Workshop report

CO_2ReMoVe NGO-research dialogue

Wednesday, February 23rd 2011
Fondation Universitaire, Rue D'Egmont 11, Brussels

Report by Heleen de Coninck and Ton Wildenborg

Introduction

On Wednesday, February 23rd, the Energy research Centre of the Netherlands (ECN) organised a workshop on behalf of the CO_2ReMoVe project, aimed at enabling environmental NGOs to influence the direction of research in monitoring and verification of geological CO_2 storage.

Whether carbon dioxide can be permanently stored in geological formations is one of the most challenging and controversial aspects of CCS. Long term permanence of geological CO_2 storage cannot be fully proven by short-term (decades) monitoring, however, leakage risk can be managed by appropriate selection and management of storage sites. Consistent monitoring and verification protocols and best practices can make significant contributions towards risk reduction. However, such methods have to be developed, tested and demonstrated at-scale.

Since 2006, in the EU Sixth Framework Programme project CO_2ReMoVe, energy companies and research organisations, collaborate to create a science-based reference for the monitoring and verification of CO_2 geological storage. Using actual operating storage sites as proxies, CO_2ReMoVe aims to offer practical insights for storage guidelines and standards. More information can be found on www.co2remove.eu.

With CO_2ReMoVe entering its final year, the project consortium would like to disseminate the initial findings, but especially receive feedback on the relevance of its results and make adjustments where necessary. Critical reflection from environmental NGOs helps to make the results more relevant for the regulation and, in particular, the public perception of CCS. During the dialogue, a summary of the scientific results and findings from various technical components of the CO_2ReMoVe project were shared, after which NGO representatives commented and asked questions.

The workshop was conducted under Chatham House rules. This report therefore only contains a reflection of general discussions and no specific quotes. The participants list and programme can be found in Annexes I and II.

Summary of the presentations and related discussion

Performance assessment
In the first presenation, it was explained how performance assessment in the CO2ReMoVe project was conducted in a number of real CCS projects, focussing on the core parameters of pressure, temperature and chemical composition. He explained the performance assessment workflow with particular attention to the different models that are used to assess storage processes at different scales: the pore scale, the near-wellbore scale, the storage reservoir scale, the storage complex and basinwide. For the In Salah project, the 3D reservoir model results could be validated with the monitoring data and also allowed for the construction of an extended 3D geomodel and geomechanical modelling.

The discussion revolved around the question to what extent the modelling results were tweaked to fit the historical data of the particular reservoir, and to what extent the models can be generalised to other projects and types of reservoirs. Performance assessment methods are to some degree site-specific. How should this non-replicability be laid down in permitting? And what do we do when predictive models and monitoring results cannot be brought into close accordance?

Monitoring and Verification
Different storage concepts were introduced in the monitoring and verification discussion, including a discussion of the ability of monitoring techniques on the basis of what the EU Directive on Geological Storage requires. It was also explained how different monitoring techniques work for different site conditions. For example 4D seismic has been very effective and relatively cost-efficient in Sleipner, but other technologies may be more cost-effectivedoes not work so well for In Salah; satellite monitoring was successful for In Salah but would not work in other conditions. In general, he concluded that it is clear that regulation on monitoring and verification should not be technology-prescriptive, but should be focussed on demonstrating key performance metrics as required by the regulations. Remaining challenges include how best to integrate different monitoring technologies to address the regulatory requirements, accurate emissions measurement and understanding long-term stabilization of the reservoir.

The participants discussed balancing the ideal monitoring portfolio with costs. In order to manage costs and benefits, the most cost-effective portfolio of monitoring techniques should be selected for each project on a site-specific, risk-assessed basis. The portfolio needs to be effective in providing storage certainty and the right level of information. Involving nearby communities in the selection of monitoring techniques could contribute to acceptance of the storage operation and can be made part of the public engagement strategy of a project.

It was also noted that monitoring is really important as regulators tend to have a strong belief in models, regardless of whether they are validated by monitoring. In addition, a question was raised about the remediation measures that can be undertaken if some leakage or other irregularity is measured. Remediation tools and strategies do exist, linked with potential leakage routes. The topic of remediation is however not within the scope of the CO2ReMoVe.

Risk assessment
The discussion on risk assessment started with a presentation that highlighted a number of definitions of risk, risk assessment, performance assessment and monitoring and verification to clarify that these different aspects have different roles in the process of risk assessment. The definition of risk (probability x consequence) suggests a quantitative outcome, but any risk assessment has subjective aspects, related to expert judgment, how consequences are valued, and the context. Risk assessment is always a combination of quantitative and qualitative types of information.

CO_2ReMoVe is mainly concerned with four different types of risk: 1) risk that CO_2 is not contained; 2) risk that injectivity of the reservoir is not sufficient; 3) risk that the storage capacity will be insufficient; 4) risk

that it will not be possible to demonstrate long-term stability of the stored CO_2. When developing scenarios during a risk assessment, people, for obvious reasons, tend to ignore the possibility that some uncertainties are unknown (i.e. there are "unknown unknowns") at any particular stage of a project. During a project, acquisition of data / information leads to greater recognition of some uncertainties, which is often confused with increasing risk. Risk should not be equated directly to uncertainty, although these concepts are related.

Challenges in risk assessment include:
– identifying key uncertainties and establishing their significance
– developing whole-system understanding by combining multiple lines of reasoning, such as different kinds of models, past experience and natural analogues.
– communication of risks and uncertainties, so that stakeholders can decide whether a risk is acceptable

As part of the CO2ReMoVe project, an integrated decision support tool for risk assessment was developed that allows for confidence and uncertainty levels, allows for input of performance assessment and M&V results, and at the same time provides an audit trail. This type of decision support was seen as positive by the participants.

The discussion kicked off with participants indicating that NGOs tend to think about different risks to those of primary concern to CO2ReMoVe, notably the global risks of not meeting emission reduction targets and potential fossil fuel lock-in risks. The role of expert judgment in risk assessment was discussed; it is an important and essential step. But experts are not fully neutral, 'group-think' may play a role, and the risk of human mistakes is ever-present. How can expert judgment be organised such that it is as impartial as possible and that group-think is avoided? Another aspect of expert judgment is when experts are not trusted anymore by certain groups. That was, among other factors, the case in the Barendrecht project. A possible suggested solution is to run expert judgments by two independent groups, one of which could be relatively lay people or a local community. An opinion was also expressed that independent risk assessments by regulators and operators, involving different expert groups could help to build confidence among the various stakeholders.

Implementation in a project: In Salah
The In Salah project shows how some of the CO2ReMoVe objectives have been implemented in practice. Note that the In Salah project design started at the end of the 1990s, before much of the recent interest in policy and regulatory frameworks for CCS. The commercial driver for the development of the In Salah field is the production of natural gas, primarily for the European market. The CO_2 storage part of the operation is relatively small in monetary terms. In addition to the ca. 100 M$ incremental investment costs for the compression and storage facilities, in total some 30 M$ has been spent to-date on monitoring and research programmes. This has demonstrated how a site-specific portfolio of different technologies can be used to select and manage an industrial-scale CO2 storage project.

There is no commercial incentive to store the CO2 produced from the In Salah development, but the developers and the host Nation collaborated to voluntarily make significant reductions to the carbon footprint of the project. A New Methodology for CCS in the Kyoto Protocol Clean Development Mechanism was submitted by the developers to the UNFCCC in August 2009, but was not reviewed by the CDM Executive Board.

The greatest estimated risks of CO2 leakage from the Storage Complex are currently associated with:

1. Potential future northerly migration of CO2 (outside of the Krechba hydrocarbon lease), which is more to do with the commercial definition of the hydrocarbon lease than loss of geological containment.
2. Leakage via wells – especially legacy wells that pre-date the current development
3. Local-scale geological overpressure

In Salah has so far prevented a total of 3,5 Mt of CO_2 from being emitted to the atmosphere. Of that, due to an unforeseen event with a legacy well, ca. 0,1 tCO_2 leaked into the atmosphere. After that event, the well was decommissioned as it had done its job, but that turned out to be relatively difficult, time-consuming (1,5 years) and expensive as a specific rig was needed that was hard to come by in Algeria. Other developments that led to more release of CO_2 than initially envisaged was that the compressors did not always work in the harsh conditions of the Algerian Sahara; one of the hottest and dryest places on Earth. Due to the compressor problems, more CO2 than planned, was vented from the production facility, before it could be geologically stored. Overall, though, the Operator believes that (if required), the In Salah project could be retrospectively compliant with the EU Directive on Geological Storage.

The project illustrates the importance of site-selection and management to providing security of storage and the good reasons why monitoring should be site-specific and risk-assessed – rather than technology prescriptive.

Take-home messages for CO_2ReMoVe project partners

NGOs tend to take a step back from the detailed technical discussion and ask the overarching question: what is the standard? What is the minimum necessary in terms of performance assessment, monitoring and verification, and risk assessment? This is actually a question that site operators also struggle with, as they currently operate with limited guidance on whether their site management is sufficient. This is something the CO2ReMoVe consortium could make recommendations on.

More specific outcomes and suggestions from the dialogue workshop:

- For performance assessment, a portfolio of different sites around the world covering all main geological attributes is needed that would have to result in a database with different settings and different tools.
- Make a matrix overview of the applicability of performance assessment and monitoring techniques to different geological contexts and for different monitoring aims. This could be included not in permitting guidelines but in best practice guidelines.
- In risk assessment, devote more specific attention to the human factor in risks; the likelihood that human mistakes are made.
- Expert judgment is an important part of risk assessment. Expert judgment needs to be organised so as to avoid impartiality and group think as much as possible.
- It is necessary for regulators to be adequately resourced, particularly in terms of having access to adequate numbers of staff / experts with relevant expertise, in order to build confidence among stakeholders that regulation is robust.

The single main question with NGOs, even after all the technical detail presented, is: how big is the gap between the current state of CO_2 storage knowledge on performance and risks and some desired standard? Researchers tend to present detailed outcomes of what they know, but remain general in explaining the details of gaps that still need to be overcome. Being more transparent about those, and trying to detail the gaps, seems a clear recommendation from the NGOs to the research community.

We are now proving a negative proposition (we find no evidence of leakage), but ideally we prove the positive proposition (the reservoir is leak-tight). A question for the CO2ReMoVe consortium: What does it take to prove the positive?

Annex I Participants to the CO_2ReMoVe NGO-research dialogue

	Name	Surname	Organisation
1	Jason	Anderson	WWF Brussels
2	Natacha	Blisson	CO_2ReMoVe - Statoil
3	Andy	Chadwick	CO_2ReMoVe - BGS
4	Heleen	de Coninck	CO_2ReMoVe - ECN
5	Finn	Dalhoff	CO_2ReMoVe - Vattenfall
6	Jean-Pierre	Deflandre	CO_2ReMoVe - IFP Energies nouvelles
7	Matthias	Duwe	CAN Europe
8	Gabriela	von Goerne	Personal capacity
9	Richard	Metcalfe	CO_2ReMoVe - Quintessa
10	Florian	Olden, van	Greenpeace
11	Ton	Wildenborg	CO_2ReMoVe - TNO
12	Iain	Wright	CO_2ReMoVe - BP

Annex II: Workshop programme

Welcome			
9:30	9:35	Welcome	Ton Wildenborg (TNO)
9:35	9:45	Objectives of the day	Heleen de Coninck (ECN, moderator)
Performance assessment			
9:45	10:10	Methods and answers from performance assessment. And what they are worth	Jean-Pierre Deflandre (IFP Energies nouvelles)
10:10	10:30	Questions from a regulator	Gabriela von Goerne (personal capacity)
10:30	11:00	Roundtable discussion	
Coffee and tea			
Monitoring and verification			
11:15	11:40	To what extent can monitoring provide the information needed to meet the regulatory requirements?	Andy Chadwick (BGS)
11:40	12:00	Unknown questions	Jason Anderson (WWF)
12:00	12:30	Roundtable discussion	
Lunch			
Risk assessment			
13:30	13:55	How can performance assessment and M&V tell us about risks and how we do know this?	Richard Metcalfe (Quintessa)
13:55	14:15	What environmental NGOs need to be sure about risks	Matthias Duwe (CAN Europe)
14:15	14:45	Roundtable discussion	
Coffee and tea			
The history of a project: In Salah			
15:15	15:45	Putting it all into practice: Case–study of the industrial-scale CO_2 storage project at In Salah	Iain Wright (BP)
15:45	16:15	Roundtable discussion	
16:15	16:30	Listing and roundup of questions	Heleen de Coninck, Ton Wildenborg