

Carbon Sequestration leadership forum
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TECHNICAL GROUP

Working Group on Evaluating Existing and New Ideas for Possible Future Technical Group Actions

Recommendations

**CSLF Technical Group Meeting
Abu Dhabi, United Arab Emirates
04 December, 2017**

Recommended actions

With reservation that a low response rate from the CSLF working group and the CSLF Technical Group delegates introduces uncertainties in the results, the following recommendations are given:

1. CSLF Technical Group awaits the results of the Task Force on Pore space utilisation before a decision is made regarding a new Task Force on Geo-steering and pressure management techniques and applications to see how much has been incorporated into the Pose Space Utilization report.
2. CSLF Technical Group considers establishing task forces or to undertake appraisals, as resources will allow, on the following topics, in order of priority:

Topic	Possible lead	Contributors
1. Hydrogen as a tool to decarbonize industries	Norway	Netherlands, Saudi-Arabia, UK
2. Reviewing Best Practices and Standards for Geologic Monitoring and Storage of CO ₂		Australia, France, Norway, Saudi-Arabia,
3. Capture by mineralisation		France, Netherlands, Saudi-Arabia
4. Global scaling of CCS		France, Saudi-Arabia

3. In addition, CSLF Technical Group considers if the topic Utilisation options of CO₂ should be added to the list of potential new task forces.

Background information

At the Technical Group meeting in Abu Dhabi, United Arab Emirates, May 1, 2017 it was decided to form a review group to:

1. Appraise all unaddressed items in the Action Plan from 2015.
2. Propose new topics for appraisal
3. Review past task force reports with the aim to see if any updates are needed.

Delegates from Australia, Saudi Arabia, the United Kingdom, and the United States volunteered to participate in the new working group, while delegates from Canada, Japan, and the Netherlands offered to provide input as needed.

This group would:

1. Review any existing documents and other materials relevant to the unaddressed and new actions as well as past task force topics
2. Recommend which, if any, activities are worth pursuing for these actions. Possible actions are:
 - Start with an appraisal for later decision on how to proceed (stop or carry on with one of the other options)
 - Establish Task Forces with voluntary participants from CSLF members. These will review status and give recommendations on next steps in a report.

- In case where the resource requirements will be too extensive for CSLF, suggest the topic as study for or in cooperation with an organization with a budget, e.g. IEAGHG or GCCSI.

The topics that were up for discussion are described in Attachment 1, a total of 24 topics.

The list in Attachment 1 was distributed to the group July 2. As of September 16, 2017, three responses had been received from the review group, despite reminder, of which one only commented on the text of a new topic. Based on a fairly free interpretation of the limited input, see Attachment 2, several topics were removed from the list and the following 12 remained on a shortlist:

1. From the 2015 list
 - a. Geo-steering and pressure management techniques and applications
 - b. Ship transport (from the 2015 list)
 - c. Dilute stream/direct air capture of CO₂, see if sufficient data exists
 - d. Global Residual Oil Zone (ROZ) analysis and potential for combined CO₂ storage and EOR
 - e. Definitions of TRL
 - f. Capturing CO₂ from mobile sources
 - g. Global scaling of CCS
2. New proposals:
 - a. Hydrogen as one of the tools to decarbonise industries (proposed by Norway)
 - b. Mineralization to use CO₂ permanently in products (Proposed by Netherlands)
3. Updates.
 - a. Review and Identification of Standards for CO₂ Storage Capacity Estimation
 - b. Examine Risk Assessment Standards and Procedures
 - c. Technical Challenges of Conversion of CO₂-EOR Projects to CO₂ Storage Projects
 - d. Reviewing Best Practices and Standards for Geologic Monitoring and Storage of CO₂.
The main reason is have an updated web version, now residing at GCCSI (cooperation?)

Comments:

1. Topic 1.a - Geo-steering and pressure management techniques and applications – should to some extent be covered by the Task Force on Pore space utilisation. Further action awaits until the report is published.
2. Update of Utilization options of CO₂ was not included due a misunderstanding.

Given the low feedback from the review group both the longlist (Attachments 1 and 2 to this note) and the shortlist were sent to **41 delegates to the Technical Group**. The delegates were invited to comment and suggest new topics, as well as to pick their four highest priority votes on the short list, ranking from 1 (highest) to 4 (lowest). The invitation was sent out 22 September and deadline was set to 13 October.

Main Findings

11 delegates out of 41 responded to the shortlist, even with an extended deadline. The 11 represent six member states and the European Commission. The scores were turned around, so that 4 is highest priority, 1 is lowest, resulting in a ranking where highest scores is top priority. A system with 2 given to first priority and 1 to the three other prioritized topics, used by IEAGHG, was also tried, with the same overall ranking.

Table 1 shows the results and form the basis for the recommendations. A few delegates marked or scored all 12 topics. For these, only the four of highest priorities are ranked in Table 1. Seven member states volunteered contributions, only one has so far volunteered task force leadership.

Table 1. Ranking of topics on the short list of potential new CSLF Technical Group task forces. 4 is top priority, 1 is lowest priority. Delegates picked four topics to rank, those without scores have not received votes.

	Dilute stream/Direct Air Capture of CO ₂	Global Residual Oil Zone (ROZ) Analysis and Potential for combined CO ₂ Storage and EOR	Ship transport	Definitions, TRL, scales and other	Global Scaling of CCS	Capturing CO ₂ from mobile application	Hydrogen as tool to decarbonise industries	Capture by mineralization	Review and Identification of Standards for CO ₂ Storage Capacity Estimation	Examine Risk Assessment Standards and Procedures	Technical Challenges of Conversion of CO ₂ -EOR Projects to CO ₂ Storage Projects	Reviewing Best Practices and Standards for Geologic Monitoring and Storage of CO ₂
IT1	0	0	0	0	0	0	4	0	2	0	3	1
IT2	0	0	0	0	3	0	4	0	0	0	1	2
UK	1		2		3		4		0			
NO	0	0	3	0	0	0	4	1	0	0	0	2
CA					1	2	4	3				
AUS			2		1					4		3
NL	1		2				3	4				
EC								2	3		1	4
S-A1		4					1				3	2
S-A2					2	3	4	1				
FR				1			2	3				4
	2	4	9	1	10	5	30	14	5	4	8	18

RANK 5 4 1 3 2

Lead NO

Contributions S-A (NL), FR S-A, FR S-A NL, UK,S-A NL, S-A;FR FR AUS, S-A FR,NO

ATTACHMENT 1

Summaries of potential task forces Abu Dhabi December 2017

Proposals from 2015 list (not prioritized):

Advanced Manufacturing Techniques for CCS Technologies. Advanced manufacturing techniques such as 3-D printing have the potential to revolutionize the synthesis and functionality of advanced technologies in many different fields. Objective of this effort is to explore the potential application of advanced manufacturing techniques to CCS technologies.

Geo-steering and pressure management techniques and applications. Brine production is considered a potential mechanism for “geo-steering” of CO₂ plume, and reservoir and pressure management. This study will investigate novel methods such as brine extraction for pressure and reservoir management in carbon storage operations. To be redefined (geo-steering covered, include risk management issues)

Dilute stream/Direct Air Capture of CO₂. This effort will explore the current state of the art of technologies that can capture dilute streams of CO₂ (<1% CO₂ concentration) and the economic and technical challenges.

Global Residual Oil Zone (ROZ). Analysis and Potential for combined CO₂ Storage and EOR. Residual oil zones are currently uneconomic but have great potential to store large volumes of CO₂ while producing additional oil. This task force will explore the current status of ROZ resource in the world and its CO₂ storage potential, technical challenges and R&D opportunities.

Study/Report on Environmental Analysis projects throughout the world. Several projects throughout the world have explored the environmental impacts of CO₂ release/CCS (e.g., QICS, CO₂ Field Lab, Montana State University ZERT facility, etc.). This study/report would summarize the findings in one concise document and draw conclusions from the work to date and identify opportunities for future work.

Update on non-EOR Utilization Options. NOTE: Not suggesting to immediately re-form this task force, but I think in the 2017 timeframe it might be good to re-visit the previous reports and identify progress, status, new ideas. For example, some new ideas for suggested inclusion are compressed air storage as buffer for power generation, and upgrading and treatment of produced brines/enhanced water recovery.

Ship transport. So far pipelines is the dominant way to transport CO₂ for storage. Transport by ships may be an interesting alternative when pipeline is too expensive, e.g. when the need for CO₂ injection is time limited; or when small amounts are to be transferred to a hub. This study will review and summarize what has been done so far and give recommendations for further work.

Definitions, TRL, scales and other. The work with 2nd and 3rd generation technologies revealed deficiencies and inconsistencies in present definitions and classification of technology maturity for CO₂ capture. Even the NETL definitions are not straightforward to interpret and not well suited for industrial applications. The latter also applies to some extent to metrics for cost performance. Further, apparently, there is no commonly accepted and used definition of what is meant by bench-, lab-, pilot- and demo-scale tests in terms of CO₂ captured, flue gas treated, power delivered or product output. This work will suggest definitions that, when developed in cooperation with IEAGHG and GCCSI, will have a chance of being generally accepted. NOTE: One could expand to include guidelines on how to assess other performances, e.g. energy penalty, although ISO TC265 is looking into this. CSLF probably has a broader participation than ISO and can work faster.

Global Scaling of CCS. Produce a simple global model which incorporates by country/region descriptions of current CO₂ emissions by source (e.g., coal power stations, vehicles, etc.). Design the model to allow the user to show the effects on emissions of trends e.g. x%/a closure of coal, y %/a increase in gas, z%/a increase in CCS. Sustain energy use along lines of current trends and track CO₂ storage required is within current storage range estimates. Use the model to explore under which conditions CCS makes its largest/smallest contribution to the prevention of global warming; perhaps using IEA fossil fuel use scenarios and emission reduction scenarios as the reference guide to assessing the role of CCS as a start.

Compact CCS. New technologies such as those using supercritical CO₂ are being developed and offer small plant footprints, at least for power production and capture. A study which evaluates how "small" various CCS plants could be made could inform us about potential operation in areas sensitive to plant size (height or footprint), or the potential for offshore operation, with savings on long gas pipelines.

Capturing CO₂ from mobile application. This is to evaluate CO₂ Capture System on-board a vehicle that mitigates CO₂ emissions from transportation system. It is done through the separation of CO₂ after the combustion process using post-combustion CO₂ capture technology.

Previous Task Force Reports, candidates for updates

Identifying Gaps in CO₂ Capture and Storage (Nov. 2006). The task force handled only capture and transport steps of the full CCS chain. Describes R&D gaps to be fulfilled to meet cost target of 10-20 €/ton CO₂ by 2020.

Identifying Gaps in Monitoring and Verification of Geologic CO₂ Storage (Nov. 2006). Cooperation with IEAGHG and also IEAGHG Report Number: 2006/TR1(REVISED). The report reviews gaps listed in the 2005 IPCC Special Report on CC (SRCCS), assesses the significance of the gaps and the R&D needs identified in SRCCS.

Review and Identification of Standards for CO₂ Storage Capacity Estimation (Aug. 2005, June 2007, April 2008). The CSLF Task Force recommended a consistent set of methodologies for estimation of CO₂ storage capacity in coal beds, oil and gas reservoirs and aquifers in March 2007 (Phases I and II). In Phase III this set was compared to standards for CO₂ storage capacity estimation developed for the US dep. of Energy by the Regional Carbon Sequestration Partnership Programs.

Examine Risk Assessment Standards and Procedures (Oct. 2009, May 2012). Phase I gave an overview of risk assessment methodologies, including literature survey, summary of on-going activities and identification of needs for additional information. Phase II included a gap assessment to identify CCS-specific tools and methodologies that will be needed to support risk assessment, and a feasibility assessment of developing general technical guidelines for risk assessment that could be adapted to specific sites and local needs.

Utilization Options of CO₂ (Oct. 2012, Oct. 2013). This report identified the most economic and promising CO₂ utilization options with potential to yield a meaningful net reduction of CO₂ emissions and/or facilitate development and/or deployment of other CCS technologies.

Technical Challenges of Conversion of CO₂-EOR Projects to CO₂ Storage Projects (Sept. 2013). The task force reviewed, compiled and reported on technical challenges that may constitute a barrier to a broad use of CO₂ for EOR and the conversion of CO₂-EOR operations to CCS operations.

CCS Technology Opportunities and Gaps (Oct. 2013). The task force identified and monitored key CCS technology gaps and related issues, reviewed the effectiveness of on-going RD&D activities for addressing these gaps, and recommended RD&D that address gaps and issues.

Reviewing Best Practices and Standards for Geologic Monitoring and Storage of CO₂ (Oct. 2013). The task force compiled and summarized relevant guidelines, best practices and manuals on CO₂ storage. Also published online by GCCSI, with the Intention to give a quick look at available standards, guidelines and best practice manuals

Technical Barriers and R&D Opportunities for Offshore, Sub-Seabed Storage of CO₂ (Sept. 2015). The report provided an overview of the current technology status, technical barriers, and research and development (R&D) opportunities associated with offshore, sub-seabed geologic storage of CO₂.

CO₂ Storage Efficiency (Published in IJGGC, Sept. 2015). This report was an update of earlier CSLF Task Force reports on CO₂ storage efficiency.

2nd and 3rd Generation Carbon Capture Technologies (Dec. 2015). This Task Force was a joint venture between the Policy and Technical Groups. The report described efforts to identify emerging technologies for emerging (2nd and 3rd generation) technologies, identified potential testing facilities to bring the technologies out of lab- and pilot-scale to demonstration scale, gave recommendation to the Policy Group.

New proposals 2017

Hydrogen as one of the tools to decarbonise industries (Proposed by Norway). Fossil fuels are used for transportation, industry and household heating and cooking around the world. This results in millions of small emission sources from which CO₂ capture will be impractical. In this case, hydrogen produced from oil, gas or gasification of coal, petcoke, vacuum residue, or biomass can be used to complement other technologies that reduce GHG. This allows for centralised capture of CO₂ that would otherwise be produced locally at the site of use. There are no technical barriers to CO₂ capture associated with large-scale hydrogen production. However, the Task Force will look into issues like:

- Process intensification, i.e. more compact, efficient and economic solutions, e.g. high-temperature hydrogen membranes and technologies for catalytic reforming of the fuel and simultaneous separation of H₂ and CO₂.
- Process integration in co-production of H₂ and, for example:
 - Electricity and heat production
 - In industrial processes where H₂, or H₂ enriched natural gas, can replace fossil fuel-based feedstock.
 - Large scale CO₂ transport and storage infrastructure, local clusters for synergies.
 - Policies and support mechanisms.

Mineralization to use CO₂ permanently in products (Proposed by Netherlands a.i). The use of CO₂ takes place mainly in EOR and newer developments like fuels, chemicals or specialities (feed-in to glass houses). In all these cases the CO₂ will be more or less back in the atmosphere. A goal for development should be to use CO₂ in a permanently stored way, preferable in large(r) scale application(s). A solution is the binding affinity of CO₂ to certain minerals, like for instance olivine. Research in (very) small scale, far less than 1 kg, is worldwide starting up. First research activities have already shown potential to avoid the very slow natural process. Produced material shows applicability to substitute for instance filler material in polymer, paper and betony. Small scale applications, like filler for 3D-printers, looks promising.

The Task Force will look into issues like:

- Inventory of the work in progress, including (types of) minerals.
- Scale-up of production facility (autoclaves, process conditions).
- Use of the exothermal binding reaction (on-site combination with CO₂ capture) .
- Markets to penetrate, starting with low-volume/high-price applications.
- Contribution to CO₂ reduction and saving on use of minerals.

ATTACHMENT 2:

Comments received from the review group on possible new CSLF Technical Group Task Forces

		Topic	Start with appraisal	Establish Task Force	Comments (e.g. suggest to or cooperate with others; other comments)	Update needed
1	From 2015-list	Advanced Manufacturing Techniques for CCS Technologies			May become a IEAGHG study, to be decided in Nov. 2017	
2	From 2015-list	Geo-steering and pressure management techniques and applications			Wait for Pore Space TF to complete	
3	From 2015-list	Dilute stream/Direct Air Capture of CO ₂	Yes		Appraisal to see if sufficient data to do anything meaningful	
4	From 2015-list	Global Residual Oil Zone (ROZ) Analysis and Potential for combined CO ₂ Storage and EOR	Yes			
5	From 2015-list	Study/Report on Environmental Analysis projects throughout the world	No	No	See Roberts and Stalker, 2017 http://www.sciencedirect.com/science/article/pii/S1876610217319112	
6	From 2015-list	Update on non-EOR Utilization Options			IEAGHG undertaking comprehensive study on CCU accounting. Wait for the result	
7	From 2015-list	Ship transport		Yes	IEAGHG has produced two reports which should be updated	
8	From 2015-list	Definitions, TRL, scales and other	Yes	No	Could suggest to ISO TC265, who should be lead on this	
9	From 2015-list	Global Scaling of CCS				
10	From 2015-list	Compact CCS			Wait for status of NET power project report, hinges on that working!!	
11	From 2015-list	Capturing CO ₂ from mobile application	Yes			
12	New	Hydrogen as tool to decarbonise industries		Yes	Good idea. IEAGHG studies on CCS on H ₂ , and Leeds and Statoil work can feed-in.	
13	New	Mineralization		Yes		

14	Update	Identifying Gaps in CO ₂ Capture and Storage	No	No	Probably covered, at least partly, by Nos. 2, 15, and 24	No
15	Update	Identifying Gaps in Monitoring and Verification of Geologic CO ₂ Storage	No	No	Covered in IJGGC SI 2015, see also ZEP (2017), GCCSI (2016), CSKI TRM	No
16	Update	Review and Identification of Standards for CO ₂ Storage Capacity Estimation				
17	Update	Examine Risk Assessment Standards and Procedures			A maturing area.	
18	Update	Utilization Options of CO ₂			See no. 6	Yes?
19	Update	Technical Challenges of Conversion of CO ₂ -EOR Projects to CO ₂ Storage Projects				
20	Update	CCS Technology Opportunities and Gaps	No	No	Probably covered, at least partly, by Nos. 2, 15, and 24	No
21	Update	Reviewing Best Practices and Standards for Geologic Monitoring and Storage of CO ₂			A maturing area, and covered in part by ISO. However, web-solution was developed (GCCSI) and it could be updated by GCCSI	Y?
22	Update	Technical Barriers and R&D Opportunities for Offshore, Sub-Seabed Storage of CO ₂	No	No	On-going Workshops on this topic	No
23	Update	CO ₂ Storage Efficiency	No	No	IEAGHG has two recent studies on this, and is an ongoing topic	No
24	Update	2nd and 3rd Generation Carbon Capture Technologies	No	No	IEAGHG doing second phase on this	