Side event US-Norway MoU CCUS collaboration - CLIMIT Summit 2017

8 March 20917, Oslo, Norway

Meeting Summary

The purpose the side event was to

- Inform about possibilities on US-Norway collaboration
- Facilitate networking and possible new activities
- Bring forward some examples from which potential new collaborations can learn
- Promote collaboration between US and Norway researchers and projects.

AGENDA

Facilitator: Kristoffer Robin Haug

14.00 – 14.40 Introductions DOE/CLIMIT/TCM

- Welcome (5 min)- Jostein Dahl-Karlsen, Norwegian Ministry of Petroleum and Energy
- The NETL capture program - Lynn A. Brickett (10 min). Presentation can be found here.
- The NETL storage program - Traci Rodosta (10 min). Presentation can be found here.
- The CLIMIT programme - Hans Jørgen Vinje (10 min). Presentation can be found here.
- Technology Centre Mongstad and US co-operations– Bjørn-Erik Haugan (5 min)

14.40-15.45 Part 1: Examples of existing collaboration – followed by panel discussions

- ION engineering and SINTEF (Buz Brown). Presentation can be found here.
- RTI and SINTEF (Markus Lesemann). Presentation can be found here.
- NTNU and Air Products (May-Britt Hägg). Presentation can be found here.
- CO_2 data sharing consortium (CSDC) (Philip Ringrose)
- LLNL and SINTEF (Susan Carroll). Presentation can be found here.

- University of Bergen and US organizations (Arne Graue). Presentation can be found here.
- Illinois State Geological Survey and NORSAR (Volker Oye). Presentation can be found here.

15.45-16.00 Break

16.00 -17.00 Part 2: Examples of upcoming and potential new activities – panel discussions

- SRI and SINTEF (Indira Jayaweera). Presentation can be found here.
- SINTEF and the University of Pittsburgh (Torleif Holt). Presentation can be found here.
- SINTEF and Westec Environmental Solutions (Ugochukwu Aronu), Presentation can be found here.
- Modularization (Susan Carroll). Presentation can be found here.
- CCUS/algae (Dorinde Kleinegris). Presentation can be found here.
- CO_2 specifications for material choices (Arne Dugstad). Presentation can be found here.

17.00 Way forward

Åse Slagtern, Research Council of Norway. Presentation can be found here.

SUMMARY

Introductions

Jostein Dahl Karlsen, Senior Adviser at the Norwegian Ministry of Petroleum and Energy, gave a brief background and history of the bilateral agreement between USA and Norway. A Memorandum of Understanding (MOU) on Collaboration in the Field of Energy Research, Development and Demonstration (RD&D) was signed in 2005. During these 11 years U.S. and Norway have had a close collaboration on CCS. One saw the need to champion CCS until a market situation has for CCS has developed. Visible results have been achieved in cooperation, e.g. within large scale testing of capture technologies and testing infrastructure. CO_2-EOR is also on the agenda.

Lynn Brickett, Carbon Capture Technology Manager at the National Energy Technology Laboratory (NETL), emphasised that NETL is an implementing entity under the US Department of Energy (DoE) and is restricted by budgets and directions received from DoE headquarters. They focus on low TRL technologies, i.e. 2nd generation and transformational capture technologies. The main focus of the portfolio is coal power, less than 25% goes to natural gas. Post-combustion technologies dominate. Lynn expected that 2nd generation will be out of the portfolio by 2020, as this is the target date. Transformational or disruptive technologies are challenging to identify and will be part of the future portfolio. Development of carbon capture systems will have elements of and benefit from computational materials discovery, synthesis and testing and manufacturing and functionalization. Involvement of and input from industrial stakeholders, including chemical companies manufacturers and EPC contractors, will be necessary.

The yearly capture portfolio was about $100 mill in 2016. The portfolio includes utilization, in terms of algae, fuels, chemicals and mineralization. Possible future directions include host sites for 2nd generation capture technologies, continuation of 2nd generation development, early TRL (Transformational) technologies, simulation (CCSI), modular systems, manufacturing, and carbon utilization.

US National Carbon Capture Center (NCCC) can presently test at up to 1 MW and can run several tests in parallel.

Tracy Rodosta, Carbon Storage Technology Manager, NETL, repeated that NETL is an implementation entity and emphasised that the underground is more difficult to comprehend than surface test facilities. The storage portfolio is 1/3 for R&D on storage and 2/3 on the large field sites where storage is taking place. Important storage R&D challenges, and where NETL has significant activities, include cost reductions in Monitoring, Verification and Accounting (MVA). Although each storage site may have different needs for monitoring, a goal is to develop a suite of cost efficient tools that can go commercial. Other issues covered by the portfolio are wellbore integrity, risk assessment, storage efficiency and security, and mitigation. Tools and sensors for monitoring wells, new materials for wells, advanced, coupled thermal/hydrologic/mechanical/chemical models, and development and field validation of toolsets that quantify potential impacts related to release of CO_2 and induced seismicity. There will also be some focus on infrastructure and large-scale injection projects.

Hans Jørgen Vinje, Programme Director of CLIMIT, gave a brief overview of the CLIMIT programme. There are presently 65 ongoing CLIMIT projects and the annual budget is around € 23 mill., equally divided between R&D projects administrated by the Research Council and demonstration projects administrated by Gassnova. The last four years have seen seven projects under the MoU umbrella, with total budgets of $ 7 mill., of which 65-70% are CLIMIT funds.

Demonstration projects under CLIMIT have open calls, whereas the R&D part has annual calls (call in spring, decisions in fall).

CLIMIT can fund international projects as long as they fall inside the CLIMIT mandate, i.e high scientific quality and contributions to value creation in Norway. Partner funding will be required and funds from DoE/NETL qualify as such. Partners must apply separately for funds in their own country and therefore projects must develop two interlinked applications.

Several CLIMIT projects have US participation. Presently there are more capture than storage projects in the portfolio.

Bjørn-Erik Haugan, Gassnova, emphasised the need to go beyond early TRL's and that a healthy portfolio must include demonstrations at larger scales. SINTEF's Tiller facility and the Test Centre Mongstad (TCM) are two facilities that will play a part in taking technologies further. ION Engineering is presently testing at TCM, and TCM is in dialogue with several other vendors of capture technology, including RTI, MTR, SRI and Fluor. Several of the possible partners have tested at NCCC and some at Tiller, illustrating the importance of having possibilities to test at several scales.

Project presentations – projects well underway

Alfred (Buz) Brown, CEO of ION Engineering, gave a brief presentation of the cooperation on instrument development and testing with SINTEF and TCM. Learnings from the collaboration include 1) that the CLIMIT style steering committee model works very well and secure all a place at the table when decisions are made; 2) the importance of transparency when it comes to work descriptions; 3) that varying exchange rates must be addressed in reimbursement parts of the contract; and 4) that communication and face-to-face meeting are important.

Markus Lesemann, Senior Director Business Development,Energy Technology Division, RTI International, briefly described two collaborations in Norway – one on solid sorbents with Norcem and one on non-aqueous solvents with SINTEF. The benefit in terms of lowering risk by testing first at Tiller and then at TCM compared to going from tests at NCCC to large scale was emphasised. It took some time to figure out the contractually picture but the end was result has been good.

May-Britt Hägg, Professor at the Norwegian University for Science and Technology (NTNU), presented the membrane technology developed at NTNU that has been licensed to Air Products, a US company with a branch in Norway. The presentation showed the importance of finding a partner with supplementary technology, in this case Air Products' hollow fiber membrane has been combined with NTNU's FSC coating technology. However, personal networks and contacts may be essential in identifying a partner.

Philip Ringrose, Geoscience Specialist at Statoil, presented a pre-project conceived under the MoU – the CO_2 Storage Data Consortium (CSDC). The CSDC was launched at the GHGT-13 conference in Lausanne November 2016 and the launch together with an online survey has given considerable customer feedback. The ambition is now to establish a data bank that has medium complexity and cost. The pre-project will be completed in June 2017 and presented at the bilateral meeting in Washington DC in August 2017. The goal is to secure co-funding from DoE/NETL and CLIMIT by end of the summer 2017. Other countries, in particular Australia, Canada and UK have shown interest, and Japan will also be approached. It will be important to demonstrate the benefits to the customers/users.

Susan Carroll, Scientist at Lawrence Livermore National Laboratory (LLNL), presented co-operation with Norwegian organizations that goes a long way back, starting with Statoil on In Salah and Snøhvit, via SINTEF and its partners in BIGCCS, to SINTEF and partners in SPINCCS and the recently started NCCS, aiming at a CO_2 well integrity atlas. The US part is funded by NETL storage programme. SINTEF's broad industry contact was mentioned as very helpful. Collaboration beyond LLNL is also beneficial. It was stressed that face-to-face meetings are important for the collaboration to work satisfactorily, and that funding stability, different timing of calls and funding opportunities, and contracts for transfer of funds may be challenge.

Arne Graue, Professor at the University of Bergen, presented two projects on use of CO_2 foam for EOR. The projects have several US partners along with partners from other countries. Funding is basically from CLIMIT and participating oil companies. Major challenges in the project include funding for monitoring CO_2 movement and logging.

Volker Oye, Head of Department at NORSAR, presented two collaborative projects between NORSAR and US partners: cooperation with the GSCO2 (Center for Geologic Storage of CO_2) on conceptual, mathematical, and numerical models applicable to geologic storage

systems, to which NORSAR was invited; and CO2CAP, a project to identify and map CO_2 plume from joined tomography (microseismic, 3D, VSP) in collaboration with Illinois State Geological Survey (ISGS), University of Texas, Midwest Geological Sequestration Consortium and SINTEF funded by CLIMIT/Gassnova and DoE. Challenges have included getting contracts in place and having regulars meetings. Access to data, cheap access to onshore sites, joint experiences and fun are amongst the successes and benefits.

Panel discussion

The ensuing panel discussion revealed that

1. One has to be aware of Intellectual Property Rights. In general the IPR's have not created problems in the presented projects but one has to pay attention to the issue and need to be clear on what is brought into the collaboration as proprietary and what will be common property. Existing patents will reduce the problem.
2. Research partners can be identified in several ways. The personal touch is important and participation in professional networks and conferences can often lead to research synergies. US participation in events like CLIMIT Summit and Norwegian participation in similar NETL CO_2 capture and storage events is very much encouraged.
3. Scientists usually find research partners on their own, but facilitation and encouragement by third parties can be helpful and are important and valuable.
4. Important that funding agencies realize that funds for travel and face-to-face meetings are important.
5. It can be a challenge to fund long secondments and electronic data access is encouraged to limit length of stays.

Project presentations – just starting and/or new possibilities for cooperation

Indira Jayaweera, Senior Staff Scientist and Program Manager, SRI International, presented two DOE funded projects that may be suitable for Norwegian industrial CCS applications and eligible for co-funding US-Norway: 1) PBI hollow fiber membrane (HFM) for syngas separation for IGCC application; and 2) Ammonia based Mixed-Salt Technology (MST) for CO_2 capture. The first is being tested at NCCC until end this summer and SRI are looking for places to go further with the unit. The second project can be taken to large scale at the TCM Chilled Ammonia Plant (CAP), preparations for which will be in co-operation with SINTEF. Information can be shared due to already filed patents.

Torleif Holt, Senior Scientist, SINTEF Petroleum, presented a co-operation between SINTEF and University of Pittsburgh on Improved performance of CO_2 EOR and underground storage by mobility control of CO_2. The project was awarded CLIMIT R&D funds late 2016 and will start in 2017. One challenge is the limited funds for international co-operation in CLIMIT R&D and co-operations have to be sought amongst those already having US funding on relevant projects. Cooperation agreements will have to be signed and technical/planning meetings organised.

Ugochukwu Aronu, Scientist, SINTEF Materials and Chemistry, presented a project with the US company Westec Environmental Solutions on innovative precipitation process. SINTEF was awarded CLIMIT R&D funds to start in 2017, whereas Westec receives from Carbon Management Canada (CMC). The project partners met at a Norway/UK/Canada CO_2 Capture Research Meeting in Oslo, 18-19 March, 2015, organised by the Research Council of

Norway.

Susan Carroll, standing in for Roger Aines, LLNL, gave a brief summary of a joint LLNL and Gassnova workshop on Small Scale and Modular Carbon Capture. Definition of "Small scale" was agreed. Modular systems can allow to start at small scale and expand later. No joint efforts defined so far but the topic is of interest for industrial systems on both countries. Presentations from the workshop can be found at http://www.cvent.com/events/small-scale-and-modular-carbon-capture-workshop/custom-36-a8fdbad41e6d4dd49d32ccf72429c911.aspx

Dorinde Kleinegris, Principal Investigator Uni Research Environment, presented a project on CO_2 for algae production. There is a pilot outside the fence of TCM, where algae are grown with CO_2 from TCM. For the capture part there is co-operation with SINTEF and MTR but no co-funding at present.

Arne Dugstad, Chief Scientist, Institute for Energy Technology, illustrated the uncertainties around impurities in CO_2 that shall be transported and possible consequences. He presented thoughts on topics for possible co-operation with interested US organisations, for example a review and experimental programme.

Panel discussion

Timing of calls in the two countries came up once again and the two modes of CLIMIT calls were repeated (see under Hans Jørgen Vinje). NETL informed that budgets are not confirmed due to the administration transition.

Two other potential collaborative projects were mentioned by Tel-tek: One on cryogenic capture with SES, for which funds have been awarded by DOE and they look to testing at TCM; and the COSTCap project that looks at partial capture.

Summing up and the way forward

Åse Slagtern, Special Adviser, Research Council of Norway, and head of the MoU Secretariat, thanked everybody for presentations and attendance. She informed on how the MoU works and what the next formal steps are. The next bilateral meeting will take place in Washington DC 28 and 29 August 2017.

There is a web site for the MoU, http://www.us-norway-ccus.com, where information can be found on calls, awards, events etc. The Secretariat is there to help and advice those you have questions or need help. Contact information is on the web site.