expert in the Industry Department of ADEME, gave an overview presentation on the status of CCUS in France. Dr. El Khamlichi began by providing information about ADEME, the Agency of Environment and Energy Management. ADEME was created in 1992 under the joint authority of the Ministry of Ecology, Sustainable Development and Energy and the Ministry of Higher Education, Research and Innovation. Since then, ADEME has been a source of advice and expertise in these areas to corporations and public authorities and has provided finance decision-making assistance.

Dr. El Khamlichi stated that ADEME is managing a €4 billion program for R&D support in the environment and renewable energy sectors, which consists of subsidies, refundable grants, and equity. This includes assistance for CCUS, which is a component in its "Sustainable Production and Renewable Energy" programme. ADEME has helped the French Government develop its greenhouse gas reduction target of a 75% reduction in these emissions by the year 2050. CCUS is a part of that strategy such that by 2050, CCS for energy intensive industries in France can prevent up to about 5 Mt CO<sub>2</sub> from entering the atmosphere. Additionally, bioenergy with CCS (BECCS) has the potential of eliminating another 10 Mt of CO<sub>2</sub> emissions by 2050.

Dr. El Khamlichi stated that geologic characterization work has determined that France has an overall CO<sub>2</sub> storage capacity estimated at about 27 gigatonnes (Gt), which includes saline aquifers, a depleted oil/gas field, and depleted coal beds. There have been several storage projects, including the CSLF-recognized Lacq Project which was an integrated oxyfuel pilot that stored and monitored 60,000 tonnes of CO<sub>2</sub> during its six years of operation. A currently-funded activity is been the H2O2O Project which is performing storage capacity assessments for eight regions identified as promising for CCUS development, with the aim of encouraging initiatives within each region by producing local development plans and business models tailored to industry's need.

Dr. El Khamlichi reported that there have also been several CO<sub>2</sub> capture projects in France, including the Lacq Project. Some of these have been pilots and some prefeasibility studies. There is also one commercial facility that utilizes Air Liquide's Crycap™ CO<sub>2</sub> cold capture system for use with hydrogen production processes and is capturing more than 100,000 tonnes of CO<sub>2</sub> per year. And as for CO<sub>2</sub> utilization, a focus has been on the steel industry where a pilot-scale project at a commercial steel-making facility is envisioned within the next few years.

Dr. El Khamlichi concluded her presentation by mentioning some of France's international collaborations for CCUS. France is a member of Mission Innovation via its Ministry of Ecology, Sustainable Development and Energy. Additionally, the Ministry of

Higher Education, Research and Innovation (via ADEME) is participating in the multilateral Accelerating CCS Technologies (ACT) initiative. Four of the current twelve ACT projects have French partners. Dr. El Khamlichi also briefly described the Phoenix initiative, where France, Germany, the Netherlands, and Spain have partnered to build a business case with respect to CO<sub>2</sub> utilization in order to ensure optimal use of public funding and private investment.

## **26. Update on CCUS in the European Union (EU)**

Wolfgang Schneider, Policy Officer for Clean Energy Transition in the European Commission's Directorate-General for Research & Innovation, gave an overview presentation on the policy-oriented status of CCUS in EU. As a preamble, Mr. Schneider provided overall European climate targets which include a 40% reduction of greenhouse gas emissions by 2030 and net-zero emissions by 2050. A 'European Green Deal' has been initiated by the President of the European Commission, The Honorable Ursula von der Leyen, which includes a more ambitious greenhouse gas emission reductions target of 50-55% in 2030. To reach the 2050 target will require a socially-fair transition in a cost-effective manner. The EU's plan for carbon emissions reduction involves seven 'building blocks', one of which is CCUS.

Mr. Schneider reported that CCUS has a crucial role in closing the circle for a net-zero economy. Even though electricity generation by renewables will continue to increase, energy intensive industries will still require CCUS, and if CCUS is combined with sustainable biomass it could result in negative emissions. However, CCUS is facing barriers in Europe. Large-scale demonstrations have not happened and there is not yet proof of economic viability. Also, there are regulatory barriers in some EU member states and there has also been public opposition. Mr. Schneider stated that an enabling framework is needed to incentivize large-scale CCUS demonstrations, to provide the right signals to the markets, and to reassure public opinion.

Mr. Schneider then briefly described the EU's Innovation Fund, which has the overall objective of driving innovative low-carbon technologies (including CCUS) toward the market. Projects that avoid emissions and boost competitiveness will be supported. Overall (and depending on the carbon price), €10 billion will be allocated for this purpose, with the first call for projects expected to happen sometime in 2020. The Innovation Fund has synergy with the EU's Horizon Europe initiative that would support development of innovative technologies at a smaller scale. The intent of Horizon Europe is to strengthen the EU's scientific and technological bases while boosting Europe's innovation capacity and competitiveness. To that end, a fund of €100 billion has been proposed, with €15 billion of that amount earmarked toward a "Climate, Energy, and Mobility" thematic cluster which includes areas related to CCUS.

Mr. Schneider stated that CCUS is also part of the EU's Strategic Energy Technology (SET) Plan, with the objectives of demonstrating and deploying at commercial scale across the entire CCUS value chain, reducing the cost of CO<sub>2</sub> capture, and demonstrating safe CO<sub>2</sub> storage. However, this is currently being hampered by the lack of a business case for CCUS in the power generation sector. This has resulted in the emphasis being shifted toward CCUS for energy intensive industries such as steel and cement which have CO<sub>2</sub> emissions as part of their processes. Overall, the best business model may well to implement CCUS in hubs and industrial clusters (with decoupling of capture, transport and storage), which would also bring in greater opportunities for CO<sub>2</sub> utilization for production of fuels, chemicals, and materials. Mr. Schneider also briefly described the

EU's Horizon 2020 initiative, which has the goal of removing barriers to make it easier for public and private sectors to work together in delivering innovation. Horizon 2020 has been active since 2014, and includes seven CCUS projects that have cumulatively received an EU contribution of approximately €80 million. Future topics for Horizon 2020 cover geologic CO<sub>2</sub> storage and low-carbon industrial production using CCS.

Mr. Schneider closed his presentation by stating that several potential research challenges exist that could slow down the promulgation of CCUS in Europe. More cost-effective CO<sub>2</sub> capture and development of new storage sites are the most obvious, but there is also a need to improve the CO<sub>2</sub> balance and energy performance of CO<sub>2</sub> conversion to value-added projects and a need for more feasibility studies which could spur development of hubs and industrial clusters for CO<sub>2</sub> transport and storage/utilization. Mr. Schneider ended by mentioning that this was his first Technical Group meeting and that he was happy to have become the European Commission delegate to the CSLF.

## **27. Update on the Rotterdam CCUS Porthos Project**

Peter Arends, Porthos Project Manager, gave an overview presentation about this planned project. Porthos would be a CO<sub>2</sub> transport and storage project, collecting CO<sub>2</sub> from heavy industries in Rotterdam, transporting the CO<sub>2</sub> via both onshore and offshore pipelines to a nearby offshore depleted gas field storage site, and storing the CO<sub>2</sub> in the gas field at a sub-seabed depth of more than 3,000 meters. Mr. Arends stated that the Port of Rotterdam is a unique location for CCUS, as it includes approximately 16% of total CO<sub>2</sub> emissions in the Netherlands, contains a large industrial cluster within a relatively small area, and has access to a nearby well-characterized under-seabed storage site. The Netherlands has a climate target of a 49% reduction of CO<sub>2</sub> emissions by 2030. This includes a reduction of 7 Mt per year from industrial sources, so the Porthos Project could be a key component in the national emission reductions strategy.

Mr. Arends stated that one of the advantages for the Porthos Project is that it can make use of an existing onshore pipeline corridor. The total length for the onshore part of the transport pipeline would be 33 kilometers and would terminate at the compressor stations. There would be compressor stations in three locations, and then an offshore pipeline about 21 kilometers in length to the storage site. The overall capacity of the CO<sub>2</sub> infrastructure would initially be about 5 Mt per year.

Mr. Arends stated that there is more CCS potential anticipated for the Netherlands than just the Port of Rotterdam, and longer term the Porthos infrastructure (after expansion to about 10 Mt per year) could accommodate CO<sub>2</sub> from Belgium and Germany. The project would provide valuable experience on CCS hub development, which could help to reduce CCS unit costs.

Mr. Arends concluded his presentation by providing the project status. CCS has been included in the Dutch Climate Accord, which would provide it a subsidy support mechanism. Industry has already expressed sufficient interest for the project to move forward, and environmental impact assessment procedures are underway. Also, front end engineering and design (FEED) analysis has started (the "Define" phase). Mr. Arends stated that there are challenges ahead toward a final investment decision. For the business case, there is not yet sufficient funding to close the financial gap. Some regulatory issues also need to be addressed, and from a technical viewpoint a clear operating philosophy based on complex flow control for the CO<sub>2</sub> needs to be developed. Mr. Arends ended by stating that a financial investment decision for the project is expected in 2021.

There were two clarifications made in the ensuing discussion. Mr. Arends confirmed that the depleted gas field was the same storage site as would have been used by the now-cancelled ROAD project. Also, the Rotterdam CCS Project, which had received CSLF recognition back in 2009 and which had a similar scope to the Porthos Project, is no longer active.

## **28. Overview of the Accelerating CCS Technologies (ACT) Initiative**

Mark Ackiewicz, ACT representative for the United States Department of Energy, provided a short overview of the multinational ACT initiative. ACT was created, initially with co-funding from the European Commission's Horizon 2020, to help establish CCUS as a tool to combat global warming. CCUS is essential for reducing CO<sub>2</sub> emissions, with international cooperation and knowledge-sharing a necessity to enable widespread CCUS deployment. Mr. Ackiewicz stated that ACT is a fit-for-purpose and flexible instrument for funding CCUS innovation, where funding from ACT member countries stays within those same countries to fund their researchers. Also, funding follows national procedures and can be tailored to each country's specific interests. And, once projects are selected, ACT monitors those projects for progress.

Mr. Ackiewicz reported that ACT has had two calls for project proposals, with a third call under consideration. For the first two calls, nine of the 26 CSLF Members participated. For ACT1, in June 2016, eight projects were selected for funding in 2017. A total of €36 million was committed, of which approximately €11.9 million came from the European Commission. The cumulative budget for the eight projects was approximately €50 million, with the projects' partners covering the costs not funded by ACT. ACT2, in June 2018, resulted in twelve additional projects selected for funding in 2019. A total of €31 million was committed, none of which came from the European Commission. The cumulative budget for the twelve ACT2 projects was approximately €43.5 million, with the projects' partners once again covering the costs not funded by ACT.

Mr. Ackiewicz stated that ACT is more than just single projects – the overall concept allows projects selected by ACT to learn from each other. To that end there have been knowledge-sharing workshops for funded projects that were held in Romania in October 2017 and in Germany in November 2018. A third workshop was held in Greece during the same week as the Technical Group meeting. Mr. Ackiewicz concluded his presentation by summarizing lessons learned through ACT. One of them was that it is challenging to attract industry interest in ACT in some countries, and this may need to be addressed in future calls. Also, it has become clear that smaller countries are benefiting from the cooperation inherent to ACT. Overall, learnings across borders and across projects has been very beneficial to all partners, and new partners are always welcome.

## **29. Update on the ACT Accelerating Low-Carbon Industrial Growth through CCUS (ALIGN-CCUS) Project**

Tom Mikunda, Energy Policy Consultant for the Netherlands Organisation for Applied Scientific Research (TNO), gave an overview presentation about this project. ALIGN-CCUS is one of the eight ACT1 projects and has more than €14 million total funding. This research-oriented project began in 2017 and is expected to conclude in August 2020. Mr. Mikunda stated that there are currently 31 project partners representing industry, academia, research institutes, government organizations, and NGOs.

Mr. Mikunda stated that ALIGN-CCUS has the aim of moving forward the development of industrial clusters and infrastructure for CCUS. To that end, there are five main

components: enabling near-term deployment of CO<sub>2</sub> capture by improving performance and reducing costs; optimizing large-scale CO<sub>2</sub> transport; reducing uncertainty in the provision of large-scale CO<sub>2</sub> storage networks; establishing the contribution of CO<sub>2</sub> utilization; and working toward social acceptance for CCUS. Five work programs are in place that correspond to the five main components of the project, and there is also a sixth work program that is conceptualizing possible blueprints for low-carbon industrial CCUS clusters. Concerning industrial clusters, Mr. Mikunda stated that Rotterdam in the Netherlands, as earlier described in the Porthos Project presentation, is one of six proposed industrial clusters of interest for ALIGN-CCUS, with others located in the United Kingdom (Teesside and Grangemouth), Germany (North Rhine-Westphalia), Norway (Grenland), and Romania (Oltenia Region).

Mr. Mikunda stated that for each work program, there is R&D or other activities in progress at one or more of the project partner sites. One of the non-R&D activities, for example, is the development of a methodology to produce standardized definitions of levels of storage readiness for candidate sub-seabed storage sites across the North Sea. This is one of the necessary steps that are needed prior to any projected large-scale deployment of CO<sub>2</sub> storage in the North Sea.

Mr. Mikunda concluded his presentation by briefly mentioning some of the project outputs. These range from academic papers and conference presentations to feature articles and reports. Outputs are being publicized and shared in many ways, such as by webinars, in newsletters, and through social media.

### **30. Update on the Pre-ACT Project**

Peder Eliasson, Senior Researcher in Geophysics for SINTEF, gave a detailed technical presentation about this project. Pre-ACT is another of the ACT1 projects and has an emphasis on CO<sub>2</sub> storage challenges, specifically the pressure-control and conformance management aspects. The overall approach is threefold: answering to industry needs; learning from demonstration, pilot, and field lab data; and providing deliverables which focus on industry uptake.

Dr. Eliasson stated that Pre-ACT has five ongoing work program modules: pre-injection modeling, novel monitoring concepts, conformance verification, decision making, and workflow demonstration. The pre-injection modeling module, through a program of modeling and laboratory work, is studying optimal injection planning via effective pressure control. The novel monitoring concepts module is investigating different geophysical methods such as regional earthquakes and micro-seismicity for conducting sparse, semi-continuous monitoring operations of stored CO<sub>2</sub>. The conformance verification module is examining multiple data types and sources to assess industrial-scale CO<sub>2</sub> storage site conformance (e.g., CO<sub>2</sub> migration within a storage reservoir conforming to what was predicted from modeling activities). The decision making module is investigating and describing procedures that should be set in motion if a conformance test fails, and is exploring consequences of various possible actions should that occur. Dr. Eliasson stated that the fifth module, workflow demonstration, is intended to demonstrate the value of project results through application of the methodology developed in the other four modules to storage scenarios at realistic sites. This fifth module also is the public outreach module, as it will communicate project results to stakeholders and regulatory authorities.

Dr. Eliasson concluded his presentation by stating that the project has sponsored three stakeholder workshops in 2019 with another scheduled for early 2020.

### **31. France's Policy Plans for a Carbon Neutral Society**

Joseph Hajjar, Head of the Emissions, Projections and Modelisation Unit in France's Ministry for the Ecological and Inclusive Transition, gave an overview presentation about the role of CCS in France's long-term strategy to address climate change. The overall goal is for France to become carbon neutral by the year 2050. Mr. Hajjar stated that this had been decided back in 2015 after extensive consultation with stakeholders and the public, and is achievable based on extensive modeling of different sectors of the French economy. There are projected to be deep cuts in CO<sub>2</sub> emissions by 2050, with remaining emissions offset by various carbon sinks.

Mr. Hajjar stated that the scenario for reaching carbon neutrality includes a sharp decrease in energy consumption by all economy sectors and a large reduction in non-energy emissions from agriculture and industrial processes. Under this scenario, energy production in France would be zero carbon based on use of renewables, biomass, and decarbonization technologies. There would also be a larger carbon sink resulting from changes in land use, a paradigm shift in how forests are managed, and implementation of CCS technologies where possible.

Concerning CCS, Mr. Hajjar stated that its potential would be limited due to the expected deep carbonization of the economy – although CCS is a necessity, decarbonization and energy efficiency are more important. For the 2050 scenario, CCS is not being envisioned for use in fossil-fueled power plants. Instead, it would be used to capture residual non-energy emissions from industrial processes as well as to generate negative carbon emissions when associated with biomass combustion. By the year 2050, the gross potential for CCS would be approximately 40-50 Mt per year of CO<sub>2</sub>. However, due to uncertainties about technology availability and cost as well as the unlikelihood of implementing CCS all possible locations, the actual potential for CCS would be approximately 15 Mt per year.

Mr. Hajjar concluded his presentation by providing information about the present status and anticipated next steps toward the 2050 scenario. The carbon neutrality objective has been officially adopted, and a draft document has been published which describes the 2050 scenario in detail as well as its possible environmental impacts. Outreach activities are in progress, and the document is expected to be finalized sometime in 2020. Mr. Hajjar stated that in the short term, the French Government will be taking steps to ensure its policies are in line with the 2050 scenario strategy, with yearly checks on economy sector indicators in order to monitor progress. Also, strategy updates will happen every five years so that the 2050 scenario stays on track.

### **32. Report on the 2019 Mission Innovation CCUS Workshop**

Lars Ingolf Eide gave a presentation that had been prepared by Rune Aarli of SINTEF about the Mission Innovation CCUS Workshop that was held in Trondheim, Norway, in June 2019. Mission Innovation is a multilateral Ministerial-level initiative that was launched in November 2015 with the overall goal of accelerating the pace of clean energy innovation, to achieve performance breakthroughs and cost reductions in order to provide widely affordable and reliable clean energy solutions. The Trondheim CCUS workshop attracted 135 attendees, included six group work sessions, and resulted in a report that presented topical summaries and described recommendations for action. Mr. Eide stated that breakout sessions for the workshop's six topics of interest were tasked to address the following issues:

- Which opportunities are identified from an industrial point of view?
- How do we most effectively get from research to commercial product?
  - What steps are needed?
- What joint activities could be established to accelerate technology development and implementation?
  - How can joint action accelerate deployment?
  - Business models: What funding instruments are/could/would be effective?
  - Mobilizing national efforts toward international efforts.
  - Public-private partnership, co-funding, etc.

Mr. Eide stated that the workshop's final report had been issued in October and was available for download from the SINTEF website (*note: the Internet link to the report was included in the presentation*). The report contains extensive sets of recommendations for all six workshop topics, using three different timelines: short-term (within 1 year), medium-term (1-3 years), and long-term (greater than 3 years). The long-term recommended actions are:

Topic 1: Decarbonizing industry sectors

- Implement incentives that encourage consumers to buy low-CO<sub>2</sub> footprint products.

Topic 2: The role of CCS in enabling clean hydrogen

- Implement detailed design for large-scale industrial clusters and infrastructure.
- Start construction, commissioning and operation of this infrastructure.

Topic 3: Storage and CO<sub>2</sub> networks

- Establish one or more internationally-recognized open-source software related to CO<sub>2</sub> storage, as has been done for climate models.
- Mature an international certification process for bankable CO<sub>2</sub> storage resources.
- Engage with the insurance and financial communities to build confidence in CO<sub>2</sub> storage, manage the risks, incentivize implementation of storage and transport networks, and manage penalties if promises were not achieved.

Topic 4: Storage monitoring

- International collaboration is needed to reduce risk and cost on offshore CO<sub>2</sub> demonstration injection projects in diverse settings.
- Decide how much and what types of data to collect to reduce costs and provide assurance using environmental monitoring.

Topic 5: Going climate positive

- Start operating pilot plants and demonstration plants for the less mature/high potential technologies.
- Build systems that allow for investment into climate positive solutions (such as bioenergy with CCS), based on business models that pay for carbon stored.
- Raise the awareness of the need for CCUS-based climate positive solutions as a complement to primary decarbonization measures such as energy efficiency and use of renewables.

Topic 6: CO<sub>2</sub> utilization

- Once the most promising routes have been selected and proven, build up international cooperation to spur investments and seek to reduce regulatory barriers on selected and most promising CO<sub>2</sub> capture and utilization routes.

Mr. Eide ended the presentation by acknowledging the organizations which provided the resources and support needed to stage the workshop: the Research Council of Norway, the U.K. Department for Business, Energy and Industrial Strategy, Total, The CLIMIT Programme, Gassnova, Equinor, the Norwegian CCS Research Centre, and SINTEF Energy Research.

### **33. Report on CCUS in Romania**

Constantin-Stefan Sava, Senior Geoscientist and Department Director at GeoEcoMar, gave a presentation that summarized CCUS possibilities for Romania and the role of GeoEcoMar in promoting CCUS. Dr. Sava stated that GeoEcoMar, Romania's National Institute for Research and Development of Marine Geology and Geoecology, has an overall focus on the study of the Danube River-Danube Delta-Black Sea macro-geosystem. Since 2001, GeoEcoMar has been involved in work related to geological CO<sub>2</sub> storage and now participates in several national and international projects and activities related to CCS, including becoming a member of the GCCSI in 2010 and the CO<sub>2</sub>GeoNet Association in 2013. GeoEcoMar is a founding member of the CO<sub>2</sub> Club in Romania and was involved in the feasibility study for the proposed Getica CCS full-chain CCS project that was to be sited at a power plant in the Oltenia region of the country. Since 2017, GeoEcoMar has been involved in two ACT1 projects: ALIGN-CCUS and ECOBASE, the latter focused on development of prospective revenue streams and business models for CO<sub>2</sub>-EOR in southeastern Europe. GeoEcoMar is also a partner in the CSLF-recognized Enabling Onshore CO<sub>2</sub> Storage in Europe (ENOS) project.

Dr. Sava stated that conditions in Romania are favorable for CCUS, as fossil energy sources account for more than 40% of the overall energy mix and a large majority of CO<sub>2</sub> emissions are caused by energy production. There are many geological storage possibilities, including hydrocarbon fields, aquifers, and coal fields. Dr. Sava stated that Romania is well-positioned to be a multimodal CO<sub>2</sub> storage center for the entire Black Sea region, as there are large-capacity storage sites near its Black Sea coast. CO<sub>2</sub> could be moved by ship across the Black Sea or down the Danube River to a seacoast terminal where it would then be transported by short pipelines to the storage sites. This would be a southeastern Europe equivalent, of sorts, to the Northern Lights project envisioned for northern Europe.

Dr. Sava concluded his presentation by stating that the ECOBASE project is working toward advancing this concept to the point where detailed infrastructure development planning becomes possible, and that he would be happy to provide an update at a future Technical Group meeting.

### **34. Report on CCUS in Poland**

Krzysztof Makowski, Senior Expert in the Energy Department of Poland's Ministry of Energy, gave a presentation that summarized CCUS possibilities for Poland. Mr. Makowski reported that by the year 2030, coal-fueled power generation is expected to account for approximately 60% of the electricity production in Poland. The "Energy Policy of Poland Until 2040" document indicates that Poland is committed to a 30% reduction of CO<sub>2</sub> emissions compared to the year 1990. To achieve that there will need to be improvements in energy efficiency and greater use of non-fossil power generation (including introduction of nuclear energy in 2033).

Mr. Makowski stated that CCUS is currently mostly an R&D activity in Poland, with smaller-scale work being done by several technical universities as well as the Polish

Geological Institute, the Central Mining Institute, and the Institute for Chemical Processing of Coal. The latter two are under the supervision of the Ministry of Energy and jointly operate a Clean Coal Technology (CCT) Centre. Mr. Makowski stated that the CCT Centre's CCUS-related activities at the Central Mining Institute have included a study of safe CO<sub>2</sub> storage in the Silesia region of Poland, development of a strategy for CCUS, and a technology options (TOPS) study for coupling underground coal gasification with CCS. The Central Mining Institute has also been involved with two EC-funded projects: the RECOPOL Project for investigating the technical and economic feasibility for permanent storage of CO<sub>2</sub> in coal seams and the COALBYPRO project for capture of CO<sub>2</sub> using power plant fly ash. CCUS-related R&D activities at the Institute for Chemical Processing of Coal have included use of CO<sub>2</sub> as a chemical feedstock, chemical looping processes for capture of CO<sub>2</sub>, and utilization of CO<sub>2</sub> for algae cultivation. Mr. Makowski also reported that Poland's National Centre for Research and Development has supported nearly 40 projects associated with CCUS during the 2007-2018 time period. These have included studies for development of zero-emission coal-fired power units with CO<sub>2</sub> capture and development of oxy-combustion technologies for coal-fueled boilers with CO<sub>2</sub> capture.

Mr. Makowski then briefly described the canceled Bełchatów CCS Demonstration Project. This had been intended to include a full-scale CO<sub>2</sub> capture facility (1.8 Mt per year) at the Bełchatów Power Plant in central Poland. The project had received a grant from the European Union's Energy Programme for Recovery and an 858 megawatt unit of the power plant had been constructed to be CO<sub>2</sub> capture ready. However, due to insurmountable difficulties with the project's financial plan the project was stopped in 2013. Mr. Makowski stated that Poland is still interested in large-scale CCS and that some Polish energy companies are interested in a pilot plant on CO<sub>2</sub> storage in the North Sea, possibly as part of the Northern Lights project being developed by Norway.

Mr. Makowski concluded his presentation by describing another of Poland's CCUS-related activities, the CO<sub>2</sub>SNG Project. This is a novel concept for electricity storage by utilizing CO<sub>2</sub> to produce synthetic natural gas (SNG) during non-peak electricity usage periods; the SNG could then be combusted to produce power during peak electricity usage periods or used for other purposes. Mr. Makowski stated that the Institute for Chemical Processing of Coal has assembled a consortium which has constructed a pilot plant at the Łaziska power plant in southeastern Poland. Initial results have shown conversion rates greater than 99% for CO<sub>2</sub> to SNG.

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

Lars Ingolf Eide and Dominique Copin briefly provided information about the workshops on November 6 and 7. Stig Svenningsen stated that the Abu Dhabi meeting of the Policy Group/CEM-CCUS in January will be a two-day event, with one day set aside for a business meeting and one day for a workshop with stakeholders. Mr. Svenningsen also reported that another meeting of the Policy Group/CEM-CCUS is scheduled for Santiago, Chile in mid-year 2020 as part of the CEM's 11<sup>th</sup> Ministerial Meeting.

Concerning upcoming meetings of the Technical Group, Åse Slagtern stated that the 2020 Mid-Year Meeting will be hosted by Norway's delegation in Oslo the week of April 20, and will include a two-day business meeting, a one-day workshop on Hubs and Infrastructure, and a site visit. *(Note: The meeting date was subsequently changed. The new date for the 2020 Mid-Year Meeting is March 23-26.)* Hamoud AlOtaibi stated that the Technical Group's 2020 Annual Meeting will be hosted by Saudi Arabia's delegation

in Jubail the week of September 26-29. There will be a two-day business meeting with additional workshop and site visit. Further details will be forthcoming.

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

Hamoud AlOtaibi stated that the King Abdullah Petroleum Studies and Research Center (KAPSARC) in Saudi Arabia is currently preparing a report on “Achieving Climate Goals by Closing the Loop in a Circular Carbon Economy”, and that it is seeking input from the Technical Group. This report, when finalized, will serve as input to the G20. During ensuing discussion there was agreement for the Technical Group to assist via the Technical Group’s ExCo. *(Note: Subsequent to the meeting, KAPSARC notified the Technical Group’s ExCo that the GCCSI will instead provide the input to the report and that the ExCo will have an opportunity to comment.)*

### **37. Closing Remarks / Adjourn**

Technical Group Chair Åse Slagtern noted that this was the final CSLF meeting for France’s delegate Didier Bonijoly. There was a round of applause in appreciation of Dr. Bonijoly’s many years of service to the Technical Group. In closing, Ms. Slagtern again thanked EDF for hosting the meeting, thanked the Secretariat for its pre- and post-meeting support, and thanked the delegates and invited speakers for their active participation. She then adjourned the meeting.

## **Summary of Meeting Outcomes and Actions**

### **Outcomes**

- The Technical Group accepts the final report of the Task Force on CCUS for Energy Intensive Industries. The task force has ended its activities and has disbanded.
- The Non-EHR Utilization Options Task Force will be organizing a future workshop on this topic rather than issuing a final report.
- The Ad Hoc Committee is continuing its activities for at least the next year and probably longer. The committee will prepare annual updates that will be passed on to CEM-CCS. A new questionnaire is likely needed for project engagement. The committee will also suggest a more descriptive name for itself.
- The Technical Group has formed a new “passive” Task Force on Reservoir Management, to be led by Australia. The task force’s continuing activities will be to keep track of ongoing and new reservoir storage management activities worldwide and to provide updates to the Technical Group if and when new outcomes arise.
- The Technical Group will co-host a workshop at the next CO<sub>2</sub>GeoNet Open Forum (May 2020). This includes helping to develop themes. (Delegates from the United States, France, and Italy will be involved in this activity.)
- A decision will be made at the next Technical Group meeting on whether or not to develop and publish a new edition of the CSLF Technology Roadmap.
- New additions to the Academic Task Force include the IEAGHG, the GCCSI, CO<sub>2</sub>GeoNet, Saudi Arabia, and (maybe) the United States and France.
- The next Technical Group meeting will include a workshop on Hubs and Clusters.
- The 2020 Mid-Year of the Technical Group will be in Oslo, Norway, during the week of March 23-26. Further details will be forthcoming soon.

- The 2020 Annual Meeting of the Technical Group will be in Jubail, Saudi Arabia during the week of September 26-29. Further details will be forthcoming soon.
- The CEM-CCS Secretariat will provide the Technical Group the program for its next meetings.

#### Actions

- The Technical Group Chair and PIRT Chair will review all previous discussions and suggestions concerning the PIRT's future and provide a recommended plan forward at the next Technical Group meeting.
- The Technical Group will provide the Policy Group/CEM-CCUS with input to help shape future stakeholder engagement activities for the CSLF. (The Technical Group's ExCo will do this.) Note: Stakeholder engagement remains a Policy Group/CEM-CCUS activity for now, and the next Policy Group/CEM-CCUS meeting will have an agenda item on this topic. At the next Technical Group meeting, a representative from the Policy Group/CEM-CCUS will provide a readout any outcomes.
- The Technical Group will summarize its activities and recent outcomes in a presentation at the next Policy Group/CEM-CCUS meeting.
- The Technical Group's ExCo will provide input to the "Achieving Climate Goals by Closing the Loop in a Circular Carbon Economy" report that is being developed by KAPSARC in Saudi Arabia. *(Note: Subsequent to the meeting, KAPSARC notified the Technical Group's ExCo that the GCCSI will instead provide that input to the report and the ExCo will be invited to provide comments.)*

#### Outcomes from the two Workshops

- A report with presentations from the Workshop on Hydrogen Production with CCS will be published as an IEAGHG report no later than early January 2020. The workshop organizing committee intends to establish a joint task force between the four organizations and possible others, with the aim to develop common projects.
- France has taken an initiative to make a few further steps by inviting contributors to the Workshop on CCUS for Energy Intensive Industries to share views on the way forward to accelerate (or make happen) the development of CCUS in EIIs, or more generally in EIIs and other sectors.

