IETA
INTERNATIONAL EMISSIONS TRADING ASSOCIATION

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CARBON DIOXIDE CAPTURE AND GEOLOGICAL STORAGE AS A CLEAN DEVELOPMENT MECHANISM PROJECT ACTIVITY

Submission to the UNFCCC Secretariat by the International Emissions Trading Association (IETA)

16th June 2008

SUMMARY OF IETA'S VIEWS

1. Carbon Capture and Storage (CCS) is an important part of a portfolio of options available for climate change mitigation, alongside energy efficiency and renewable energy. To achieve the levels of CO_2 reductions needed, all mitigation options must be used to their full potential regardless of whether all options can be deployed in all countries.
2. CCS is necessary in order to meet near-term emission reduction targets and longer-term stabilization of atmospheric CO_2 concentrations. In order to avoid emissions "lock-in" once plant is built, it is timely that CCS is demonstrated and deployed now. Delaying its use risks large GHG emissions to the atmosphere that could have been captured and stored, thereby reducing our ability to tackle global climate change;
3. CCS is a proven technology. The oil and gas industry has gained considerable experience over several decades relating to the capture, transport and storage of CO_2 and the monitoring of CO_2 injected in geological formations;
4. CCS can contribute towards sustainable development. Economic development and rural electrification in coal-based developing countries can only align with the need for GHG mitigation through use of CCS;
5. CCS needs incentives for deployment due to the additional costs of capture, transport and storage. Certain "early opportunities" for CCS deployment could be incentivized via the CDM, providing valuable learning effects for wider deployment of CCS in the medium-term;
6. Future financing of CCS may not necessarily come from project based mechanisms. However, in the meantime, project-based mechanisms provide a valid potential incentive for CCS deployment in non-Annex I countries, especially for "early opportunities";
7. CCS projects will not flood the CDM market. Long project lead times will physically limit the number of projects that can be approved and come into operation before 2012, and the CER prices are likely to remain too low to incentivize widespread deployment of CCS in the short term. In the longer term, demand for greater CO_2 cuts will be needed and CCS projects will compete with other mitigation options where they are cost-effective;
8. CCS needs effective regulation to ensure safe deployment. Early deployment of CCS projects in developing countries will come with capacity building efforts from developed countries and other non-Annex 1 countries with good expertise of sub-surface management operations;
9. CCS should be a technology that is implemented wherever it is technically possible, The need for incentives and regulation means that evolution of public policy on CCS is imperative;
10. Many Annex I countries are making rapid progress in developing public policy which creates an enabling framework for CCS deployment. A large number of non-Annex I countries also support the demonstration and deployment of CCS technologies. Early deployment of CCS projects to lower the cost of capturing CO_2 and enhancing the experience with CO_2 storage will be critical in developing CCS to a global industrial level in order to achieve CO_2 emission reductions of global significance.

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1. Background

In response to decision FCCC/SBSTA/2007/L.19, The International Emissions Trading Association (IETA) welcomes the opportunity to submit to the Secretariat our views on CO_2 capture and storage (CCS) projects as Clean Development Mechanism (CDM) project activities. As requested, this submission addresses technological, methodological, legal, policy and financial issues additional to those referred to in FCCC/SBSTA/2007/16, also reflecting the informal discussions that took place during 27th Session of the Subsidiary Body for Scientific and Technological Advice (SBSTA27).

2. The Role of CCS in Reducing Atmospheric Greenhouse Gas Emissions

IETA believes that:

- CCS is an important part of a portfolio of options available for climate change mitigation, alongside energy efficiency and renewable energy.
- CCS is urgently needed in order to meet near-term emission reduction targets and longer-term stabilization of atmospheric CO_2 concentrations.
- CCS is a proven technology. The oil and gas industry has gained considerable experience over several decades relating to the capture, transport and storage of CO_2 and the monitoring of CO_2 injected in geological formations.
- Deployment of CCS as an effective climate change mitigation option requires good site selection, project design and management; effective regulation; development of appropriate host country institutional arrangements; treatment of liability transfer; and treatment of trans-boundary issues.

Our views are supported by various expert publications. The IPCC [(1)] has recently concluded that greenhouse gas (GHG) emissions must be reduced by 50-85% of 2005 levels by 2050 in order to avoid the devastating consequences of climate change. However, global energy demand is forecast to grow by 55% between 2005 and 2030, with 74% of the increase driven by high energy demand in developing countries [(2)]. The continued use of fossil fuels is expected to meet most of this demand, resulting in a 57% increase in global

(1) IPCC, 2007: Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Metz, B. O,R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)] Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA., 851 pp.)
(2) OECD/IEA "World Energy Outlook 2007, China and India Insights" (2007). Available at http://www.worldenergyoutlook.org/2007.asp

CO_2 emissions by 2030 [(1)]. No single solution is available to achieve the levels of GHG emissions reductions needed - therefore a broad portfolio of mitigation technologies will be required. EU and other Annex 1 countries regard CCS to be a profound mitigation option available to meet their emission reduction goals. Scenarios from the International Energy Agency (IEA) indicate that the potential for reducing emissions through the increased use of renewable energy and energy efficiency is limited, and whilst they will play a vital role in tackling climate change, the use of renewables and other low carbon electricity generation technologies such as nuclear power will not be able to address the huge expected growth in CO_2 emissions associated with the electricity supply industry, as well as other industrial processes, particularly in emerging economies.

Consequently, the IPCC regards CCS as a technology with the potential to achieve large reductions in global CO_2 emissions over the next 10-20 years and up to 55% of the cumulative mitigation effort by 2100 [(2)]. Given its potential application across a range of CO_2 emissions sources and geographical locations, CCS also has the potential to reduce overall mitigation costs and increase the flexibility in achieving emission reductions worldwide.

There is now widespread and growing recognition of the potential for CCS in combating global climate change amongst policy makers. The IPCC has concluded that CCS is among the technologies with the largest economic potential to reduce CO_2 across a wide range of emissions sources, whilst the IEA describes CCS as a 'promising emission reduction option with potentially important environmental, economic and energy supply security benefits' [(3)]. Furthermore, G8 Energy Ministers, recently meeting in Japan (8 June 2008) issued a joint statement with Energy Ministers from China, India and South Korea stressing that CCS played a 'critical role' in 'tackling the global challenges of climate change and energy security' [(4)]. We believe that the policy framework and financial mechanisms must and can be developed to encourage companies and governments to gain the experience needed to build momentum towards widespread global industrial scale operations. This view was echoed recently by Nobuo Tanaka, Executive Director of the IEA who stated that 'deployment of CCS should be a 'litmus' test for the seriousness of environmental negotiators dealing with climate challenge' [(5)].

(1) OECD/IEA (2007) *op cit.*
(2) IPCC Special Report on Carbon Dioxide Capture and Storage; Summary for Policymakers. Prepared by Working Group III of the Intergovernmental Panel on Climate Change (2005). Cambridge and New York: Cambridge University Press http://www.ipcc.ch/pdf/special-reports/srccs/srccs_summaryforpolicymakers.pdf
(3) IEA "Prospects for CO_2 Capture and Storage" (2004). Available at http://www.iea.org/textbase/nppdf/free/2004/prospects.pdf
(4) Joint statement available at http://www.enecho.meti.go.jp/topics/g8/g8sta_eng.pdf
(5) Key note address to the 11th International Energy Forum (IEF) in Rome, 21 April 2008. See http://www.iea.org/Textbase/press/pressdetail.asp?PRESS_REL_ID=254

IETA's view is that CCS needs an effective regulatory and legal framework to ensure safe deployment. We view the key requirements for undertaking CCS as an effective climate change mitigation option as:

- Good site selection, project design, management (this is considered under *Technical issues* and *Methodological issues* below).
- Effective regulation, including permitting procedures, to ensure safe deployment (this is considered under *Legal Issues* below).
- The development of appropriate host country institutional arrangements (this is considered under *Legal Issues* below).
- Arrangements for transfer of long-term liability (this is considered under *Legal Issues* below).
- Treatment of CCS projects involving more than one country i.e. trans-boundary issues (this is considered under *Legal Issues* below).

3. CCS inclusion in the CDM - encouraging early deployment

IETA believes that:

- CCS needs incentives to facilitate deployment. With the exception of certain situations, there are no other benefits of deploying CO_2 other than for climate change mitigation. The CDM offers a mechanism in the short term for incentivizing 'early opportunity' CCS projects that would otherwise not be financed.
- There are real and cost-effective CCS 'early opportunities' available now in developing countries in need of financing. Such projects can help facilitate the critical pathway towards wider deployment of CCS needed in the long term.
- CCS meets the objectives and criteria of the CDM

Whilst the potential to mitigate climate change from CCS is significant in both developed and developing countries, the IPCC Special Report on Carbon Dioxide Capture (SRCCS) and Storage (1) indicates that a large number of the most cost-effective 'early

(1) See Figure 2.9 in Chapter 2, page 97 in: Metz B, Davidson O, de Coninck, HC, Loos M, and Meyer LA (eds.). 2005. IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change. Cambridge and New York: Cambridge University Press. Available at http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf

opportunities' [(1)] for CCS projects are located in developing countries. However, CCS projects are highly unlikely to be undertaken in developing countries in the absence of financial or other incentives. IETA believes that the CDM provides a suitable, and currently the only, financing mechanism in the short term for incentivizing such 'early opportunities' for CCS projects in developing countries.

In our view, CCS meets the objectives and criteria of the CDM and supports the ability of developing countries to contribute towards the Convention's central objective of stabilizing atmospheric GHG concentrations. The need to incentivize cost-effective CCS opportunities through the CDM is particularly critical to reduce the CO_2 emissions arising from a wide range of industrial processes (e.g. ammonia, cement production, gas processing - including liquefied natural gas production for export markets).

There are real and cost-effective opportunities available now in developing countries in need of financing. The CDM provides an opportunity to establish a framework for funding using the power of the carbon market to achieve least cost reduction and drive early CCS deployment. Such projects can help facilitate the critical pathway towards wider deployment of CCS needed in the long term whilst facilitating the transfer of clean technology to developing countries. We strongly believe that incentivizing low cost early opportunities in developing countries will enable the development of the infrastructure and knowledge (e.g. pipelines and storage potential mapping) needed for wider deployment in the future. This view is supported in the SRCCS which concludes that: "early opportunities […] could provide valuable early experience with CCS deployment, and create parts of the infrastructure and knowledge base needed for the future large-scale deployment of CCS systems" [(2)].

IETA believes that, depending on the development of a post-2012 international policy framework, mechanisms in addition to the CDM will likely be required to promote CCS on a significant scale. However, in the short term the CDM can act as a much needed catalyst to help build technical understanding of CCS applications, reduce technology costs and develop the confidence needed for widespread deployment. Critically, the CDM represents the main means available for allowing CCS to become commercially available in those developing countries where CO_2 emissions will rise most rapidly in future years. Further, if the decision from the Conference of Parties was to disallow the inclusion of CCS in the

(1)'Early opportunities are described in the SRCCS as: projects that [are likely to] "involve CO_2 captured from a high-purity, low-cost source, the transport of CO_2 over distances of less than 50 km, coupled with CO_2 storage in a value-added application such as EOR. SRCCS. Technical Summary, page 44.

(2) SRCCS, page 341.

CDM, the negative message sent by such a decision could adversely impact the widespread deployment of this important mitigation option. We therefore view CCS inclusion in the CDM as a critical bridging opportunity towards a low-carbon future in which CCS is deployed on a large scale as part of a portfolio of mitigation options.

The Synthesis of Parties' and organizations' views produced by the secretariat at the request of SBSTA (the 'Synthesis Report') (1) noted that conflicting views were apparent among Parties in relation to CCS inclusion as a CDM project activity. Various specific concerns have been expressed relating to the potential inclusion of CCS within the CDM within different fora. Although several of these issues are cross-cutting by their nature, for the sake of clarity IETA has considered each of these concerns below under the key issue areas identified in the Synthesis Report.

4. Financial issues

IETA considers that the key financial issues are:

- the potential market impact arising from CCS inclusion in the CDM;
- the cost-effectiveness of CCS in relation to other mitigation options; and
- the potential for CCS to divert investment away from renewable energy and energy efficiency.

The concern has been expressed by some Parties that the inclusion of CCS in the CDM could have a potentially significant market impact, leading to the 'crowding out' of other types of project. However, IETA believes that although the technical global potential for delivering CO_2 reductions from CCS is large, those that could be incentivized under the CDM for delivery of CERs during the 2008-2012 Kyoto commitment period is likely to be small. The levels of investment required, the long project lead times, CDM approval process and post-2012 uncertainty will mean that only a handful of CCS projects could in reality come into operation before 2012. In addition, CER prices are likely to remain too low for widespread deployment of CCS in the short to medium term; the financial incentive provided by the CDM would rather help kick-start a modest number of cost-effective 'early opportunities' in developing countries needed to gain the experience and cost reduction needed along the pathway to wider deployment in the longer term. We therefore believe the concerns of CCS 'crowding out' the CDM are unfounded, particularly in the short term. In

(1) FCCC/SBSTA/2008/INF.1 "Synthesis of views on issues relevant to the consideration of carbon dioxide capture and storage in geological formations as clean development mechanism project activities" Available at http://unfccc.int/resource/docs/2008/sbsta/eng/inf01.pdf

the longer term, demand for greater CO_2 reductions will be needed and CCS projects will compete with other eligible mitigation options where they are cost effective.

The Synthesis Report noted the concern that CCS was not cost-effective compared to other mitigation options. We believe it is important to note that, as with renewable energy, potential CCS projects and technologies vary widely leading to a wide range of costs; while some 'early opportunities' may be incentivized by CDM revenues, these represent only a small share of global CCS potential. A central objective of the Kyoto flexible mechanisms is to achieve emissions reductions at least cost, and therefore the market will decide which CCS projects can compete on a least cost basis; the inclusion of CCS allows for greater availability of cost-effective projects and allows for more stringent reduction targets to be developed post 2012. IETA believes that the incentive provided by the CDM can give rise the enhancement of valuable experience for geological storage of CO_2 where concentrated stream of CO_2 can be captured at reasonable cost. In particular, this is the case for the oil and gas industry as well as for some petrochemical activities. Together with demonstration projects focusing mainly on lowering the cost of capture from plants deployed in Annex 1 countries, the CDM can play make an important contribution to build the necessary conditions for scaling up deployment of CCS to a global level.

IETA acknowleges the concern expressed by some Parties that investment in CCS might detract from investment in renewables and energy efficiency activities. However, we strongly believe that CCS is one of number of mitigation options which will be required together to achieve the levels of GHG reductions needed during this century; a view shared by the IPCC, IEA and a growing number of policy makers. While renewables can offer large emissions savings and contribute to energy security goals, the requirement for baseload power and intermittency issues will limit their deployment. In addition, CCS offers the only realistic option to address process emissions from a range of industrial processes, such as cement production or natural gas processing. IETA believes that CCS is not a replacement for other options and indeed can be complimentary to renewable technologies; for example the application of CCS with biomass generation or biofuels refining offers the potential for achieving negative GHG emissions.

5. Cross-cutting issues

IETA considers that the key cross-cutting issues are:

- the potential of CCS to lead to the increased used of fossil fuels and CO_2 emissions; and
- the role of future CCS deployment post-2012

Parties have expressed the concern that the use of CCS may lead to the increased use of fossil fuels, and therefore increased emissions of CO_2. This issue has been raised principally in the context of enhanced hydrocarbon recovery (EHR), a niche application which will apply to only a limited share of CCS projects. However, the perception assumes that fossil fuels (principally oil from enhanced oil recovery and also potentially natural gas from enhanced coal bed methane recovery) would substitute lower carbon energy sources such as renewables or nuclear power. We believe this assumption to be unfounded. In this context, the IEA has concluded that 'it is equally likely that this oil or especially this gas comes in substitution of energy fuels with greater carbon content, such as coal or non-conventional oil resources, in which case it [CCS] further reduces global emissions instead of increasing them' (1). Similarly, the IPCC notes in its *Fourth Assessment Report* that higher priced conventional oil resources may be replaced by high carbon alternatives such as from oil sands, oil shales, heavy oils, and synthetic fuels from coal and gas, leading to increasing GHG emissions unless production plants are equipped with CCS (2) .

Several Parties have noted the uncertainty regarding the post-2012 international climate change policy framework. IETA believes that the future financing needed for large-scale future deployment of CCS will not necessarily come from project-based mechanisms such as the present-day CDM. However, regardless of the form of a post-2012 framework, the IPCC have stated that emissions must be reduced by 50-80% by 2050 and policymakers in the European Union, the United Kingdom and other regions have adopted long term ambitious reduction targets reflecting this goal. As noted earlier, we believe that CCS will be needed along with other mitigation options to help achieve these ambitious targets and that the incentives provided by the CDM to finance 'early opportunities' can provide the critical first steps along the pathway to meeting this challenge. Early experience of undertaking CCS projects in both developed and developing countries will also be critical to gain public acceptance of CCS technology and demonstrate the benefits to civil society.

6. Legal issues

IETA considers that the key legal issues are:

(1) IEA, Carbon Capture and Storage in the CDM (2007). Available at http://www.iea.org/textbase/papers/2007/CCS_in_CDM.pdf
(2) IPCC, 2007: *Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Metz, B. O,R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)] Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA., 851 pp.). Available at http://www.ipcc.ch/ipccreports/ar4-wg3.htm

- the creation of robust regulatory regimes in host countries and permitting practices which determine conditions for the storage of CO_2 including provisions to ensure that the CO_2 is sealed from the atmosphere, and treatment of liability;
- options for transfer of long-term liability as part of the CDM process; and
- regulatory and institutional capacity building in host countries

Our view is that a precondition for CCS project to be approved for registration as a CDM activity is that the CO_2 storage is undertaken within a regulatory and legal framework that ensures safe storage of CO_2 according to principles and best practice, thereby making the CCS acceptable as a climate change mitigation project. The IPCC 2006 Guidelines (1) describe the requirements for CCS to be accepted as a climate change mitigation activity that can be accounted for in national GHG inventories. This covers e.g. the development of robust permitting requirements which establish clear responsibilities upon host countries in respect of liability transfer between project operators and host countries during, and upon cessation of, CO_2 storage. In this context, the European Commission has recently brought forward proposals for regulating CO_2 storage sites which define a range of permit authorization conditions for the storage of CO_2, including terms for liability transfer (2).Australia has developed a regulatory regime for CCS and other countries are developing their own frameworks. It may be appropriate for the CDM EB to develop guidance for the permitting and controlling of CO_2 storage in respect of host countries and project proponents, and other conditions, for the approval of CCS projects as CDM activities.

IETA supports the view that the ultimate liability for any long-term seepage emission needs to lie with the host country. The host country is most able to ensure the operating conditions of any seepage emissions and the storage reservoir lies within its jurisdiction and control post closure. Furthermore, considering the long-term nature of CCS, post-project closure monitoring and remediation liability could only be practically assumed by the host country. See the Synthesis Report paragraph 70 for further discussion of this issue.

We believe that host countries should be able to define the specific details of liability arrangements suitable to each specific project and national circumstance, in the same way that sustainable development criteria are currently prescribed by host countries for CDM project activities. Sufficient flexibility will be required in implementing liability regimes, for example in defining the timing and terms of any liability transfer to the host country and any residual monitoring requirements, and should be defined on a case-by-case basis. It is

(1) 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 5. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
(2) More information is available here: http://ec.europa.eu/environment/climat/ccs/eccp1_en.htm

important to note in this context that the leakage risks from the transfer of liability to the host country over the long-term will be extremely low because the risk of CO_2 seepage is greatest during project operations and immediately following storage site closure.

IETA believes that permitting arrangements containing specific provisions regarding liability requirements can be accommodated within the CDM process, for example through the use of the environmental impact assessment or via the introduction of a new section to the CDM Project Design Document (PDD). In addition to the proposals brought forward by European Commission in the CCS Directive which outline such requirement within permit authorization conditions, there are several legal approaches in place worldwide providing useful examples of handling long-term liability; these include for example the Gorgon LNG project in Western Australia in which the environmental impact statement (EIS) outlines a range of issues including site selection criteria, site characterization, permanence, stewardship and liability. We believe that the host country must have an appropriate liability regime in place in order to host a CCS project under the CDM and that the CDM provides the best opportunity for such a regime to be developed on a project "learning-by-doing" basis, as has typified the evolution of the CDM to date.

We believe that CCS projects crossing national boundaries can be adequately accommodated within the project boundary definition of the CDM process. We support the views expressed in the Synthesis Report which note that the 2006 IPCC Guidelines provide robust guidance on accounting for emissions involving more than one country and that these can be applied to CDM project activities.

As with other mitigation technologies, capacity building of host country regulators will be essential to the development of institutional experience and knowledge required for greater deployment of CCS. IETA believes that the CDM process can provide the opportunity for accelerating capacity building in host countries through the development of appropriate regulatory frameworks based on real CCS projects. Such developments can lay important groundwork in view of wider large-scale deployment in the future.

7. Technological issues

IETA considers that the key technological issues are:

- empirical evidence of storage site performance;
- the risk posed by long-term CO_2 leakage (seepage); and
- treatment of leakage within the CDM

We believe that CCS is a proven technology. The IPCC SRCCS states that: "Complete CCS systems can be assembled from existing technologies that are mature or economically feasible under specific conditions, although the state of development of the overall system may be less than some of its separate components" (1) . The oil and gas industry has gained considerable experience over several decades relating to the capture, transport and storage of CO_2 and the monitoring of CO_2 injected in geological formations. The IPCC states that "information and experience gained from the injection and/or storage of CO_2 from a large number of existing enhanced oil recovery and acid gas projects, as well as from the Sliepner, Weyburn and In Salah projects, indicate that it is feasible to store CO_2 in geological formations as a CO_2 mitigation option" (2). Further information relating to the performance of these projects, which cover a range of technology application and storage reservoir types, is provided in an Annex to this submission.

Any leakage raises two situations. The first is leakage of CO_2 as a safety issue. This is a matter that should be dealt with by the appropriate national regulations. Material leakage is highly unlikely: the IEA GHG Programme has recently produced a document *'Geologic Storage of Carbon Dioxide: Staying Safely Underground*' (3) detailing the levels of risk from seepage. This document concludes that "Geological storage projects have already successfully stored millions of tonnes of CO_2, some for many years, with no detectable leakage via geological formations". The second issue is that under the CDM leaks become economic in nature and should be addressed via the transactional arrangements by which the storage is funded, and it is perfectly feasible for this to be designed into the arrangements whereby CCS would be included under the CDM. We therefore support the views of Parties noted in paragraphs 19 to 23 of the Synthesis Report in respect of appropriate operation of reservoirs and remediation. We further support the view noted in paragraph 26 that environmental impact concerns should be addressed in line with CDM modalities and procedures, as set down in decision 3/CMP.1.

8. Methodological issues

IETA considers that the key methodological issues are:

- CO_2 storage site characterization and identification of potential leakage pathways;
- monitoring requirements for CCS as CDM project activities; and

(1) SRCCS. Summary for Policy makers. Page 8.
(2) IPCC, SRCCS. Page 197; Note also lately Snøhvit in conjunction with LNG production in North of Norway
(3) IEA, Geological Storage of Carbon Dioxide – Staying Safely Underground (2008). Available at http://www.cslforum.org/documents/geostoragesafe.pdf

- the potential non-alignment between the end of the CDM crediting period and the CCS project closure date

It is our view that flexibility is required to accommodate different geological conditions and their distinct storage characteristics, and that such differences mean that sound characterization of reservoirs and good site selection procedures are needed to ensure long-term integrity of storage. This view is reflected in the consensus of Parties' views expressed in paragraph 31 of the Synthesis Report. We also agree with the consensus of views noted in paragraph 37 that the main objective of site characterization is to identify the capacity of the geological formation to trap CO_2. The 2006 IPCC Guidelines (1) state that site characterization should identify and characterize potential seepage pathways and quantify properties of the storage system. The SRCCS provides a framework for site selection and good characterization of storage sites and the IEA GHG R&D Programme (2) also addresses issues relating to criteria for storage site selection which are aligned with the factors outlined in paragraph 38 of the Synthesis Report.

We believe that the CDM project boundary for a CCS project should accommodate components across the full CCS life cycle, a view noted in the Synthesis Report noted as having agreement from all submissions. Paragraphs 48 and 49 of the Synthesis Report refer to the 2006 IPCC Guidelines' approach to estimating seepage and the components of a monitoring program; we support these provisions and consider that they offer a robust approach to designing a monitoring methodology under the CDM.

The Synthesis Report notes the concern expressed by one organization that the end of the CDM crediting period may not necessarily align with the cessation of the CCS project (for example, if the project were to continue beyond the maximum 21 years crediting period), and therefore poses the question of whether storage sites could potentially be closed at the end of the crediting period, continue to operate or cease storage of CO_2. In IETA's view, if the injection and operation of the CO_2 storage site continues after the termination of the crediting period, this should be addressed by the host country regulations and the permitting conditions incumbent upon the project operator. Provisions for make up of CERs that have been issued for CO_2 volumes emitted from the storage within a defined time period can be built into the host country permitting provisions. Such liabilities can be covered by insurance, or by other financial assurance mechanism. Provisions make up of CERs could also be determined by the CDM EB and administered by the EB Secretariat.

(1) 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 5. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
(2) IEA Greenhouse Gas R&D Programme. 2007. ERM – Carbon Dioxide Capture and Storage in the Clean Development Mechanism. Available at: http://www.co2captureandstorage.info/networks/CCS-CDM.htm.

At such a future point in time, we expect that the issue of how such situations could be dealt with will be considered as part of a future regime for CCS regulations within a post-2012 climate policy framework. Without pre-empting the form of such a future policy regime, we consider that other - not necessarily project-based - incentive mechanisms will allow for the continued operation of established CCS activities, and the design of any such mechanism would incorporate some transitional arrangements for CCS projects initiated under the CDM. Analogous examples of 'grandfathered' support mechanisms can be seen elsewhere e.g. European Member State ongoing support for historic renewable energy credit contracts. We therefore believe that given an increasing demand for global GHG emissions reduction over the next 10-20 years, this issue should not be seen as a significant obstacle to the financing of early CCS project opportunities through the CDM.

9. Policy issues

IETA considers that the key policy issues are:

- CCS is required as one of a portfolio of mitigation options available;
- accounting options for any long-term seepage;
- CCS contribution to sustainable development; and
- the potential risks to human health and ecosystems posed by CCS

Our view is that reconciling increasing world energy demand with the transition to a low-carbon future will require an unprecedented effort by the global community to develop the appropriate policy and technology responses. The effects of climate change are being felt now and a delay in achieving significant cuts in emissions will lead to increasingly severe consequences. Furthermore, the costs of deferring action will significantly outweigh the costs of taking action sooner as suggested by the economic analysis of the Stern Review [(1)]. IETA believes that CCS represents one of several important mitigation options needed to achieve the significant emissions cuts needed this century.

Although CCS deployment potential may vary across countries and regions, its use will allow for more stringent and cost-effective global emissions reductions to be available. If the deep emissions reduction required are to be achieved then all mitigation options must be used to their full potential regardless of whether all options can be deployed in all countries. Whereas for some countries, protecting their bio-sequestration capability may be the largest

(1) N.Stern "Stern Review: The Economics of Climate Change" (2007) Cambridge University Press. Available at http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

contribution they can make in combating climate change, for other countries with less significant bio-production, it may be their potential to store large volumes of CO_2 which offers the most promising option. Our view is that all countries should take the responsibility to allow an enabling framework to develop which enhances the fullest abatement potential to be realised within the different individual countries, and not to discourage important mitigation options which may not be readily available to themselves. International regulations and mechanisms should encourage this to happen.

Accounting options for any long-term seepage should be considered in conjunction with issues presented by long-term responsibility for monitoring and remediation. IETA believes that CERs resulting from CCS project activities should be considered permanent and fungible, as expressed by Parties in paragraph 86 of the Synthesis Report. We uphold the view that the guiding principle for accounting rules for CCS project activities under the CDM should be consistency with current approaches under the Kyoto Protocol which ensure that the actual effect of a project on the atmosphere is reflected in the number of Kyoto units issued and accounted for over time. We therefore do not support the use of temporary or long-term CERs which have been designed to address the issue of non-permanence by afforestation and reforestation projects. The time period over which emission reductions are achieved through use of CCS is thousands of years, whereas for bio-sequestration it is decades. In the context of climate change, this difference in time scale of permanence suggests that it is inappropriate to compare CCS with afforestation and reforestation. We believe that the lower market value associated with temporary or long-term CERs would also serve to limit the potential for CCS project investment and therefore the potential for building capacity and experience needed ahead of wider, more large-scale, deployment.

The Synthesis Report notes the concern raised by some that CCS does not contribute to sustainable development. IETA believes that CCS can contribute towards sustainable development and that host countries are best placed to judge whether a particular project meets its sustainability criteria on a case-by-case basis. Countries with high CO_2 emissions and geological structures that allow for CO_2 storage can, through the deployment of CCS, enhance their capability to manage their sub-surface energy assets at the same time as improving their ability to use their fossil energy resources in a sustainable way. We support the view expressed in paragraph 78 of the Report that climate change is linked with efforts in development and poverty reduction and that current patterns of energy supply and demand threaten to cause severe climate change, and that CCS is one of the technologies that could facilitate the required change towards the low-carbon economy. The financing of CCS ‘early opportunities’ through the CDM can facilitate the transfer of technology to developing countries, enabling significant and cost-effective CO_2 reductions in support of the objectives of the Convention and the Kyoto Protocol. The application of CCS can also have benefits in terms of local atmospheric pollution, the effects of which cause considerable harm to human health and ecosystems.

We believe that the risks to human development and the natural environment associated with climate change significantly outweigh those associated with CCS projects, which will be needed along with other mitigation options to achieve the levels of emissions reduction needed to stabilize atmospheric CO_2 concentrations this century. The IPCC has stated that CO_2 leakage rates of less than 1% are likely over 1000 years for appropriately selected and managed storage sites, and further that the environmental impact risks from CCS activities are comparable with those of natural gas storage. In the event of a CO_2 release, technologies are available to monitor CO_2 levels and provide appropriate warnings (Section 5.6 for the SRCCS describes in detail a range of direct and indirect monitoring techniques available for this purpose).

We hope that the above comments will provide valuable input to your further work.

Yours sincerely

Henry Derwent
President

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ANNEX - INFORMATION RELATING TO THE SLEIPNER, IN SALAH AND WEYBURN CO_2 INJECTION PROJECTS

Background

Two major areas of concern identified in the Synthesis Report and elsewhere are the need for (a) appropriate site selection for long-term storage of CO_2 and (b) monitoring the flux of CO_2 from the storage to prove that containment integrity has not been compromised. This Annex to the submission provides further information on these two important aspects with reference to three large-scale existing CO_2 injection projects: Sleipner, In Salah and Weyburn.

Site Selection

The Synthesis Report identified the following factors which need to be taken into account when choosing an adequate site for storage of CO_2:

a) *Depth of the storage formation.* The deeper the storage is the more gas can be stored due to the higher pressure. The high pressure will also mean that more of the gas will dilute into the saline aquifer and thereby be stored in a more stable state.

b) *Vertical and lateral extent of the formation(s) and thus the subsurface project boundary.* In some areas the lateral extent of the storage can become a problem as it may extend into different countries.

c) *Physical and chemical nature of the geological trapping mechanisms, including the reservoir and seal (cap rock thickness and integrity, and lateral sealing).* These are critical components, since they define the system in which the gas is stored, and thereby the way the gas will behave under different circumstances.

d) *Geological homogeneity or heterogeneity in the storage formation.* The homogeneity has an impact on the uncertainty of the forecasts for the storage. If the area has a very heterogenic formation it is more difficult to analyze the geology of the whole area.

e) *The formation's permeability and fluid migration rate.* Permeability and migration rate in different areas of the storage will decide the likelihood of leakage as well the storage adequacy for storing the gas.

f) *Geological storage volume in the formation.* The volume, together with chemical and geological factors decides the maximum amount of gas that can be safely stored in the storage.

g) *Regional and/or local geological stability.* The geological stability of the region has great implications on long-term storage since geological instability can lead to possible pathways for the gas to migrate to the surface.

h) *Environmental conditions in the vicinity of the planned storage site and their sensitivity to potential CO_2 leakage.* The sites should be chosen so that, in case of leakage, the local health and environmental impacts are as small as possible.

Monitoring

The Synthesis Report noted broad support across submissions that site characterization should include a monitoring programme to verify whether the site is performing as forecast in computer modeling. The results of monitoring should be used to recalibrate any models applied and to further assist in the identification of seepage. The monitoring plan should also identify potential leakage pathways and measure leakage.

The 2006 IPCC Guidelines (1) suggest the following methods for monitoring CO_2 content as well as possible fluxes:

- Seismic surveys
- Microseismic monitoring
- Wellhead pressure monitoring during injection, formation pressure testing
- Gravity surveys
- Sonar
- Electrical methods
- Gas analysis
- Groundwater and surface gas analysis
- Soil gas analysis
- Satellite or airborne hyperspectral analysis
- Satellite interferometry

(1) 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 5. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

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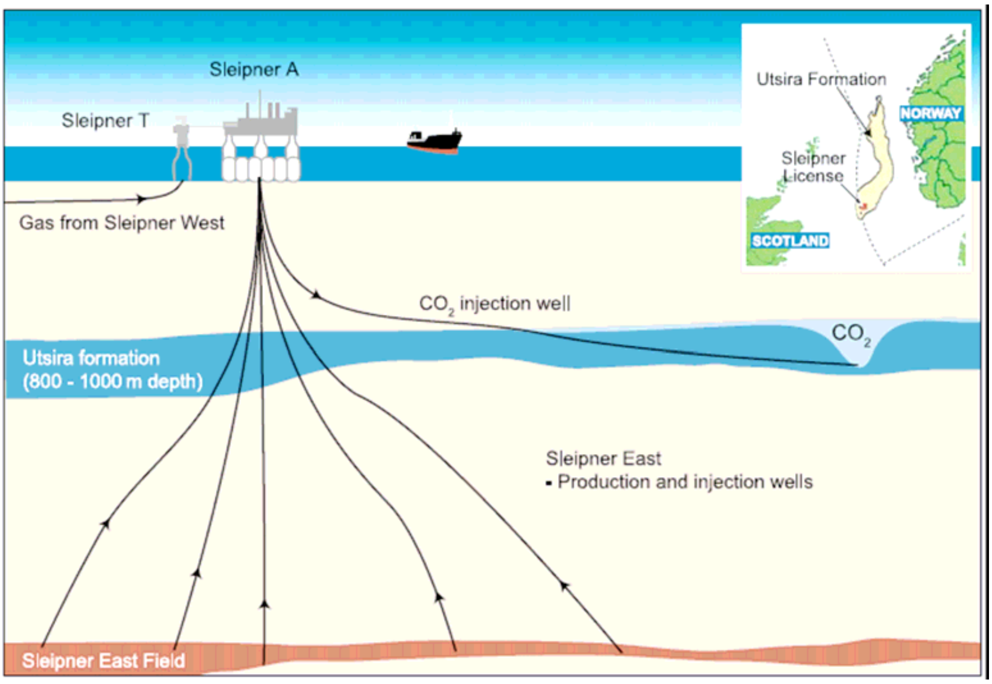
The Sleipner Project

The first, longest running and largest demonstration of CO_2 injection in an aquifer up to now is at Sleipner, in the central North Sea 250 km off the cost of Norway. Since October 1996, Statoil and its Sleipner partners have injected CO_2 into a saline aquifer, the Utsira Sand, at a depth of 1012 m below sea level, some 200 m below the reservoir top. The CO_2 is separated on the platform from natural gas produced from the deeper lying Sleipner gas field and injected into the aquifer through a deviated well at a lateral distance of about 2.3 km from the platform. [(1)]. The project is being carried out in three phases. Phase-0 involved baseline data gathering and evaluation, and was completed in November 1998. Phase-1 involved the establishment of project status after three years of CO_2 injection. Phase-2, involving data interpretation and model verification, began in April 2000 [(2)].

Simplified diagram of the Sleipner CO_2 storage project



Source: SRCCS

(1) R.Arts et al "Ten year's experience of monitoring CO2 injection in the Utsira Sand at Sleipner, offshore Norway" *First Break* Volume 26 (2008)
(2) SRCCS

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Site Information

In the vicinity of Sleipner, the Utsira Sand is a highly porous (30-40%), very permeable (1-3 Darcy), weakly consolidated sandstone, lying at depths between about 800 m and 1100 m, with a thickness of about 250 m around the injection site (1) . The cap rock consists of three seals covering the saline formation that acts as a well for the CO_2 storage. The directly overlying primary seal is an extensive, thick shale layer and the secondary and tertiary seals are thinner shale layers. Gas transport testing on core material (2) indicates that the Sleipner cap rock has acceptable sealing capacity, capable of holding a super-critical CO_2 column of least 100 m and perhaps up to 400 m, depending on the density of the CO_2 (which is very sensitive to pressure and temperature at the reservoir top).The storage volume will be sufficient to store 20 $MtCO_2$ during its 20 year project lifetime.

Source:	Sleipner West Gas Field (~9% CO_2 from field is re-injected)
Transport:	Direct injection into the Utsira Formation
Storage Media:	Brine-saturated unconsolidated sandstone
Depth:	800-1100m
Area:	26,100 km^2
Porosity:	30-40%
Permeability:	1-3 Darcy
Sand/Shale Ratio:	0.7-1.0
Project Lifetime:	20 years, starting 1996
Capacity:	1 $MtCO_2$/year
Total project capacity:	20 $MtCO_2$

Source: various

Leakage Monitoring

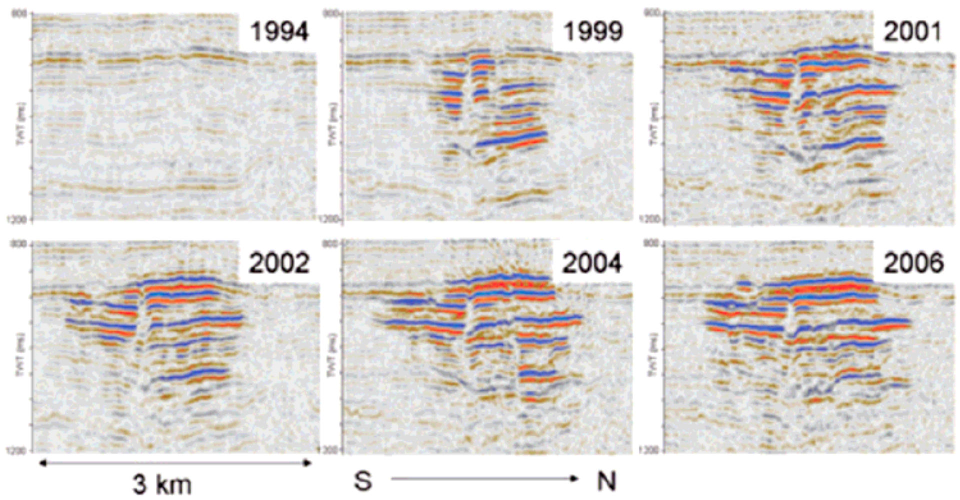
A reservoir flow simulation has been constructed from the geological model indicating how the stored CO_2 will react in the high-pressure sub-surface environment. This has been followed by an extensive monitoring program comprising extensive seismic monitoring of the CO_2 plume and seafloor gravity monitoring to ensure storage integrity and validation of the reservoir simulation results.

(1) R.Arts et al "Ten year's experience of monitoring CO2 injection in the Utsira Sand at Sleipner, offshore Norway" First Break Volume 26 (2008)

(2) Harrington, J.F., Noy, D.J., Horseman, S.T., Birchall, D.J., and Chadwick,
R.A. (2008] Laboratory study of gas and water flow in the Nordland Shale, Sleipner, North Sea. In: Grobe, M., Pashin, J., and Dodge, R. (Eds.) Carbon Dioxide Sequestration in Geological Media. AAPG Special Publication, in press.

Baseline 3D seismic data were acquired in 1994 with repeat surveys undertaken in 1999, 2001, 2002, 2004, and 2006 with, respectively, 2.30, 4.20, 4.97, 6.84, and 8.4 million tonnes (Mt) of CO_2 in the reservoir [(1)]. Predicted changes in seismic response were based on acoustic rock properties estimated from well logs and assumed acoustic properties of CO_2 under reservoir pressure and temperature conditions (using a published equation of state, calibrated by laboratory data). The development of the CO_2 plume at the different trapping levels can be followed through time; CO_2 reached the top of the reservoir in 1999 with, as observed previously clear evidence of buoyancy-driven filling of a small topographical trap at the top of the reservoir, confirming the spreading of CO_2 beneath the cap rock [(2)] . There is no evidence so far of CO_2 migrating into the overburden. In general terms, the middle and upper parts of the plume have become more reflective with time and continue to spread laterally, controlling the overall extent of the plume.

Development of the CO_2 plume over the ten years imaged with seismic data



Source: Ten year's experience of monitoring CO_2 injection in the Utsira Sand at Sleipner, offshore Norway, 2008

(1) R.Arts et al "Ten year's experience of monitoring CO_2 injection in the Utsira Sand at Sleipner, offshore Norway" First Break Volume 26 (2008)

(2) Chadwick, R.A., Arts, R., and Eiken, O. (2005) 4D seismic quantification of a growing CO_2 plume at Sleipner, North Sea. In: Dore, A.G. and Vining, B. (Eds.) Petroleum Geology: North West Europe and Global Perspectives – Proceedings of the 6th Petroleum Geology Conference. Geological Society, London, 1385-1399; Chadwick, R.A., Arts, R., Eiken, O., Williamson, P., and Williams, G. (2006) Geophysical monitoring of the CO_2 plume at Sleipner, North Sea: an outline review. In: Lombardi, S., Altunia, L.K., and Beaubien, S.E. (Eds.) Advances in the Geological Storage of Carbon Dioxide. Springer, Dordrecht, NATO Science, IV Earth and Environmental Sciences Vol. 65, 303-314.; Chadwick, R.A., Noy, D., Lindeberg, E., Arts, R., Eiken, O., and Williams, G. (2006) Calibrating reservoir performance with time-lapse seismic monitoring and flow simulations of the Sleipner CO_2 plume. 8th International conference on Greenhouse Gas Control Technologies (GHGT-8), Trondheim, Norway.

Time-lapse seafloor gravity monitoring has also been undertaken at Sleipner. The possibility of detecting injected CO_2 with repeated gravity measurements is strongly dependent on its density and subsurface distribution. Since an initial feasibility study indicated measurable changes [(1)], a first seabed gravity survey was acquired at Sleipner in 2002, with 5.19 Mt of CO_2 in the plume. The survey was based around pre-positioned concrete benchmarks on the seafloor that served as reference locations for the (repeated) gravity measurements. Relative gravity and water pressure measurements were taken at each benchmark using a customized gravimetry and pressure measurement module mounted on a remotely operated vehicle. Thirty benchmarked survey stations were deployed in two perpendicular lines, spanning an area some 7 km east-west and 3 km north-south and overlapping the subsurface footprint of the CO_2 plume. Each survey station was visited at least three times to better constrain instrument drift and other errors [(2)]. In September 2005 the repeat gravity survey was carried out with around 7.76 Mt of CO_2 in the plume. Further repeat surveys in a few years' time will have a much higher gravity change to measure, with correspondingly greater confidence in the density estimates [(3)] .

The monitoring undertaken indicates that CO_2 storage at Sleipner has been very successful over the last decade with no indications of migration into the reservoir overburden. The combination of seismic monitoring with seabed gravimetry has helped to constrain the reservoir simulation model and to gain insight into the flow behaviour of the CO_2 in the reservoir.

The In Salah Project

The In Salah Gas Project, a joint venture between Sonatrach, BP and Statoil located in the central Saharan region of Algeria, is the world's first large-scale CO_2 storage project in a deep saline formation, which is down-dip from a reservoir containing natural gas. The natural gas taken from several fields in the the In Salah development is relatively high in CO_2 (2-9%) which must be reduced to levels required for pipeline transport to the European market (around 0.3%). Rather than venting, the separated CO_2 is compressed, dehydrated, transported by pipeline to three injection wells and pumped back to the producing horizon of the Krechba field.

(1) Williamson, J.P., Chadwick, R.A., Rowley, W.J., and Eiken, O. (2001) Gravity monitoring of the CO_2 bubble at Sleipner. British Geological Survey, Commissioned Report CR/01/063.
(2) R.Arts et al "Ten year's experience of monitoring CO2 injection in the Utsira Sand at Sleipner, offshore Norway" First Break Volume 26 (2008)
(3) ibid

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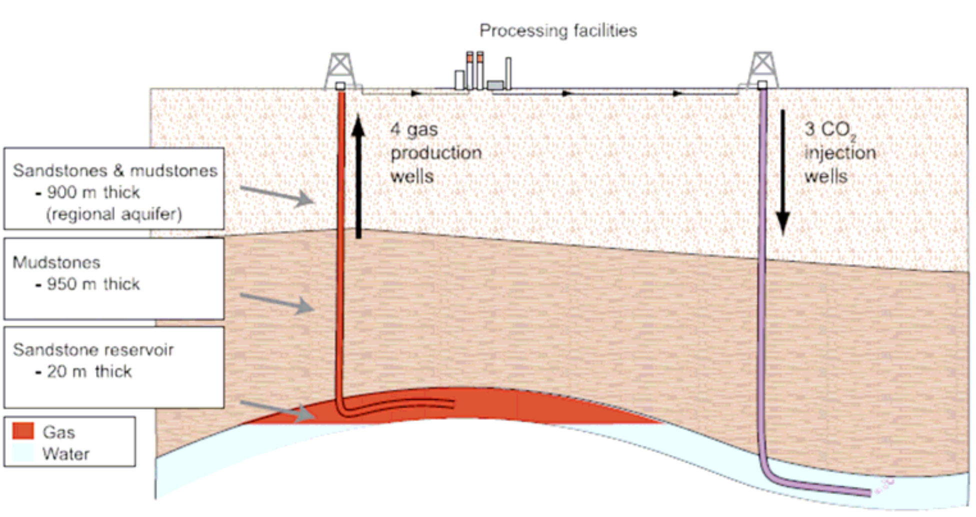
Simplified diagram of the Krechba field of the In Salah Project



Source: SRCCS

Site Information

The seal for the storage comprises a 950m thick layer of mudstone that has sealed CO_2 for at least 20 million years. Over the next 25 years, the CO_2 is estimated to migrate within the injection formation towards the production wells. By the time it has reached that far, the natural gas will already be depleted and the wells sealed.

Source:	The In Salah Development: Krechba, Teg and Reg fields
Transport:	Pipeline.
Storage Media:	Carboniferous sandstone saline formation
Depth:	1900m
Area:	200km^2
Porosity:	13-20%
Permeability:	10 mD
Project Lifetime:	25 years, starting 2004
Capacity:	1.2 MtCO_2/year (maximum rate)
Total project capacity:	17 MtCO_2

Source: BP, Sonatrach

Leakage Monitoring

A preliminary risk assessment of CO_2 storage integrity has been carried out and baseline data acquired. Processes that could result in CO_2 migration from the injection interval have been quantified and a comprehensive monitoring programme is planned involving the following components:

- Sample analysis of water, gas and solids
- Satellite measurements (INSAR)
- Chemical tracers were injected with the CO2 and detected at the monitoring well
- Pressure surveys, surface and down-hole (static and interference)
- Electric logs (production, SP and tomography)
- Gravity baseline, soil-gas survey, micro-seismic and tilt-meters
- 4D Seismic
- Aquifer monitoring well with oriented cap-rock core and cuttings analysis
- Geo-mechanical monitoring

CO_2 and tracer (from KB502) have now been detected at a monitoring well. There is no indication of geological CO_2 leakage.

Weyburn CO_2 - EOR Project

The Weyburn CO_2- enhanced oil recovery project is located in the Williston Basin, a geological structure extending from south-central Canada into north-central USA. The project has two involved parties: EnCana Corporation, operating the Weyburn oilfield and the Dakota Gasification Company. The Dakota Gasification Company uses coal to create methane and the main by-product is CO_2. The CO_2 is then transported via pipeline to Weyburn in Canada for use in recovering oil from the field. When the field is completely depleted of oil it will be sealed to prevent release of CO_2.

Site Information

The area where the field is located is tectonically inactive. Geophysical studies show that the Weyburn field’s integrity has not been compromised in 50 million years. Thus the geological setting of the Weyburn oil pool is considered to be highly suitable for long term secure storage of CO_2. The seal for the storage is made from a primary layer of anhydrite.

Source:	Dakota Gasification Company coal gasification plant
Transport:	325 km pipeline from Dakota Gasification Company coal gasification plant to Weyburn oilfield
Storage Media:	Vuggy intershoal and shoal limestone
Depth:	1450m
Area:	180km^2
Porosity:	20%
Permeability:	-
Oil/Water Ratio:	0.3
Project Lifetime:	20-25years, starting 2000
Capacity:	1.1 - 3.8 MtCO_2/year
Total project capacity:	20 MtCO_2

Leakage Monitoring

Since CO_2 injection began in late 2000, the EOR project has performed largely as predicted. Monitoring is extensive, with high-resolution seismic surveys and surface monitoring to determine any potential leakage. Surface monitoring includes sampling and analysis of potable groundwater, as well as soil gas sampling and analysis (1). To date, there has been no indication of CO_2 leakage to the surface and near-surface environment (2).

(1) Moburg, R., D.B. Stewart and D. Stachniak, 2003: The IEA Weyburn CO_2 Monitoring and Storage Project. Proceedings of the 6th International Conference on Greenhouse Gas Control Technologies (GHGT-6), J. Gale and Y. Kaya (eds.), 1–4 October 2002, Kyoto, Japan, 219-224.

(2) White, D. (ed.), 2005: Theme 2: Prediction, Monitoring and Verification of CO2 Movements. In: IEA GHG Weyburn CO2 Monitoring and Storage Project Summary Report 2000-2004, M. Wilson and M. Monea (eds.), Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies (GHGT-7), Volume III, p73–148; and Strutt, M.H, S.E. Beaubien, J.C. Beabron, M. Brach, C. Cardellini, R. Granieri, D.G. Jones, S. Lombardi, L. Penner, F. Quattrocchi and N. Voltatorni, 2003: Soil gas as a monitoring tool of deep geological sequestration of carbon dioxide: preliminary results from the EnCana EOR project in Weyburn, Saskatchewan (Canada). Proceedings of the 6th International Conference on Greenhouse Gas Control Technologies (GHGT-6), J. Gale and Y. Kaya (eds.), 1–4 October 2002, Kyoto, Japan, Pergamon, Amsterdam, v.I., 391–396.