

Carbon Sequestration leadership forum

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PROJECTS AND INTERACTION REVIEW TEAM (PIRT)

Engagement of CSLF-recognized Projects

Preliminary Results

Background

The Terms of Reference (ToR) for the CSLF Projects Interaction and Review Team (PIRT) include the following:

- Assessing projects proposed for recognition by the CSLF
 - Making recommendations to TG on recognition by the CSLF
 - Reviewing the CSLF project portfolio; identifying synergies, complementarities, and gaps; where to have CSLF recognized projects; providing feedback to TG
 - Organizing periodic events to facilitate the exchange of experience and views on issues of common interest among CSLF projects and providing feedback to the CSLF
 - Fostering enhanced international collaboration for CSLF projects
 - Ensuring a framework for periodically reporting to TG on the progress made by CSLF projects
 - Managing technical knowledge sharing activities with other organizations and with CSLF-recognized projects

At the London meeting in June 2016, there was consensus by the CSLF that the PIRT is to find ways to improve its interactions with CSLF-recognized projects. To that end, a new format for projects to report their status was developed.

This summary of preliminary results is based on a collection of reports received from 25 of the 35 active CSLF-recognized projects as well as one recently-completed project. The PIRT will endeavour to gather such information from all of the active projects on a biennial basis, in years where there will be a CSLF Ministerial Meeting.

When reviewing the reports the reader should keep in mind the criteria for project recognition by CSLF, found in the PIRT ToR:

- Projects must contribute to the overall CSLF goal.
- There is no restriction on project type to be recognized as long as the project meets the criteria listed below.
- Proposals will meet at least one of the following criteria.
 - An integrated CCS project with a capture, storage, and verification component and a transport mechanism for CO₂.
 - Demonstration at pilot- or commercial-scale of new or new applications of technologies in at least one part of the CCUS chain.
 - Demonstration of safe geological storage of CO₂ at pilot- or commercial-scale.
- CCS projects seeking CSLF recognition will be considered on their technical merit

Main findings

Tabular summaries of the projects that reported back are included in this report. Note that in several cases additional knowledge has been used to fill in the spread-sheet.

Below are some takeaways from the submitted project engagement forms.

Findings of general interest to other CSLF activities, including the Technology RoadMap (TRM):

1. The active CSLF recognized projects include many operative or soon-to-be-operative large-scale integrated CCS projects (LSIPs) (others have been completed as CSLF recognized projects) but not all (e.g. Petra Nova and Lula are not on the list)

2. Success factors: Factors influencing success are, not surprisingly,
 - a. Secure funding
 - b. Encouragement from owners,
 - c. Collaboration between stakeholders like industry, academia, authorities and research organisations
 - d. Good communications with locals and other stakeholders
3. Factors leading to project stop:
 - a. Target reached
 - b. Lack of funding

None of the projects reported failure to meet targets as reason for stop.

Specific comments to the returned project forms:

1. Few of the returned project forms address general technology needs (we did not ask), only project specific challenges or next steps.
2. The questions were answered in a variety of ways with respect to completeness and quality of the returned forms.
 - a. For example, the question of factors that secured continued progress was answered both in terms of financial support and moral encouragement, as well as in terms of technical achievements but often without indications of what mattered most
 - b. The question on information was answered both in very general terms and with specific references and links
3. Role of CSLF recognition: None of the project engagement forms address the overall CSLF goals, nor is there information on why CSLF recognition was sought, what the benefits, if any, have been, nor what the projected expected from CSLF. The reason is that this was not asked for. It may be up to PIRT to decide how the projects contribute to the CSLF goals, but it might have been useful to challenge the projects on this.
4. Fulfilment of criteria: Most projects satisfy at least one of the three criteria. However, there are a few where it is not obvious how they meet at least one of the criteria. These were probably recognized prior to the establishment of the criteria.
5. CO₂ captured/stored: This question is relevant for some but far from all projects. Some information on amounts of CO₂ captured and/or stored had to be taken from elsewhere and could not always give the accumulated amount to date. A direct question might have been useful.
6. Outcomes and advances: Described outcomes range from the obvious to very specific technical learnings.
7. Information: Access to information ranges from very open to confidential.

Recommended actions

- Identify why projects sought recognition, what the benefits have been, and what they expect from CSLF.
- Decide what, if anything, CSLF can offer to the projects.
- Decide what CSLF/PIRT wants to achieve by recognising projects.
- If CSLF conducts a new engagement round, include questions on the above and be more specific on available information and further needs.

Action on PIRT:

The PIRT is requested to review the information received from the projects and decide where we go from here.

Summaries of Information Received from CSLF-recognized Projects

Australia

Project	Active?	Amount of CO ₂ captured/stored	Information produced	Outcomes	Factors that resulted in progress / Why did it end?	Future plans
CarbonNet	Yes	N/A	3 project reports; 5 storage reports, 3D maps, 2 transport reports.	Opportunities for CCS network with life cycle costs.	Considerable potential for storage combines with federal and state support.	Finalizing plans for appraisal of storage site and to obtain Declaration of Storage and a CO ₂ Injection License by 2020.
Gorgon CO ₂ Injection Project	Yes	Target is 3½-4 Mt per year.	Updates to selected groups (CSLF and IEA) at milestones.	No technical barriers but costly.	Willingness of Partnership + some minor Federal funding.	Continued construction and commissioning with targeted start-up 3Q 2017.
South West Hub Project	Yes	N/A	Numerous technical reports and summaries of community engagement activities.	Modeling indicates that commercial amounts of CO ₂ can be stored by residual trapping.	Federal and state funding support, collaboration with industry, community service.	Additional laboratory and desktop analysis over the next 6-12 months.

Canada

Project	Active?	Amount of CO ₂ captured/stored	Information produced	Outcomes	Factors that resulted in progress / Why did it end?	Future plans
Alberta Carbon Trunk Line	Yes	N/A	Non-technical video (available at Enhance Energy website).	N/A	Continued federal and provincial support.	Finalize financing, start construction for project completion by end 2017.
Boundary Dam Integrated CCS Project	Yes	>1 Mt (from Oct. 2014 through Feb. 2017).	Monthly progress reports on operations of capture facility.	Significant lessons learned on capture at coal-fired power plants that may reduce costs up to 30% on future plants.	Not specified.	Operation continues.
CANMET Energy Technology Centre (CETC) R&D Oxyfuel Combustion for CO ₂ Capture	No (ended Dec. 2009)	N/A	Mostly confidential but some results presented at several international conferences and published in proceedings	Unique data for pilot-scale oxyfuel combustion; development of new burners, proof-of-concept and several patents. Follow-on further research on new generation oxyfuel combustion with focus on high pressure oxyfuel combustion processes.	Work programme completed in Dec. 2009. Technology judged to have reached level of maturity for pre-commercial field demonstration.	Project has ended.
Quest	Yes	Up to 1.2 Mt per year from start in Nov. 2015.	Much information, including engineering and subsurface details (available at Alberta Energy website).	Overall success of the fully integrated project, capture efficiency and reservoir performance better than expected. A range of monitoring technologies deployed. No microseismic response detected.	Financial support from federal and provincial sources; operational success the first year of operations.	Continued capture, injection, collection of MMMV data; update reservoir model and revise plume prediction.

Japan

Project	Active?	Amount of CO ₂ captured/stored	Information produced	Outcomes	Factors that resulted in progress / Why did it end?	Future plans
CO ₂ Separation from Pressurized Gas Stream	Yes	N/A	Technical reports (available at RITE website)	Improved separation performance of molecular gate membranes and performance target achieved.	Continuous funding from Ministry; collaboration with academia, industry and research partners; good results on membrane materials.	Continue development and plan pre-combustion capture tests with real water gas shift flue gas.
Tomakomai CCS Demonstration Project	Yes	0.1 Mt per year.	Leaflets and informational materials (available at Japan CCS Company website). Daily and cumulative injection volumes and microseismic data released on website and a public monitoring screen in Tomakomai City Hall.	Injection operations progressing smoothly.	Funding and guidance from government; collaboration with academia, industry and research partners; community acceptance.	Continue injection to March 2019; conduct annual 2D/3D seismic surveys and monitoring of wells. Conduct surveys to secure compliance with prevention of marine pollution act.

Norway

Project	Active?	Amount of CO ₂ captured/stored	Information produced	Outcomes	Factors that resulted in progress / Why did it end?	Future plans
CO ₂ Field Lab Project	No (in hiatus)	N/A	Site characterizations are available upon request to the project whereas open data from the injection experiments can be found in the literature.	Scale matters and CO ₂ breakout did not occur as modelled, probably a consequence of heterogeneity; mobile gas measuring equipment proved invaluable; combinations of geophysical techniques provided a consistent picture; extensive baseline a prerequisite; communication with local authorities essential.	The shallow injection experiment successfully conducted in 2011 and the CO ₂ Field Lab Project ended in 2015, one reason being the lack of industrial funding. Since then, then the field lab at Svelvik, Norway, has been approved as part of the Norwegian node in the European lab infrastructure project ECCSE, making efforts to secure new funding less problematic.	Two new monitoring wells planned 2017-2018; plans for repeatable experiments finalised, decision expected Q2 2017.
CO ₂ Technology Centre Mongstad (TCM)	Yes	N/A	Many presentations and papers at conferences, including GHGT12 and GHGT13.	Significant contributions to understanding amine degradation and emissions as well as mist formation; several baselines for MEA performance.	Support for continued activity from owners; a significant number of vendors want to test technologies at the scale offered.	Operations with clients to continue until 2020.
Norcem CO ₂ Capture Project	Yes (until mid 2017)	N/A	Newsletters, benchmark study Phase 1, presentations at conferences. Plan is to issue publicly available report with main results and learnings.	Four technologies proven able to capture CO ₂ emissions from cement plant but all need clean-up of NO _x , SO _x and dust before capture. Test programme contributed to maturing of all four technologies. CAPEX and OPEX increases when technologies matured from bench scale to pilot scale. Testing under real conditions is necessary.	Financial support and encouragement from company and authorities.	Project will be wrapped in Q2 2017. Applications for Concept and FEED phase in progress.

Korea

Project	Active?	Amount of CO ₂ captured/stored	Information produced	Outcomes	Factors that resulted in progress / Why did it end?	Future plans
Dry Solid Sorbent CO ₂ Capture Project	Yes	170 tonnes per day from 10 MWe slipstream of 500 MWe coal-fueled power plant. CO ₂ captured and then released.	Numerous technical papers.	Dry sorbent technology is feasible for use in capturing CO ₂ from coal-fueled power plants, but process and sorbent modifications may be needed to be competitive and viable. Performance loss of sorbent is primarily due to side reactions between active material in sorbent and other flue gas components besides CO ₂ .	Korea's master plan calls for a commitment to large-scale CCS demonstration projects by 2020. Approx. 50% funding from Korean government. Dry solid sorbent may overcome cost and environmental issues associated with wet scrubbing CO ₂ capture technologies.	Program for next 6 months will include 1500 hours of continuous operation using an improved sorbent that minimizes side reactions.

Saudi Arabia

Project	Active?	Amount of CO ₂ captured/stored	Information produced	Outcomes	Factors that resulted in progress / Why did it end?	Future plans
Carbon Capture & Utilization / CO ₂ Network Project	Yes	N/A	Patents in USA and Europe.	CO ₂ to be utilized to produce products such as methanol, urea, and 2-EH.	CO ₂ purification plant commissioned Q1 2016.	Continued operations. (?)
Oxy-combustion of Heavy Liquid Fuels Project	Yes	N/A	None so far; site evaluation and talks with industrial partner are confidential.	Evaluation of market situation in western Saudi Arabia.	Scope revised, project being assessed for different location in Saudi Arabia; discussions on possible collaboration with industrial partner.	Finalize feasibility study.
Uthmaniyah CO ₂ -EOR Demonstration Project	Yes	0.8 Mt per year with start in July 2015.	Reports on seismic monitoring, inter-well chemical tracer data, and project facilities design.	Importance of reservoir characterization; benefits of inter-well chemical tracer data.	Follow-up by involved parties; synergy between teams; support in allocating resources.	Continue capture and injection operations.

United Kingdom

Project	Active?	Amount of CO ₂ captured/stored	Information produced	Outcomes	Factors that resulted in progress / Why did it end?	Future plans
CO ₂ Capture Project, Phase IV (CCP4)	Yes	N/A	Available at project website: numerous papers, fact sheets and presentations. Books with results from Phases I-III; the book <i>Technical Basis for CO₂ Storage</i> ; and educational tools.	Two pilot field demonstrations of capture technology; comprehensive well seal programme.	Leadership and long-term vision of member companies; essential collaboration between industry, academia and government; dedication of technical teams.	Continue to end of 2018, with focus on projects related to novel capture technology, tracer testing, potential pilot on CO ₂ removal from natural gas flue gas, and how CO ₂ -EOR constitutes de facto storage.

United States

Project	Active?	Amount of CO ₂ captured/stored	Information produced	Outcomes	Factors that resulted in progress / Why did it end?	Future plans
Air Products CO ₂ Capture from Hydrogen Facility Project	Yes	Captured and stored 3 Mt between Apr. 2014 and June 2016.	Scientific/technical report summarizing the entire project, from definition through multiple years of operation, to be published by about end of 2017.	Knowledge and applicability of scaling up vacuum swing adsorption technology for separation of CO ₂ ; showcase safe integration of the technology into a large-scale operating environment.	Funding and support from U.S. Department of Energy; support from the CO ₂ off-taker (Denbury); pipeline operations and maintenance support from host refinery (Valero).	Continue operations. Milestone of 4 Mt captured and stored will be reached approx. Sept. 2017.
Illinois Basin - Decatur Project (IBDP)	Yes	1 Mt.	Wide variety of communications material available online; working with Norway to establish data sets that can be shared.	Comprehensive microseismic data set.	Supportive and collaborative industrial partner; detailed site characterization prior to and during injection; support from U.S. Department of Energy; stakeholder engagement; and strong technical leadership.	Analysis of plume location; microseismic results from injection; reworking deep monitoring well.
Illinois Industrial Carbon Capture and Storage (IICS) Project	Yes	Target is 1 Mt per year. Storage to commence in 2017.	Prior to start of operations, information is available on 1) site characterization; 2) engineering and construction; 3) permitting experience (UIC Class VI)	Experiences and achievements related to project development, design, construction, permitting and commissioning.	Large source of CO ₂ with low cost capture; location close to storage site; public funds available; availability of CO ₂ storage tax credits.	Q1 2017: Start-up of injection operation.
Kemper County Energy Facility	Yes	N/A, offtake of CO ₂ started in Feb. 2017.	Information is being gathered and will be published as required by the U.S. Department of Energy for the demonstration phase.	Capture and compression has gone well but too early to describe other outcomes.	Plant is built and commissioned due to support from United States Department of Energy and the project sponsor (Southern Company).	Continue capture and CO ₂ delivery operations.
Kevin Dome (Big Sky Carbon Sequestration Partnership) *	Yes, but project will be not able to obtain underground injection permit.	N/A	Well log data can be shared; second generation geostatic model is ready for potential distribution; core samples may be shared.	Basis for distribution of heterogeneity in rock type geologic models using of shear and p-wave impedance and density from seismic monitoring.	Target geologic formation is not sufficiently saline to obtain EPA UIC Class VI injection permit. Because Kevin Dome is natural analog to CO ₂ storage sites, and because the project has collected samples and data during site characterization, work to maximize learnings will continue for approx. two more years.	Complete third generation geostatic model; plan for laboratory experiments on fracture and permeability and flow models.

* Part of the overall Regional Carbon Sequestration Partnerships Project

United States (cont.)

Project	Active?	Amount of CO ₂ captured/stored	Information produced	Outcomes	Factors that resulted in progress / Why did it end?	Future plans
Michigan Basin Development Phase Project	Yes	Approx. 0.6 Mt.	Project information available at project website.	Implementing CCS for CO ₂ -EOR; use of synthetic models for better understanding; experience with monitoring technologies (INSAR, fiber optic based microseismic sensor system); development of new log interpretation; contribution to best practices and standards.	Availability of host site and host company willingness; consistent federal funding; existing infrastructure; building on successful previous phases; workable regulatory framework.	Update regional source-sink analysis; progress regional geologic characterizations; post-injection and active EOR monitoring and accounting; planning new CO ₂ flood; public education and outreach.
NET Power Demonstration Project	Yes	N/A	Several publications and scientific papers.	First turbine using supercritical CO ₂ for working fluid; demonstration of novel oxy-combustion system for CO ₂ cycles, novel control systems; numerous patents for other applications of the Allam Cycle.	Support from industry, project almost entirely privately funded; the economic potential of the technology (near-zero emissions combined with high efficiency and low cost).	Complete construction (75% as by Mar. 2017) and start up later in 2017.
Plains CO ₂ Reduction (PCOR) Partnership *	Yes	Monitored 3.6 Mt CO ₂ injected by Denbury Onshore LLC for CO ₂ -EOR	More than 80 technical reports available to the public; over 25 fact sheets; seven documentaries; PCOR Partnership Atlas with general storage overview; Best Practice Manuals, numerous papers, presentations and journal articles; quarterly reports. Information available.	Integration of site characterization, modelling, simulation, risk assessment and monitoring, verification and accounting (MVA) into a fit-for-purpose approach to CO ₂ storage projects; application of multiple MVA techniques; knowledge transfer to CO ₂ -EOR operators; complementary projects related to CO ₂ storage.	Support from U.S. Department of Energy; strong collaboration between public and private stakeholders with broad experiences. Contributions of Partners a key to success; many project components in form of pilot and demonstration projects and communications; a Technical Advisory Board with subject matter experts.	Complete numerous program tasks and communication lessons, continue knowledge transfer through BPMs and participation in conferences. PCOR is scheduled to end in 2018.
Plant Barry **	No (ended in Dec. 2014)	Approx. 0.24 Mt (between Aug. 2012 and Dec. 2014)	Information on effects of contaminants on solvent degradation and waste generation have been shared.	Site may become generator of large amounts of hazardous waste (due to selenium build up in solvent) but mitigation found. Solvent verified to maintain effectiveness over long operating times.	Technology brought to commercial scale (used in Petra Nova Project).	Awaiting U.S. Department of Energy decision on awards.
SEACARB Anthropogenic Test (Citronelle) **	Yes	0.114 Mt (between Aug. 2014 and Dec. 2014).	Performance data (CO ₂ injection rate, downhole pressure, DTS/DAS fiber optic data, geochemical sampling, and other data) are available and sharable.	The Plant Barry to Citronelle program provided valuable information on business and technical aspects of CCS and instrumental in development of Petra Nova Project.	Continued implementation of underground injection control (UIC) permit mandating testing and monitoring programme; utilization of full suite technologies to monitor CO ₂ plume.	Post-injection site care (PISC) to terminate Sept. 2017. Field data to be assessed over next 6 months.

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** Part of the overall SEACARB Phase III Anthropogenic Test and Plant Barry CCS Project