



US - NORWAY COLLABORATION ON CCS/CCUS

United States Department of Energy

&

Ministry of Petroleum and Energy, Norway

Annual Bilateral Meeting

Pittsburgh, Pennsylvania, USA

30 August 2019

Meeting Notes

Plenary

Delegates from the United States of America (USA) and Norway met in Pittsburgh, Pennsylvania, USA, 30 August 2019, under the US-Norway bilateral agreement on collaboration within the subject of Carbon Capture, Utilization and Storage (CCUS). The objectives of the meeting were to present activities and achievements since August 2018, and to discuss future areas of cooperation. The meeting took place at David L. Lawrence Convention Center, Pittsburgh, in conjunction with the NETL review meeting “Addressing the Nation’s Energy Needs Through Technology Innovation – 2019 Carbon Capture, Utilization, Storage, and Oil and Gas Technologies”,

Brian Anderson, Director, National Energy Technology Laboratory (NETL), U.S. Department of Energy (DOE) welcomed the participants to NETL on behalf of the US DOE. Work under the USA-Norway bilateral agreement was initiated in 2005 and has led to several cooperative research projects and also a general Cooperative Research and Development Agreement (CRADA). Anderson particularly mention the CRADA between NETL and Gassnova, which, amongst other, will open for easier exchange of data from the Technology Centre Mongstad (TCM) and NETL modellers. He emphasized that CCUS is necessary for achieving goals of the Paris Accord, and expressed hope that the cooperation will lead to breakthroughs that will allow on-time commercialization of large scale CCUS.

William Christensen, Deputy Director General, Ministry of Petroleum and Energy (MPE), Norway, gave an update of the Norwegian large-scale project. The main objective is the get CCS going in Europe. The first exploration license for an injection well was issued by the Norwegian Petroleum Directorate (NPD) to Equinor, Total and Shell, and drilling the well will start in December 2019. An investment decision is expected 2020/2021.

Richard Lynch, DOE, gave a short overview of the bilateral cooperation.



Heads of delegation: Brian Anderson, NETL (left) and William Christensen, MPE (right)

Espen Bernhard Kjærgård, Research and Technology Section, Climate, Technology & Industry Department, MPE, gave the objectives of the workshop:

- Identify ways for even better cooperation for accelerating development CCUS technologies.
- Identify new common issues and collectively solve them.
- Update and identify the way forward for financial instruments and business models

Summary of themes for future R&D cooperation within storage

Darin Damiani, DOE, and Philip Ringrose, Equinor, reported from the storage breakout session. The discussions during the day and at the end indicates some potential themes for future co-operative R&D within storage:

1. Identifying learnings for emerging CCS hubs – de-risking
 - Bigger risk issues for offshore, e.g. slope stability
2. Modeling Sleipner benchmark – workshops in 2020 and possible joint paper?

3. Adding further to operator experience to well integrity atlas
 - More need to look at approaches to handle legacy well issues
4. Real-time machine-learning applications (pressure analysis, etc)
 - New geophysical sensing / monitoring methods
5. Solving Gt-scale storage problems – focused on pressure development
 - Data handling challenge for major basin-scale projects and hubs
6. New ACT projects give good vehicle for further collaboration
7. Scaling up to handle the large data volumes

Summary of themes for future R&D cooperation within capture

Lynn Brickett, DOE, and Bjørn-Erik Haugan, TCM, reported from the storage breakout session.

The discussion was around the following questions:

- What R&D would be most impactful for a commercial-scale industrial capture project?
- To our Norwegian colleagues: given what you've seen on US R&D projects at our conference, are there any collaborative opportunities that stand out?

One point that was emphasized to achieve impactful R&D for a commercial-scale industrial capture project, was to identify what is specific for industry. Further it was pointed at process intensification, 3D printing, multifunctional sorbents, modularization for design and manufacturing. Specific for industry purposes is to optimize the integration of the capture technology into the industry process design as well as identify specific technologies that are beneficial for certain industries. Another area for collaboration that was identified was up-scaling of sorbents.

For future new collaborative opportunities capture from industrial sector was identified as specifically important. Several areas was identified and it was suggested to arrange workshops for invited people to discuss these areas in more detail:

- on additive manufacturing
- on modeling and
- on process control

US joined the [ACT](#) for the second call in 2018 with the US national labs as eligible for applying for funding. Further development of the relation between the National Labs (NLs) and Norwegian R&D actors was looked upon as a new opportunity to prepare for future ACT calls.

Business models:

Jeff Bobeck, Carbon Capture Coalition (CCC) stated that the 45Q legislation in place, but new initiatives will be needed to stimulate the CCUS market. These include initiatives in Congress to

revitalize R&D programs on capture, progress on infrastructure development, and financial issues. So far 45Q has **not** generated a flood of projects, due to many legal issues still in the law:

- Transferability issue (ie. who can get the tax rebates)
- CO₂ utilization was included in 45Q, which was good, but life-cycle analysis requirement has in fact made it unrealistic to agree real projects
- Definition of secure geological storage is challenging –ISO guidelines could provide a way forward
- Threshold for minimum CO₂ capture maybe too high

Talks from **Eva Halland**, Norwegian Petroleum Directorate (NPD) and **Johnny Stuen**, Fortum Oslo Varme, on how new business for CO₂ handling – capture, storage and EOR – could emerge, based on Norway experience. Fortum is finding significant new business options for WtE plants around Europe. In the Netherlands, there are also very productive discussions on potential new capture sources.

Philip Ringrose, Equinor, said Equinor has identified CO₂ sinks all over Europe, and that the interest for CCS increased when the owners were made aware the sinks exist. Hubs will open new business opportunities.

Mike Godec, Advanced Resource International (ARI) open by stating that there were five offshore storage pilots in US in the 1980s. Several CCS hubs are already in operation around Gulf of Mexico (onshore) region but incentives and collaboration are needed to address initial cost hurdles. He pointed to differences between onshore and offshore storage, and indicated that a good Gulf of Mexico (GoM) pilot site will need to keep costs down, e.g. nearshore away from existing infrastructure or using available infrastructure. Perhaps 45Q or a pre-commercial demo could be sufficient to stimulate a pilot. An example concept offshore Louisiana was shown.

Mark Coalmer, Oil and Gas Climate Initiative (OGCI) told the audience of OGCI activities related to CCUS. This is a new risky business, as “No one wants to be first to be first” – they want to be second. OGCI has established a \$1B investment fund for CCUS – mainly looking at pre-FEED and FEED stage projects. They have talked to investors and there is huge interest for investment day coming up in Chicago in September. The US market capacity is estimated to be \$5-9B annually in CCUS the biggest potential being natural gas, ammonia, ethanol, cement and hydrogen. Such concentrated CO₂ streams have cost profile of \$60-160 per tonne – dilute streams will be more expensive (capture costs of \$45-200+ per tonne). It is estimated that 3.8Gt/yr CCUS need to be stored by 2040.

Collaborative mechanisms:

Lynn Brickett, DOE, introduced by stating that six projects have been through cooperative agreements. The agreements take time, intellectual property rights (IP) can be challenging. However, templates have been developed that that should speed up all negotiations.

Åse Slagtern, Research Council of Norway (RCN), reviewed the European program Accelerating CCS Technologies (ACT). The majority of projects (from ACT1) is at TRL 2-5, higher TRL projects are very costly and not possible via ACT funding alone. Cooperation within the ACT consortium is very good. Countries like the Netherlands, Norway and the UK are very much in line with same goals for a full chain CCS implementation, and smaller CCS countries benefit much from the cooperation. However, it appears hard to attract industry in many countries. Learnings across borders and across projects are beneficial to all partners. The US joined ACT in 2018 and are partners in the second call where 12 new projects have received funding.

Jørild Svalestuen, Gassnova, gave a brief summary of CLIMIT – the Norwegian national CCS funding program. Commercial partners and potential along with value creation are the main requirements for collaborative projects.

Charles Taylor, NETL, gave an extensive overview of the collaboration toolbox of NETL, including Memorandum of Understanding (MoU) and CRADA. NETL has over 900 active agreements in place with industry, academia, non-Fossil Energy DOE organizations, non-DOE Government organizations, NGO's, small business, State and Local Governments. There are numerous existing mechanisms for

partnering with NETL. Partnerships need to be mutually beneficial to both parties, and the type of agreement determines funding, intellectual property, exchange of personnel, eligibility, services, facilities, equipment, and licensing

Bjørn-Erik Haugan, TCM, gave examples of co-operation between NETL and TCM and stated that exchange of research personnel is a fast way for knowledge exchange, but it requires funding.

Philip Ringrose, Equinor, presented some experience from Equinor's cooperation with Lawrence Livermore national Laboratory (LLNL). The negotiation had been cut to half. It is important to be clear up front of goals and scope.

Michael Matuszewski, Aristosys, Inc, pointed out that the uncertainties in CCS12 have been reduced by 10 -33 % thanks to the cooperative agreement between NETL and TCM, which allowed exchange of data and model.

Outcome of the meeting and action points

The meeting showed that the bilateral co-operations are working well and that progress is being made in both capture and storage.

Actions points are

- Organize workshops defined during storage and capture the breakout sessions, to be held over the next 18 months until the next meeting
- The exploration license for the Northern Lights well should be translated to English.
- Information the Gassnova invitation to participate in a CO₂ plume dynamics modeling challenge should be translated to English and placed on the Gassnova web site.

Next meeting

Next meeting together in Norway in conjunction with the CLIMIT summit in Feb 2021.