IEAGHG Information Paper: 2015-IP36; CSLF Report on Technical Barriers and R&D Opportunities for Offshore, Sub-Seabed Geologic Storage of Carbon Dioxide

A new report was issued by the Carbon Sequestration Leadership Forum (CSLF) at its 6th Ministerial Meeting in Riyadh in November 2015, titled *"Technical Barriers and R&D Opportunities for Offshore, Sub-Seabed Geologic Storage of Carbon Dioxide".* This report was produced by the CSLF's Offshore Storage Technologies Task Force, and in its 132 pages it provides a substantive and thorough overview of offshore storage in terms of the current technology status, projects, technical barriers, and research and development (R&D) opportunities.

Specifically, the report includes information on:

- Existing and proposed offshore storage and enhanced oil recovery (EOR) projects.
- The current status of offshore CO_2 storage and EOR resource capacity assessments.
- The current status of transport, wellbore/well construction
- Monitoring technologies.
- Regulatory requirements.
- Risk analysis tools and methodologies and R&D opportunities.
- Recommendations for further action.

Offshore storage provides several advantages. Near-offshore capacity is globally significant and information can be available from oil and gas exploration and production to provide a good understanding of the offshore geology. There is often a single owner and manager of both mineral and surface rights. Risks to freshwater aquifers are less of a concern than onshore. Existing pipeline rights-of-way for oil and gas production could facilitate CO_2 pipeline infrastructure development. For federally-owned storage resources, revenues could be generated from offshore carbon storage activities. A range of monitoring technologies exist for offshore and are being used, with the potential for improvement.

The report points out that there are several challenges, some of which are similar to onshore storage activities. These include: containment risks presented by existing wells; protection of competing economic and environmental interests; costs of operating offshore projects are likely to be significantly higher than those onshore; some near-offshore regions may have unique development challenges related to infrastructure development; much work has identified the ongoing risks of ocean acidification via CO_2 absorption from the atmosphere, but the more localized impacts from well leakage were less understood, although these are being studied and there is a growing body of knowledge.

The report notes that there are only a handful of offshore storage projects that are currently injecting CO_2 into saline formations: the Sleipner and Snøhvit projects in Norway, the K-12B project off in the Netherlands, and one CO_2-EOR project in Brazil. However, about a dozen more projects have been proposed, including projects in Japan, China, the United Kingdom, and the Netherlands. These projects play an important role in understanding the offshore storage environment and application of CCS in an offshore setting.

The report draws conclusions and makes some specific recommendations in the following areas:

Storage Capacity Assessments: It is recommended that a more thorough evaluation of the geologic storage aspects of many basins be pursued. It is also recommended that an increased level of knowledge sharing and discussion be implemented among the international community to outline the potential for international collaboration in offshore storage.
***Transport Infrastructure**:* Hence, optimization of current practices is important, on areas such as CO_2 product specifications and sharing of infrastructure to optimize utilization. Additionally, during the pilot and demonstration phase of CCS, CO_2 volumes will be relatively small. However, these projects could be developing the first elements of the large-scale infrastructure, if sufficient incentive is given to oversize the components of the transport infrastructure. Especially during the early phase of CCS, public-private partnership is essential to generate these large infrastructural works.
Offshore CO2-EOR: Offshore CO_2-EOR is seen as a way to catalyse storage opportunities and build the necessary infrastructure networks. One of the barriers reported widely for offshore CO_2-EOR projects is the investment required for the modification of platform and installations, and the lost revenue during modification. Recent advances in subsea separation and processing could extend the current level of utilization of sea bottom equipment to also include the handling of CO_2 streams. By moving equipment required to separate and condition the CO_2 to the seafloor, modifications to the platform can be minimized. It is recommended that RD&D activities explore opportunities to leverage existing infrastructure and field test advances in subsea separation and processing equipment.
Understanding CO_2 Impacts on the Subsea Environment: It is recommended to expand upon modelling efforts to understand CO_2 dispersion in an ocean environment. Advances are needed so that systems can simulate leakage in the context of natural variability by combining both pelagic and benthic dispersion and chemistry, including carbonate and redox processes.
Monitoring Technology Development: Deep-focused monitoring relies on established hydrocarbon industry tools which are mature. There is scope for improving some of these technologies and related data processing and interpretation for CO_2 storage. Shallow-focused monitoring is less advanced compared with deep focused monitoring, but systems are being developed and demonstrated. New marine sensor and existing underwater platform technology such as automated underwater vehicles (AUVs) and mini-remotely operated vehicles (Mini-ROVs) enable deployment and observation over large areas at potentially relatively low cost. Seafloor and ocean monitoring technologies can detect both dissolved phase CO_2 and precursor fluids (using chemical analysis) and gas phase CO_2. AUV technology capable of long range deployment needs to be developed so that the AUV can be tracked transmit data via a satellite communications system. Real-time data retrieval and navigation will enable onshore operators to modify or refine surveys without costly intervention using a survey vessel. Further developments in integrated in situ sensors has been underway over the last 5 years. The quantification of leakage at the seabed remains a technical challenge.

IEAGHG was one of the co-authors of the report, leading on some of the sections and providing a summary table of offshore monitoring techniques in the Appendix.

An overall conclusion and recommendation that the report draws is *"There is a growing wealth of research, development and practical experiences that are relevant to CO_2 storage* *offshore, but this expertise is familiar only to a few specific countries around the world. However there is also significant global potential for offshore* CO_2 *storage, and countries who are not yet active but may become interested in offshore storage, would benefit from knowledge sharing from these existing experiences and expertise. Such international knowledge sharing would be facilitated by international workshops and by international collaborative projects. The CSLF is very well-positioned to encourage and support such knowledge-sharing activities."*

To note that, building on this overall conclusion and recommendation, the Bureau of Economic Geology at the University of Texas is developing such an international knowledge-sharing workshop for 2016, in collaboration with South Africa and IEAGHG.

The full CSLF report is available at
http://www.cslforum.net/publications/documents/riyadh2015/tg_OffshoreSubSeabedStorageTaskForceFinalReport-Riyadh1115.pdf .

Tim Dixon
Tim.dixon@ieaghg.org
23/12/2015