

## CO<sub>2</sub>ReMoVe Project

EU and Industry to Develop New Technologies for Monitoring Geologically Stored CO<sub>2</sub>

An extensive new research program into the long-term potential for CO<sub>2</sub> capture and storage (CCS) technology to help reduce global greenhouse gas emissions has been launched by a consortium of leading energy companies, research organizations and the European Union. Over the next five years, the CO<sub>2</sub>ReMoVe project will study the geological storage of CO<sub>2</sub> at oil and gas field operations in the North Sea Sleipner and Snohvit fields (Norway), the Sahara desert at In Salah (Algeria), and the German locality of Ketzin. These projects involve the industrial-scale storage of CO<sub>2</sub> in deep geological formations (rather than releasing it to the atmosphere).

CO<sub>2</sub>ReMoVe will trial a number of approaches to monitoring and verifying CCS activities at the four storage sites included in the program. These methodologies will include 3D seismic technology, electromagnetic testing, fluid sampling from within the fields, and soil testing. The

research program is also intended to lead to the development of scientifically-based best-practice guidelines for the identification of suitable storage sites and protocols & tools for monitoring the storage of CO<sub>2</sub> in these sites. The results will be shared to advance worldwide understanding of how CO<sub>2</sub> can be stored and monitored safely. The project is expected to conclude by mid 2011.

The European Commission Directorate General for Research is the lead sponsor and will provide €8m to the CO<sub>2</sub>ReMoVe project. The project will be carried out by researchers from a number of European academic institutions, with technical guidance provided by the consortium partners and coordination by the Netherlands Organization for Applied Scientific Research (TNO).

Leading European energy companies (BP, ConocoPhillips, ExxonMobil, Wintershall, Schlumberger, Statoil, Total and Vattenfall) will provide technical guidance and contribute a total of €7m to support CO<sub>2</sub>ReMoVe. Other participating organisations include DNV, the International Energy Agency and a number of academic research organisations. In total, 28 parties from 11 different countries will participate in the project. For more information please contact Ton Wildenberg (e-mail: ton.wildenberg@tno.nl, tel. +31 30 256 4636)

## CO<sub>2</sub>GeoNet ~ Offshore Buoy for Monitoring Subaquatic CO<sub>2</sub> Leakage

By Hans-Martin Schulz & the CO<sub>2</sub>GeoNet submarine CO<sub>2</sub> monitoring team\*

One research objective of the EU-funded project CO<sub>2</sub>GeoNet (Network of Excellence; [1]) is to develop, test and operate an offshore buoy for monitoring subaquatic CO<sub>2</sub>. This work gains basic experience, and will define technical gaps in order to facilitate further developments of continuous geochemical monitoring devices (e.g. within the EU-supported CO<sub>2</sub>ReMoVe project) as applied to open sea environments and lakes. Integration is a main goal of the network. The aim of collaboration in CO<sub>2</sub>GeoNet is to (I) integrate the individual partner's expertise, and to (II) establish the basic infrastructure within the team for forthcoming gas and water monitoring coupled to ecological impact investigation at natural CO<sub>2</sub> site.

Partners for the development, testing and operation of the offshore buoy are BGR, OGS and URS.

The Bundesanstalt für Geowissenschaften und Rohstoffe (BGR, Hannover, Germany) is the central scientific and technical institution to support the federal government and consults ministries, the EU, and the German industry in all geo-relevant matters, e.g. regarding gas monitoring with analytical expertise [2].

The Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS, Trieste, Italy) is a research institute financed by the Italian Ministry of University and Research. Its function is to carry out applied and basic research in geology, geophysics and oceanography, as well as to disseminate knowledge in these fields [3].



Sleipner A Platform by sunset. (Courtesy of Statoil)

The Fluid Geochemistry Group at the Università di Roma "La Sapienza" (URS, Rome, Italy) is a well established research entity which has been involved over the last 25 years in the study of gas generation, migration and accumulation, as well as aqueous geochemistry, in both natural and human-altered geological systems [4].

## Activities

The work of this JRA (Joint Research Activity) in the framework of CO2GeoNet started in July 2005. BGR, OGS and URS jointly elaborated a concept for the technical development and construction of a CO<sub>2</sub> monitoring buoy. The main challenge of this cooperation was to define the technical prerequisites for the installation of the monitoring devices and to integrate all the single devices with a limited power supply.

OGS has a long experience in designing, assembling, deploying and maintaining offshore monitoring systems. Three real-time meteo-oceanographic buoys are currently in operation in the Gulf of Trieste (northeastern Adriatic Sea). Two buoys are endowed with profiling probe and acoustic current profiler. Moreover, also two acoustic current profilers, monitoring the flux of the two main rivers in the area, and three Directional Waveriders are currently working in real-time, all managed by the OGS Oceanography Department in the frame of monitoring programs. Based on these experiences, OGS constructed a buoy as a platform for this monitoring JRA. The buoy is equipped with a power supply system, a sea-floor apparatus and an elastic mooring-link (Fig. 3), especially designed for the technical requirements of this project. Originally equipped with three solar panels, the new monitoring buoy has six solar panels. OGS deployed the buoy in its offshore position, and carried out the diving activities (fixing the buoy and the sampling funnel on the seafloor). As a final task, OGS will establish an online-presentation of data on the CO2GeoNet webpage which will be available to all CO2GeoNet partners.



Fig. 1 - The CO<sub>2</sub>GeoNet submarine CO<sub>2</sub> monitoring team (from left to right): Aldo Annunziatellis, Guido Crispi, Roberto Laterza, Jürgen Poggenburg, Hans-Martin Schulz & Dino Viezzoli. Eckart Faber (BGR) and Stefano Graziani (URS) are missing here.



Fig. 2 - The new monitoring buoy in the offshore test position.

A funnel-like sampling system is used to sample the gas escaping from vents on the sea floor. Gas bubbles migrate upwards within a pipe to the monitoring devices on the buoy. BGR developed a gas monitoring device for CO<sub>2</sub>, CH<sub>4</sub> and gas flow rates, including a 3-way plastic sphere valve for taking gas samples. Due to local methane fluxes analysed in the Gulf of Trieste by OGS and BGR in an earlier study, both a CO<sub>2</sub> and CH<sub>4</sub> sensor were installed. Furthermore, BGR designed the baseline technical

devices for data acquisition, storage and download. Original data are accessible to all partners for analysis.

URS developed a monitoring device for the analysis of dissolved CO<sub>2</sub> and CH<sub>4</sub>. The methane sensor for the analysis of dissolved CH<sub>4</sub> is mounted on the BGR system and placed at the sea-bottom. A CO<sub>2</sub> IR sensor is included in the monitoring device mounted on the OGS buoy, and specifically developed for this JRA. A semi-permeable tube, placed at the



Fig. 3 - The gas sampling funnel in a tripod frame

sea-bottom, is used to collect air with CO<sub>2</sub> in equilibrium with dissolved CO<sub>2</sub>. The air in the tube is conveyed to the IR sensor by using a micro-pump. Collected data are stored in the monitoring device and available for the BGR data-logger.

The first offshore operation of the monitoring buoy started in September 2006. Since then data about free and dissolved CO<sub>2</sub> and CH<sub>4</sub> gas concentrations and gas fluxes are delivered. This first operational testing of basic gas monitoring installations was conducted in the Gulf of Trieste as this is an appropriate marine test site due to the available infrastructure by OGS and due to its shallow water depth of less than 20 m.

## Outlook

After a test period and the recognition of technical gaps, several topics still have to be considered in forthcoming developments. These are e.g. (I) gas monitoring in a more offshore site with larger gas emissions from the seafloor, and (II) testing the system in harder environmental conditions (higher waves and stronger currents) etc.

Subaquatic gas leakage occurs in open-sea environments and inland lakes. The development of a gas monitoring unit also for lacustrine environments will help to gain

long-term data sets to establish natural baselines in aquatic realms.

The northern parts of the Netherlands, Germany, and Poland form a belt of lowlands. These regions were morphologically overprinted during the last glacial, and many lakes resulted from glacier melting. This region is underlain by numerous mature gas fields. These gas fields are preferred targets for forthcoming CO<sub>2</sub> injection projects. Thus, tools for monitoring subaquatic gas leakage also in inland lakes will be highly needed in such projects.

## Resources

- [1] [www.co2geonet.com](http://www.co2geonet.com)
- [2] [www.bgr.bund.de](http://www.bgr.bund.de)
- [3] [www.ogs.trieste.it](http://www.ogs.trieste.it)
- [4] <http://tetide.geo.uniroma1.it>

\*The CO<sub>2</sub>GeoNet submarine CO<sub>2</sub> monitoring team: Istituto Nazionale di Oceanografia e Geofisica Sperimentale, Trieste (Italy): Dino Viezzoli, Guido Crispi, Roberto Laterza; University of Rome (Italy): Aldo Annunziatellis, Stefano Graziani, Salvatore Lombardi; Bundesanstalt für Geowissenschaften, Hannover (Germany): Eckart Faber, Manfred Teschner, Jürgen Poggenburg.

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# CO<sub>2</sub>-EOR Monitoring Pilot

Pembina Cardium,  
Alberta, Canada

The monitoring of CO<sub>2</sub> injection at one of the four pilot CO<sub>2</sub>-enhanced oil recovery (EOR) pilot projects in Alberta, Canada, that have been initiated with support from both the provincial and federal governments, has been underway for over one year. Carbon dioxide trucked to the site from a nearby gas plant is injected at ~1760 m depth into the Pembina Cardium oil field, which is the largest conventional oil field in Canada. The monitoring site, which is owned and operated by Penn West Energy Trust, was selected in 2004 by a research team involving the Alberta Energy and Utilities Board (Alberta Geological Survey) the Alberta Research Council, the University of Alberta and the University of Calgary as the most suitable of the four pilot projects for a comprehensive CO<sub>2</sub> monitoring research program. Since project initiation in the winter of 2005, research providers from these organisations have collaborated on deploying state of the art monitoring tools and techniques, building on the recent learnings from other similar projects, including the IEA GHG Weyburn CO<sub>2</sub> Monitoring and Storage Project. The Pembina Cardium is complementary to the Weyburn field being a clastic reservoir. The monitoring research program is planned to last until at least 2008.

Under the auspices of Canada's Energy Innovation Network (EnergyINet) Carbon Management program, research is being undertaken in the following areas:

- Baseline Geology and Hydrogeology
- Assessment of the Potential for CO<sub>2</sub> Leakage
- Reservoir Surveillance
- Environmental Monitoring
- Geophysical Monitoring
- Geomechanical Characterization of the Reservoir and Seals

## Conferences & Meetings

**1**0th Annual Conference & Expo on Clean Air, Mercury, Global Warming & Renewable Energy. 21st - 24th January 2007, Westin La Paloma Resort & Spa, Tucson, Arizona. Contact: EUEC, P.O. Box 66076, Tucson, Arizona 85728, USA. Tel: +1 520 615 3535 Fax: +1 602 296 0199 info@euec.com www.euec.com/

**W**orld Sustainable Development Forum. Exploring the Natural Resource Dimensions. 22nd - 24th January 2007, New Delhi, India. Contact: The Summit Secretariat, TERI, Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi - 110 003, India. Tel: +91 11 2468 2100 Fax: +91 11 2468 2144 dsds@teri.res.in www.teriin.org/dsds

**F**uels & Emissions Conference. 23rd - 25th January 2007. BMW Pavilion, Cape Town, South Africa. www.sae.org/events/sfl/

**F**ourth USDA Greenhouse Gas Conference: Positioning Agriculture and Forestry to Meet the Challenges of Climate Change. 5th - 8th February 2007, Baltimore Marriott Camden Yards, Baltimore, Maryland. Contact: Keith Schlesinger, Director of Meetings and Conventions, Soil Science Society of America, American Society of Agronomy, 677 S. Segoe Rd., Madison, WI 53711, USA. Tel: +1 608 268 4962 Fax: +1 610 229 4658 kschlesinger@soils.org

**E**uropean Energy Efficiency Conference. 1st - 3rd March 2007, Wels, Austria. Contact: Christiane Egger, Conference Director, O.Oe. Energiesparverband, Landstrasse 45, A-4020 Linz, Austria. Fax: +43-732-772014383. office@esv.or.at www.esv.or.at

**W**orld Biofuels Markets Congress - Exhibition. 6th - 7th March 2007, Brussels Expo, Belgium. www.worldbiofuelsmarkets.com

**G**W18: Earth Summit for Global Warming Mitigation. 19th - 20th April 2007, Miami, USA. Contact: Global Warming International Center, PO Box 50303, Palo Alto, CA, USA, 94303-0303. Tel: +1 630 910 1551 Fax: +1 630 910 1561 http://gw18.globalwarming.net/

**C**oal's New Frontier. 24th - 25th April 2007, Adams Mark Hotel, St Louis. Contact: Georgina Lucey Tel: +44 1730 265095 georgina.lucey@mccloskeycoal.com www.mccloskeycoal.com

**2**6th Session of the Intergovernmental Panel on Climate Change (IPCC-26). 4th May 2007, Bangkok, Thailand. 9th session of Working Group III, 30th April - 3rd May 2007, Bangkok, Thailand. 10th session of Working Group I. 29th January - 1st February 2007, France 8th session of Working Group II. 2nd - 5th April 2007, Brussels, Belgium. Contact: Rudie Bourgeois, IPCC Secretariat. Tel: +41 22 730 8208 Fax: +41 22 7 30 8025/13 IPCC-Sec@wmo.int www.ipcc.ch/

**E**WEC 2007 European Wind Energy Conference and Exhibition. 7th - 10th May 2007, Milan, Italy. Contact: EWEC Organizer; Tel: +32 2546 1980 Fax: +32 2546 1944 info@ewea.org http://www2.ewea.org/06b\_events/events\_EWEC2007.htm

**1**5th European Biomass Conference and Exhibition. From Research to Market Deployment - Biomass for Energy, Industry and Climate Protection. 7th - 11th May 2007, ICC Berlin International Congress Center, Berlin, Germany. Contact: Tel: +39 055 5002174 Fax: +39 055 573425 biomass.conference@etaflorence.it www.conference-biomass.com

**R**isø International Energy Conference 2007. Energy solutions for sustainable development. 22nd - 24th May 2007, Risø National Laboratory, Denmark. Contact: Vivi Nymark Morsing, Risø National Laboratory, P.O. Box 49, 4000 Roskilde, Denmark. Tel: +45 4677 5151 Fax +45 4677 5199 vivi.nymark@risoe.dk www.risoe.dk/konferencer/Energyconf07/

**2**0th World Energy Congress: Energy Future in an Interdependent World. 11th - 15th November 2007, Rome, Italy. organisingsecretariat@rome2007.it www.rome2007.it

### Greenhouse Issues

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