Further guidance relating to the clean development mechanism

- carbon dioxide capture and storage technologies -

FCCC/KP/CMP/2006/L.8:
INFORMATION ADDRESSING THE FOLLOWING ISSUE

(a) Long-term physical leakage (seepage) levels of risks and uncertainty

Submitted by Greenpeace

The UNFCC Art. 2 calls for the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. The latest assessment report of the IPCC has shown that global emissions have to be reduced by 85% in 2050 (compared to 2000 levels) and stabilised at low levels to avoid a temperature increase above 2°C compared to pre-industrial levels.
Carbon dioxide capture and storage might help achieving this goal. However, use of CCS may also pose risks. Next to local impacts CO_2 leaking from storage sites could contribute to the future global GHG budget. In the worst case the implication would be that the entire global energy and agricultural system would essentially need to be non-emitting. Any leakage from CO_2 disposal activities would be a serious issue or at the very least would need to be offset by the use of “some-as-yet-to-be-defined” negative emitting energy technology[1].

A risk assessment is a difficult task. In quantitative terms, “risk” is defined by a risk quotient, which is: likelyhood x consequence. This means, for all considered risks, not only are estimates required of the consequences should a risk event occur, but also estimates of the lifelihood of those consequences occuring. The potential risk of CO_2 injection could be related to a diverse range of factors including imperfections and variability of the reservoir and the cap rock, injection engineering conditions, CO_2 escape volumes and rates, project costs, stakeholder perceptions, legal claims, contamination (e.g. surface waters, groundwater, soils), earthquakes, infrastructure failure[2]. The retention time of CO_2 is site specific. Consequently, a diverse range of expertise needs to be represented for future storage project approvals and reviews.

The possibility that some CO_2 might leak from geologic reservoirs seems a certainty. What is unknown is the extent and rate of leakage. Theoretically, there are two different types of leakage: gradual and long-term release of CO_2 from a storage reservoir due to a non-existent or imperfect sealing mechanism; and sudden release of CO_2 caused for example through abondened or unknown wells, or a well bore failure. An injection well itself is closely linked to the operational phase of a storage project. Injection of fluid and/or gaseous phases including CO_2 has been successfully deployed for many years in EOR (enhanced oil recovery) applications and has shown that it can be handled with confidence and safety (such projects, not being undertaken for the purpose of reducing CO_2 emissions could seek to claim credit for avoided CO_2 emissions in the future). Once the CO_2 exits the injection well and enters the geological underground, the fate of the CO_2 is largely out of human control, characterized by a higher degree of uncertainty[3].

The possibility for long-term physical leakage strongly depends on the chosen storage site. Different classes of geologic formations have differing abilities to effectively isolate CO_2 from the atmosphere. Even within a single geologic formation differences can occur due to heterogeneity of rock formations[4]. The abilities are based upon differences in physical, structural and chemical trapping mechanisms, different geologic characteristics (e.g., depth, type of caprocks, whether there is a history of tectonic activity in the area of the target formation) and different histories of use (e.g., a history of intentionally fracturing of the formation for hydrocarbon resource extraction). Even if a good storage site has been chosen, injection of CO_2 (or any other fluid) necessarily causes changes in pore-fluid pressures and in the geomechanical stressfields that reach far beyond the volume occupied by the injected fluid.

CCS projects are long-term projects. Whereas the CO_2 injection stage is easy to define, the post-injection stage can not be defined precisely. The time frame can range from a hundred years to a thousand years. The longer the time frame, the higher the uncertainty for estimating the total amount of leakage. Because of the long timeframe of storage projects the risk of leakage would remain even after the issues of climate change are resolved as long as highly concentrated CO_2 remains stored in reservoirs. In the long run (well above many tens of thousands of years) however residual CO_2 trapping, solubility and mineral trapping will finally reduce the risk of leakage. Experiences with long-term CO_2 storage do not exist. Although storage projects are now in operation and being carefully monitored, time is too short and overall monitoring too limited, to enable direct empirical conclusions about the long-term performance of geological storage[5].

Given the long timeframe, the possibility of physical leakage and the limits to monitor leakage, fulfilling the need to control and account emissions is difficult to achieve. Reporting may indeed be challenging where leakage rates from storage sites are unknown. Performance-based regulations and accounting would not work as it hangs on the ability to infer performance from quantities that can be directly measured. For geological storage of CO_2, however, a performance-based approach would have to specify quantities, such as the maximum rate of leakage over at least the next century that cannot in principle be directly measured. Models and monitoring schemes help but give only prove the moment physical leakage occurs. For project developers it is crucial to include leakage into any calculation. However, it remains a problematic issue elucidating specific discounting or default emissions factors that can normalise any potential future emissions back to present day simply because we don't know.
For any storage project to start it is crucial that a best storage site is chosen. And even with the best ("best" needs to be defined and characterised) risk and uncertainty of long-term leakage remains. If storage projects are to be undertaken national, international, and an independent group of experts need to be in place to prove, review, varify, evaluate a project. Otherwise projects should not be approved.

References:

[1] Dooley J.J., Wise M.A.: Why injecting CO_2 into various geologic formations is not the same as climate change mitigation: the issue of leakage. *B2-5*, Joint Global Change Research Institute Battelle
[2] Bowden A.R., Rigg A.: Assessing reservoir performance risk in CO_2 storage projects. *GHGT-7*
[3] Heinrich J., Herzog H., Reiner D. (2003): Environmental assessment of geological storage of CO_2. *2nd Nat. Conference on Carbon Sequestration*, Washington
[4] Flett M., Gurton R., Weir G. (2006): Heterogeneous saline formations for carbon dioxide disposal: Impact of varying heterogeneity on containment and trapping. *J.of Petroleum Science and Engineering. 01483*
[5] IPCC (2005): Special report on carbon dioxide capture and storage. *SRCCS, p. 246*