UPDATES FROM CSLF RECOGNIZED PROJECTS

November 2013

Carbon Sequestration Leadership Forum

www.cslforum.org

Table of Contents

Return to Contents Page

Archer Daniels Midland Company's Illinois Industrial Carbon Capture and Storage Project "CO_2 Capture from Biofuels Production and Sequestration into the Mt. Simon Sandstone"Decatur, Illinois, U.S.A.

United States Department of Energy (DOE) and Archer Daniels Midland Company (ADM) made significant progress in the development and construction of the largest saline storage project in the U.S. This large-scale industrial project is under construction at the ADM's agricultural processing and biofuels complex in Decatur, Illinois. This project, cost shared with funds from the American Recovery and Reinvestment Act of 2009, will be demonstrated under the DOE's Industrial Carbon Capture and Storage (ICCS) program. The Office of Fossil Energy's National Energy Technology Laboratory (NETL) manages this project, which receives $141.4 million in Recovery Act funding and another $66.5 million in private sector cost-sharing. The project team members are ADM, DOE, Schlumberger Carbon Services, University of Illinois-Illinois State Geological Survey (ISGS), and Richland Community College (RCC).

This project, also referred to as the Illinois ICCS project, will demonstrate an integrated system for capturing CO_2 from ADM's ethanol plant and geologically storing it in the Mount Simon Sandstone, a saline reservoir that covers portions of the Midwest including central and southern Illinois. The CO_2 is produced as a co-product during the processing of corn to fuelgrade ethanol. The project scope includes the design, construction, and integrated operation of CO_2 capture, compression, dehydration, and injection facilities (one million tons of CO_2 per year). The project will develop and implement a monitoring, verification, and accounting program for the stored CO_2. The technology demonstrated and the lessons learned from this project will also aid the development of the regional carbon capture, utilization, and storage (CCUS) industry, i.e., enhanced oil recovery in the depleted oilfields in the Illinois Basin.

The Illinois ICCS project construction was initiated in May 2011. Detailed design, installation of the compression, dehydration, and transmission equipment, and installation of related piping, electrical, and instrumentation was completed in June 2013. Commissioning of this system was initiated in July 2013. The construction of an electrical substation, which will supply power to the compressors, is in progress. A 7240-ft deep CO_2 monitoring well and a 3555-ft deep geophysical well were drilled in November 2012. U.S. Environmental Protection Agency is reviewing ADM's application for an injection well permit. Upon receiving the permit, and drilling and completing the injection well, the project is scheduled begin CO_2 injection into Mt. Simon Sandstone in the summer of 2014.

The Illinois ICCS project is implementing a robust CO_2 monitoring plan to protect groundwater sources. The ongoing baseline monitoring efforts include near surface and deep subsurface activities. The near surface monitoring includes soil CO_2 flux measurements to monitor changes in CO_2 concentrations and shallow groundwater sampling for geochemical analysis. The deep subsurface monitoring includes geophysical (seismic) surveys and passive seismic surveys. Public education and outreach on CCUS is an integral part of this ICCS project. To promote knowledge sharing in CCUS, a 15,000 sq. ft. center containing classrooms, training and laboratory facilities, called the National Sequestration Education Center (NSEC), was established at RCC in September 2012. RCC is implementing a new associate degree program, first in the U.S., with an emphasis on CCUS. As part of this outreach effort, the project team is planning to organize an international workshop on CCUS education and training in July 2014 at NSEC.

Return to Contents Page

CSLF projects update – CarbonNet Project – Victoria, Australia

The Victorian Government of Australia, through its CarbonNet Project, is investigating the potential for a large-scale, multi-user carbon capture and storage (CCS) network in the state of Victoria's Gippsland region. The project is at feasibility and commercial definition stage, exploring options for a CCS hub that could integrate multiple carbon dioxide (CO2) capture projects, and transport the CO2 via a common-use pipeline to be injected into suitable offshore geological storage formations, deep below the sea bed. CarbonNet was established in 2009 and is funded by both the Australian and Victorian governments, and in 2012 was named one of the Australian Government's CCS Flagship projects.

Victoria's Gippsland region offers great potential for CCS. It is home to one of the world's largest brown coal deposits, which lies adjacent to the significant geological potential for carbon storage in the offshore Gippsland Basin. In 2009, the Australian Government's Carbon Storage Taskforce compared the geological storage potential of sites around Australia and found the Gippsland Basin to contain the highest technical ranking of all Australian sites, and the largest storage potential of any east coast basin.

A key focus of CarbonNet's feasibility studies over the past year has been the evaluation of prospective storage sites. The project benefits from data acquired and made public by the oil and gas industry that has been active in the region for decades, and detailed planning for further appraisal activities is underway. Potential storage sites were shortlisted and in 2012 experts from around the world gathered in Melbourne to undertake a peer review to assess CarbonNet's analysis of storage sites. CarbonNet has also engaged global quality control and risk management services provider Det Norske Veritas (DNV) to assess the project's storage site selection process with reference to its recommended practice.

Feasibility studies include the assessment of capture and transport options, and technical advisers have been engaged to prepare studies on capture and transport options, planning and environment, cost and scheduling, and verification review.

While the regulatory framework for a CCS project in Victoria is in place, CarbonNet has the potential to be the first commercial scale CCS project in the state. To minimise risks associated with this, CarbonNet is working with regulators to support their understanding of CCS and analyse the regulatory framework for potential issues, gaps or overlaps.

Development of a business model that is attractive to investors is a key element of CarbonNet's feasibility and commercial definition stage, and the project has engaged with industry to develop commercial options.

Finally, CarbonNet is committed to early engagement of stakeholders, and has been engaging with local communities and authorities, government and industry throughout its feasibility and commercial definition stage, providing information on the project and responding to stakeholder feedback.

For more information on CarbonNet, please visit www.dpi.vic.gov.au/carbonnet or email CarbonNet.Info@dsdbi.vic.gov.au.

Return to Contents Page

The CO_2 Capture Project (CCP)

The CCP, a partnership of major energy companies, was formed in 2000 to advance technologies and improve operational approaches to help CCS become a viable option for CO_2 mitigation. Currently in its third phase of activity (2009-2013) the program will culminate in at least two field demonstrations of capture technologies and a series of monitoring field trials which will provide a clearer understanding of how to better monitor CO_2 in the subsurface. The CCP has four work streams: Storage Monitoring and Verification; Capture; Policy & Incentives; and Communications:

Capture: The Capture team is working to developing a suite of viable next generation technologies from a technical and economic standpoint. The focus is on oil refinery, oil production and power generation scenarios. Recent highlights include:

Fluid Catalytic Cracking (FCC) Unit: The CCP completed its first capture field demonstration, confirming oxy-firing as a technically viable option for capturing CO_2 from one of the main emitting units of refinery operations, the FCC unit. The demonstration took place at a Petrobras research facility in Paraná state, Brazil.

Once-Through Steam Generators (OTSG): The CCP's second large-scale demonstration of capture technologies is due to take place in late 2013, at an oil sands production facility in Alberta, Canada. OTSG are used in the in-situ extraction of heavy oils and bitumen using steam assisted gravity drainage and are the main source of CO_2 emissions in this increasingly important source of hydrocarbons. The projects will assess the effectiveness of oxy-firing in capturing CO_2 emissions from this source.

Storage Monitoring and Verification (SMV): The SMV Team is working to address issues critical to making CO_2 storage a practical reality. The team is focused on the main themes; Assurance R&D, Field Trialing and Contingencies. Recent highlights include:

- Preliminary results from Capillary Entry Pressure and Relative Permeability studies
- Further results from PS InSAR satellite monitoring program at Decatur, Illinois, US
- Modular Borehole Monitoring technology successfully deployed at Citronelle Dome, Alabama, US
- Contingencies program underway to increase public and regulatory confidence around storage integrity by understanding current versus needed capabilities to manage unexpected migration of CO_2 or displaced brine from a storage site.

Policy & Incentives: The CCP Policy and Incentives Team commissions frequent reviews of the regulatory landscape - with a particular focus on the US, Europe, Canada, and Australia. Recent highlights include:

- CCS Regulatory Study: Challenges and key lessons learned from real-world development of projects
- Scoped out next major study, focusing on local community benefit options, to be delivered in 2013

Return to Contents Page

Communications: The Communications team is continuing to work closely with the technical teams to take the rich content from the on-going work of the teams and deliver it to audiences that are critical to the advancement of CCS. Recent highlights include:

- Launch of dedicated multi-format digital resource, the CCS Browser (www.ccsbrowser.com), to help the public learn more about CO_2 capture and storage.

For further information and updates visit www.co2captureproject.org

Return to Contents Page

Fort Nelson Carbon Capture and Storage Project

1. Project Location

Fort Nelson, British Columbia, Canada

2. Project Leads

Al Laundry (alaundry@spectraenergy.com)
Ed Steadman (esteadman@undeerc.org)

3. Project Objectives

The primary objective of the Fort Nelson carbon capture and storage (CCS) feasibility project is to verify and validate the concept of utilizing one of North America's large number of saline formations for large-scale CO_2 injection, proposed to be in the 1.3 to 2 Mt a year range, of anthropogenic CO_2 for permanent storage. Specific goals include the following:

- Cost-effective risk management; simulation; and monitoring, verification, and accounting (MVA) strategies for large-scale CO_2 storage in deep saline formations.
- Testing and refinement of reservoir modeling intended to predict and estimate CO_2 injectivity (the potential for placing CO_2 into the reservoir) and to confirm the practical CO_2 storage capacity for this site, the areal extent and mobility of the supercritical CO_2 plume in the reservoir, and improved methodologies to ensure that site characterization and MVA results better support risk management objectives and modeling efforts.
- Testing strategies to predict the effects of CO_2 plume on the integrity of vertical and horizontal sealing formations, including the testing and modeling of key geomechanical and geochemical parameters. This includes assessing the impact of injecting a cooler sour CO_2 stream into a hotter, in situ saline fluid.
- Test and model for reactions and fate of entrained H_2S in the injected supercritical CO_2 stream and impacts on reservoir and containment rocks.

4. Recent Milestones

- Pressure testing of various potential injection zones and sealing formations was conducted in the exploratory well.
- A second round of risk assessment was conducted.

5. Status

- Developing a comprehensive MVA plan for surface, shallow subsurface, and deep subsurface monitoring. The MVA plan is based on the results of past characterization, modeling, and risk assessment efforts. The MVA plan is being prepared according to guidelines presented in the CSA (Canadian Standards Association) Standard Z741-12, Geological Storage of Carbon Dioxide.

Return to Contents Page

Zama Acid Gas Enhanced Oil Recovery, CO_2 Sequestration, and Monitoring Project

1. Project Location

Zama City, Alberta, Canada

2. Project Lead

- Ed Steadman, Energy & Environmental Research Center, Grand Forks, North Dakota, USA
  - E-Mail: esteadman@undeerc.org
- James Sorensen, Energy & Environmental Research Center, Grand Forks, North Dakota, USA
  - E-Mail: jsorensen@undeerc.org
- Julie Gunderson, Apache Canada Ltd, Calgary, Alberta, Canada
  - E-Mail: julie.gunderson@apachecorp.com

3. Project Objectives

To validate the sequestration of CO_2-rich acid gas in a depleted oil reservoir.

4. Recent Milestones

- Improved static geologic models of additional pinnacles have been developed and detailed dynamic simulations of injection and production have been conducted.
- Modeling activities have resulted in improved estimates of OOIP, recoverable reserves, and CO_2 storage capacity for six pinnacles in the Zama oil field.

5. Status

- Over 100,000 tons of acid gas has been injected through January 2013.
- Approximately 65,000 incremental barrels of oil has been produced using this technique.
- Improved static geologic models of additional pinnacles have been developed and detailed dynamic simulations of injection and production have been conducted.
- A report presenting the results of the laboratory and modeling activities conducted since 2011 is being prepared. The report is anticipated to be finalized in early 2014.

Carbon Sequestration Leadership Forum
November 2013

Gorgon Project

Carbon Dioxide (CO_2) Injection Project Update

The Gorgon Project in Western Australia is more than two-thirds complete.

The Chevron-operated Gorgon Project is under construction off the northwest coast of Western Australia.

A subsea development of the Gorgon and Jansz-Io fields will deliver gas to a three-train, 15.6 million tonnes per annum liquefied natural gas (LNG) facility and a domestic gas plant on Barrow Island.

An integral component of the Project is the design, construction and operation of a Carbon Dioxide (CO_2) Injection Project which will inject and store reservoir CO_2 extracted as part of the gas processing operations into the Dupuy Formation, more than two kilometres beneath Barrow Island.

The Project plans to inject between 3.4 and 4.0 million tonnes of reservoir CO_2 each year. This will reduce greenhouse gas emission from the Gorgon Project by around 40 percent.

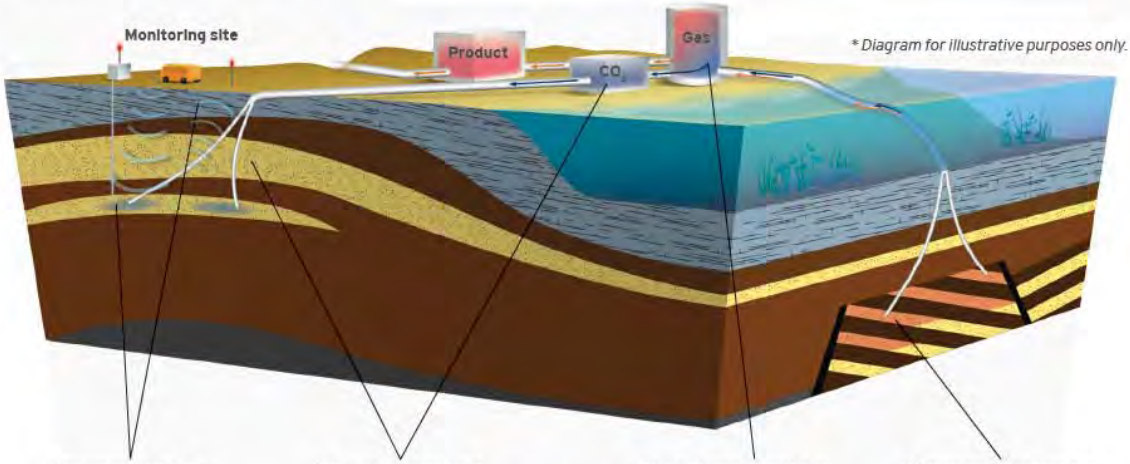
CO_2 Injection Project Progress

Construction continues on the facilities required for CO_2 injection. The design, construction and assurance testing of the six carbon dioxide compressor trains has been completed and incorporated into three compressor modules.

Drilling of the wells and installation of the CO_2 pipeline is expected to commence in late 2013.

Gorgon Project Timeline

- A final investment decision was made on the Gorgon Project in September 2009.
- The first LNG cargo is due to be loaded in the first quarter 2015. Domestic gas will be delivered to the market in 2015.
- Commissioning of the CO_2 Injection Project and commencement of injection operations is planned to take place following start-up of the second LNG train in late 2015.



** Diagram for illustrative purposes only.*

Movement of the CO_2 underground is monitored by repeated seismic surveys and surveillance wells.

CO_2 is compressed and transported by pipe ine to one of three drill centres where it is injected more than 2 kilometres into the Dupuy Formation beneath Barrow Island.

Naturally occurring CO_2 is separated from the inlet gas.

Natural gas is fed from the reservoir to the plant.

Operated by **Chevron Australia** in joint venture with

ExxonMobil

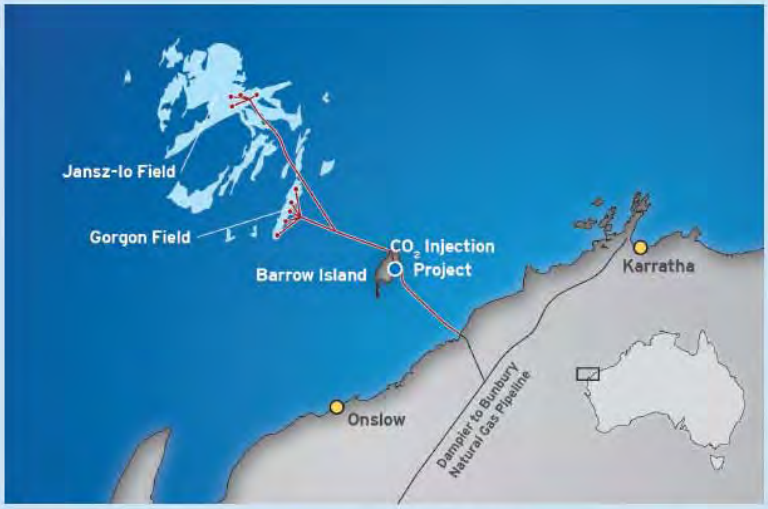
Osaka Gas | Tokyo Gas | Chubu Electric Power

Construction Progressing on CO_2 Injection Project

An aerial view of Drill Centre B, located several kilometers north of the LNG plant site. It is proposed that four of the nine injection wells will be drilled from this Drill Centre using directional drilling technology.

The three amine absorber towers and the first CO_2 removal process module in position on the LNG plant site. The three CO_2 compressor modules will be installed immediately to the right of each process module.

The *Ensign 963* drilling rig, which will be used to drill the CO_2 injection wells, already been mobilised to Barrow Island for unrelated work. It is expected to commence drilling the CO_2 Injection Project wells in late 2013.



The CO_2 Injection Project is an important component of the Gorgon Project.

In July 2013, Barrow Island welcomed the arrival of one of the largest modules for the LNG plant, a CO_2 removal process module measuring 81 metres long, 41 metres wide and weighing 5,500 tonnes.

While not specifically part of the CO_2 Injection Project facilities, the reservoir carbon dioxide will be separated from the raw natural gas in one of three CO_2 removal units. Each unit comprises a CO_2 removal process module, amine absorber tower , and ancillary pipework.

Australian Government
Department of Resources, Energy and Tourism

The Austra ian Government has committed $60 mil ion to the Gorgon Carbon Dioxide Injection Project as part of the Low Emissions Technology Demonstration Fund (LETDF).

For more information on the Gorgon Project:

Visit our website

www.chevronaustralia.com/ourbusiness/gorgon

Return to Contents Page

CO_2 Separation from Pressurized Gas Stream Project

CSLF Project Status Report

Sep. 2013

1. Project Location

Kyoto, Japan (membrane module development)
Pittsburgh, Pennsylvania, USA (testing)

2. Project Lead

Dr. Kenichi Ikeda, RITE (Research Institute of Innovative Technology for the Earth)
- E-mail: kenikeda@rite.or.jp

3. Project Objectives

- Development of membrane material with molecular gate function and composite membrane of excellent CO_2 selectivity over H_2
- Development of commercial size membrane module
- Testing of the module (with NETL, USA)

4. Recent Milestones

- Development of high performance membranes (2011FY-)
- High pressure test of membranes and membrane modules (2013FY)
- Process simulation of simple one stage process (2012FY-)

5. Status

- 1st duration: 11/2003 — 03/2006 Completed

Development of novel dendrimer materials for CO_2 separation
Fabrication of dendrimer composite membrane modules and their test

- 2nd duration: 04/2006 — 03/2011 Completed

Launch of bench and commercial membrane module production (Jan.2009)
Bench membrane module production (Oct.2009)
Real gas pre-testing of bench membrane module (Nov.2009)
Testing of pre-commercial size membrane module (Dec.2010)

- 3rd duration: 04/2011 — 03/2015 ongoing

Improvement of flat sheet membrane performance
Separation factor (>125) at 0.56MPa (CO_2 partial pressure)
Improvement of membrane module performance
Process simulation for one stage simulation
Development of technology for CO_2 caputure cost of 1,500JPY/t-CO_2

References:

Shuhong Duan, Ikuo Taniguchi, Teruhiko Kai, Shingo Kazama, “Poly(amidoamine) dendrimer/poly(vinyl alcohol) hybrid membranes for CO_2 caputure”, Journal of Membrane Science, Vol.423-424, pp107-112 (2012).

Return to Contents Page

CO2 Technology Centre Mongstad Announces Groundbreaking First Demonstration Year

World's largest CO2 test facility announces year one findings which prepare the ground for widespread CCS deployment to combat climate change

7th May 2013: One year on from its inauguration, CO2 Technology Centre Mongstad (TCM) has announced achievements that are crucial to de-risking Carbon Capture & Storage (CCS) investments.

The main function of TCM's first stage of operation has been to test solvents used to absorb CO2 from fossil fuel exhaust gases. Two technology demonstrations have been overlaid onto TCM's core utility infrastructure; which provides access to 100,000 tonnes per year of simulated coal, oil and gas-fired CO2 flue gases; from a gas-fired Combined Heat and Power plant (CHP) and a refinery cracker[1]. TCM is the only industrial-scale test centre for gas fired emissions globally, giving it a unique relevance in the context of the current global dash for gas.

Since test activity started in July 2012 the facility has been in operation for more than 5,000 hours. The TCM core utility infrastructure has operated with more than 98% availability. This has made it possible to supply the two absorption plants with exhaust gas and other utilities as requested by the two technology owners utilizing the large scale test units. TCM is currently testing Aker Solutions amine technology in the amine plant and Alstom Chilled Ammonia technology the ammonia plant. Once the plants were tested and accepted by TCM, each vendor is allowed an agreed period to test and improve their technologies. The tests in the amine plant have been performed according to the vendor's test plan, with two different solvents, including transient tests and reclaimer operation. Similarly, testing, optimization and modification of the ammonia plant is on-going in cooperation with Alstom.

As well as testing technologies, rigorous air sampling undertaken during plant operations has made a major contribution to CCS by gaining real life results from industrial testing related to the formation, degradation and dispersion of amine solvents. Based on the TCM programme,

[1] The composition of the cracker gas is similar to flue gas from coal fired power stations

three scientific reports[2] have been published, which for the first time have independently recommended the viability of safe amine carbon capture.

To enable technology verification, TCM's industrial-scale laboratory collects a vast amount of data from more than 4,000 measuring points connected to online instruments. The lab tests around 100 samples each day, providing vital information on the selection and use of amine and ammonia chemicals for absorbing and releasing CO2 with minimum energy use. Instruments and sampling systems have been successfully verified and optimized, which is an important achievement for technology development and verification of CCS technologies.

Another development is that, tests are soon to be performed with a solvent mix of the amine, monoethanolamine (MEA), and water. An absorption process using MEA is used as a base case when different CCS technologies are evaluated and tested. Tests will be performed with 30 wt.% MEA solution in water and with two feed sources (natural gas fired power plant exhaust and refinery cracker exhaust). The MEA based chemical absorption process is used as a baseline when comparing different carbon capture technologies. TCM's MEA test will provide a new and improved baseline from an industrial size "lab" facility. The baseline will be valid for a variety of CCS applications, both in the process industry and in power production.

Tore Amundsen, Chairman of TCM DA and CEO of Gassnova SF, said:
"At a time when so many full-scale projects are being delayed, the importance of R&D, testing and demonstration is even greater. TCM is unique in a global context. We are optimistic and believe that TCM will play an important role going forward. The Norwegian government involvement is essential for TCM's existence and future."

Frank Ellingsen, Managing Director, CO2 Technology Centre Mongstad, said:
"The last year has brought new levels of certainty to expected capital expenditure and ongoing costs of CCS by establishing the viability of capture processes. These advancements have

[2] Operational Experience and Initial Results from the First Test Period at CO2 Technology Centre Mongstad, November 2012, Energy Procedia
Establishment of Knowledge base for Emission Regulation for the CO2 Technology Centre Mongstad, November 2012, Energy Procedia
Health and environmental impact of amine based post combustion CO2 capture, November 2012, Energy Procedia

reduced the knowledge gap of CCS technological development. It's very exciting to see that off the back of these achievements, world-leading technologists are lining up to take advantage of the ongoing programme."

Henning Østvig, Senior Vice President in Aker Solutions, said:
"Our Advanced Carbon Capture Technology is being demonstrated every day at industrial scale with a high plant uptime and at a capture rate of the predefined 85-90%. Results from emission monitoring campaigns at TCM has shown excellent results, which was one of the most important issues to be demonstrated before scaling up the technology to full-scale carbon capture at Mongstad. We in Aker Solutions are very proud of this achievement and knowledge gained."

Eric Staurset, Country President ALSTOM Norway AS said:
"We are proud to be part of the world's most advanced test centre for development of CO2 capture technologies. Our experiences so far with our Chilled Ammonia Process at Mongstad have confirmed our view of the Chilled Ammonia technology as a viable and very competitive technology".

Howard Herzog, Senior Research Engineer at the Massachusetts Institute of Technology (MIT), said:
"CO2 Technology Centre Mongstad is a great asset to the worldwide CCS community. At a time when it is proving difficult to finance a large-scale CCS demonstration, due in part to the current economic concerns as well as uncertainty in climate policy, TCM provides a path forward for technological innovation."

From 2014, the next round of testing of other absorption solvents will begin at TCM's amine plant, which is capable of processing up to 80,000 tonnes of CO2 per year. Aker Solutions, Hitachi, Mitsubishi and Siemens have all registered their interest in this first invitation cycle. Negotiations are currently underway to finalize the next users. TCM is also offering available space designated for installing further technology test unit(s), either for the construction of a new generation solvent test facility, or for entirely new technologies. Companies can register

Return to Contents Page

their interest for utilization of this additional space with TCM until July 1st 2013. More information on the third site and registering interest can be found at http://www.tcmda.com.

Notes to editors:

About Technology Centre Mongstad

The IEA estimates that fossil fuels will account for 60% of energy generation by 2030, making CCS a vital technology for decarbonising the world's energy supply. The IEA, the EU and the IPCC indicate that a fifth of the carbon reduction target needed to curb a two degree rise in global temperatures by 2050 could come from CCS alone.

Technology Centre Mongstad (TCM) is the world's largest and most advanced facility for testing and improving CO2 capture. TCM is a joint venture set up by the Norwegian state (75.12 %), Statoil (20 %), Shell (2.44 %) and Sasol (2.44 %). It aims to increase knowledge on carbon capture technologies, in order to reduce technical and financial risk, and accelerate the development of qualified technologies capable of wide scale international deployment. Up to eighty per cent of the costs of CCS are related to CO2 capture, so TCM is encouraging the use of their facilities to refine the capture process and bring costs down.

The center comprises two CO2 capture plants each with a capacity to capture approximately 80,000 tons of CO2 from the nearby refinery or 20,000 tons from a gas fired power plant. In addition the center has available space and infrastructure to sustain the next generation technologies to be tested in the future

More information on the facility, can be found at http://www.tcmda.com .

Press contact

For further information, contact:
Ginnia Cheng
ginnia.cheng@edelman.com
+44 20 3047 2377

Return to Contents Page

August 23, 2013

Archer Daniels Midland Company's Illinois Industrial Carbon Capture and Storage Project Photos

CO_2 Capture from Biofuels Production and Sequestration into the Mt. Simon Sandstone, Decatur, Illinois, U.S.A.

the **ENERGY** lab

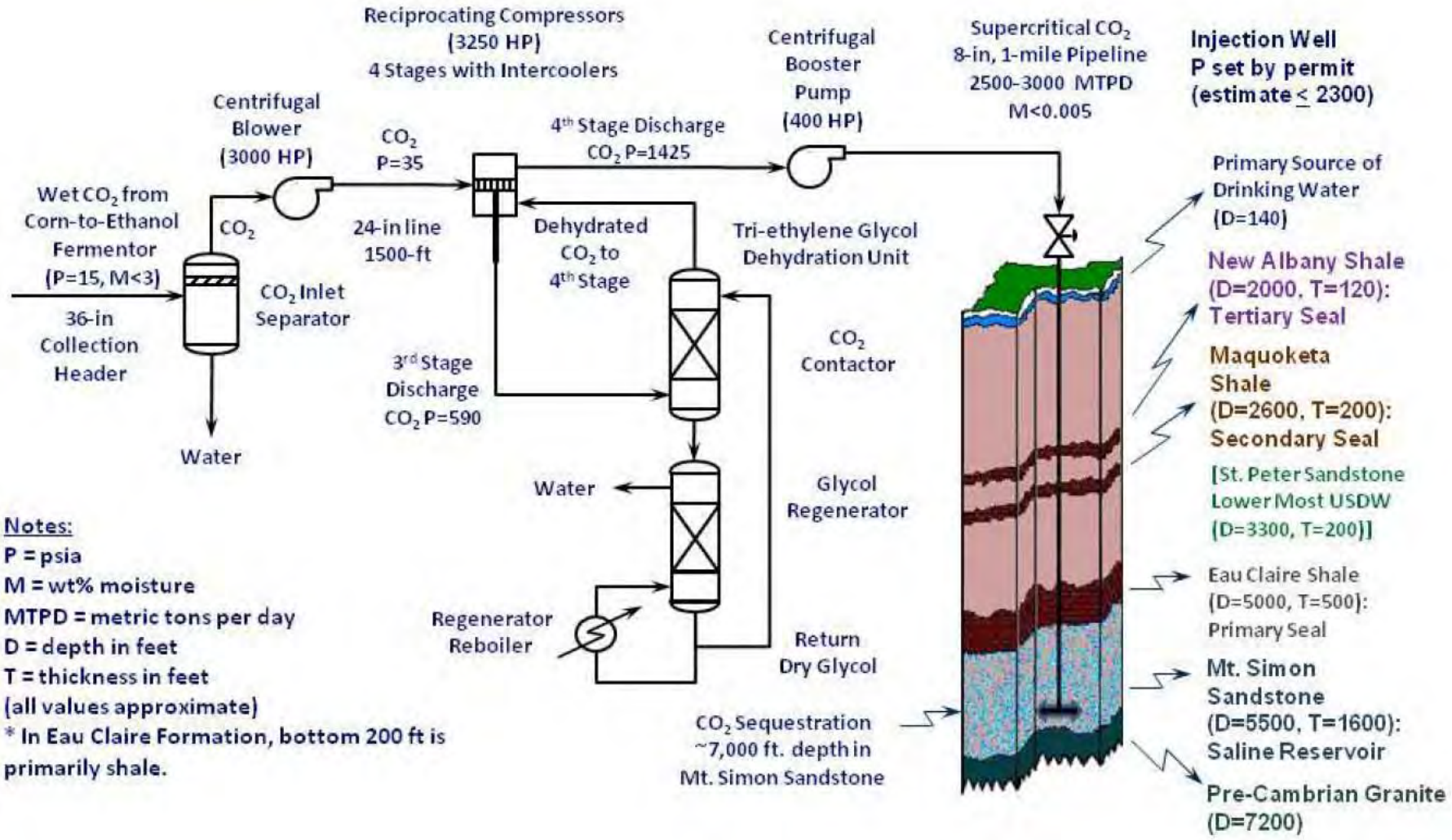
Sai Gollakota and Scott McDonald

For CSLF Projects Document - 5th Ministerial Conference, Washington, D.C., November 4-7, 2013

U.S. DEPARTMENT OF ENERGY

Return to Contents Page

Illinois ICCS – Simplified Flow Diagram



Notes:
P = psia
M = wt% moisture
MTPD = metric tons per day
D = depth in feet
T = thickness in feet
(all values approximate)
* In Eau Claire Formation, bottom 200 ft is primarily shale.

Return to Contents Page

3250-hp Reciprocating Compressor and Auxiliaries

(Courtesy of Archer Daniels Midland Company)

Return to Contents Page

Four Compressor Train

(Courtesy of Archer Daniels Midland Company)

Return to Contents Page

Inter-stage Piping in the Compressor Facility

(Courtesy of Archer Daniels Midland Company)

Return to Contents Page

3000-hp Blower System

(Courtesy of Archer Daniels Midland Company)

Return to Contents Page

Tri-ethylene Glycol Dehydration System (3000 TPD CO_2)

(Courtesy of Archer Daniels Midland Company)

Return to Contents Page

Commissioning-Energizing the Switchgear

(Courtesy of Archer Daniels Midland Company)

Return to Contents Page

Deep Monitoring Well Drilling

(Courtesy of Schlumberger Carbon Services)

Return to Contents Page

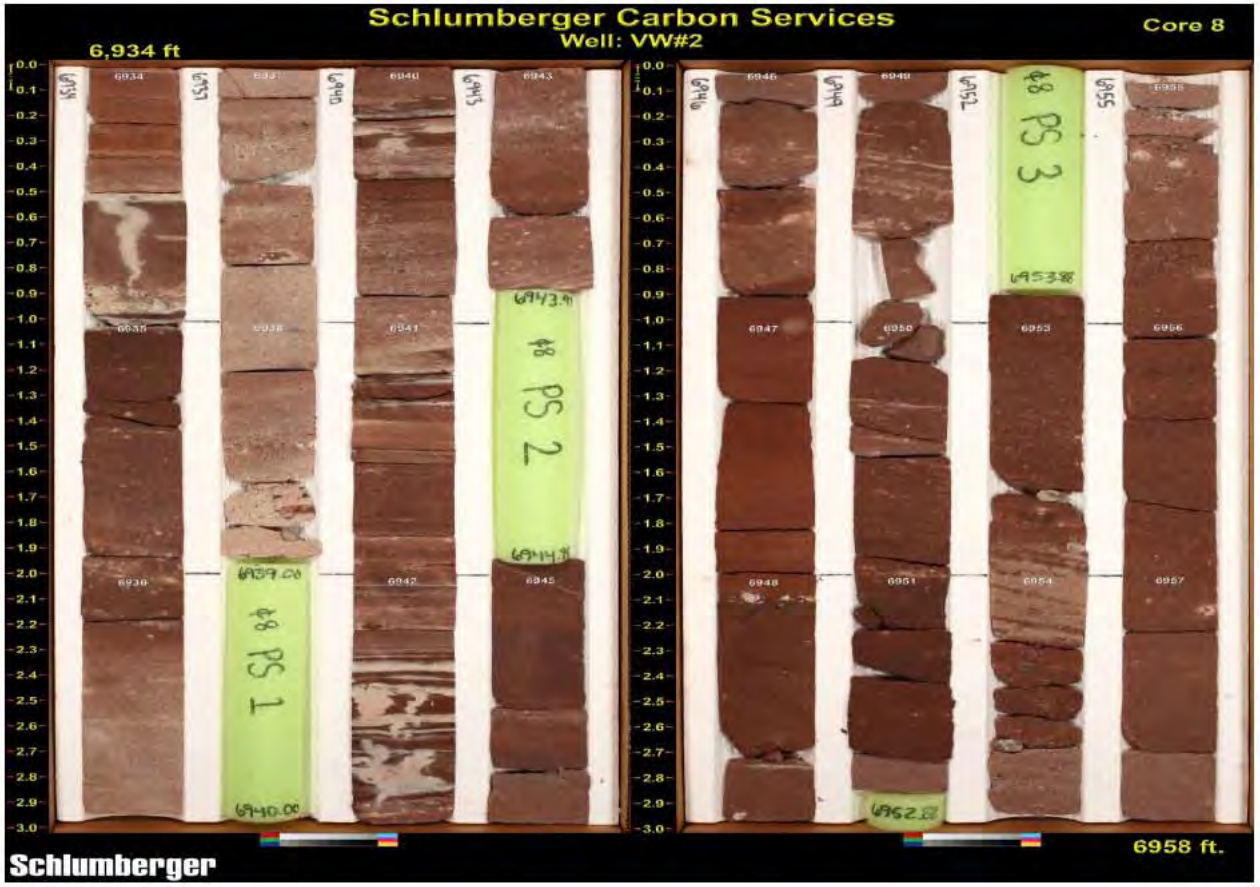
Verification Well

(Courtesy of Archer Daniels Midland Company)

Return to Contents Page

Photographs of Mt. Simon Core Obtained From Deep Monitoring well

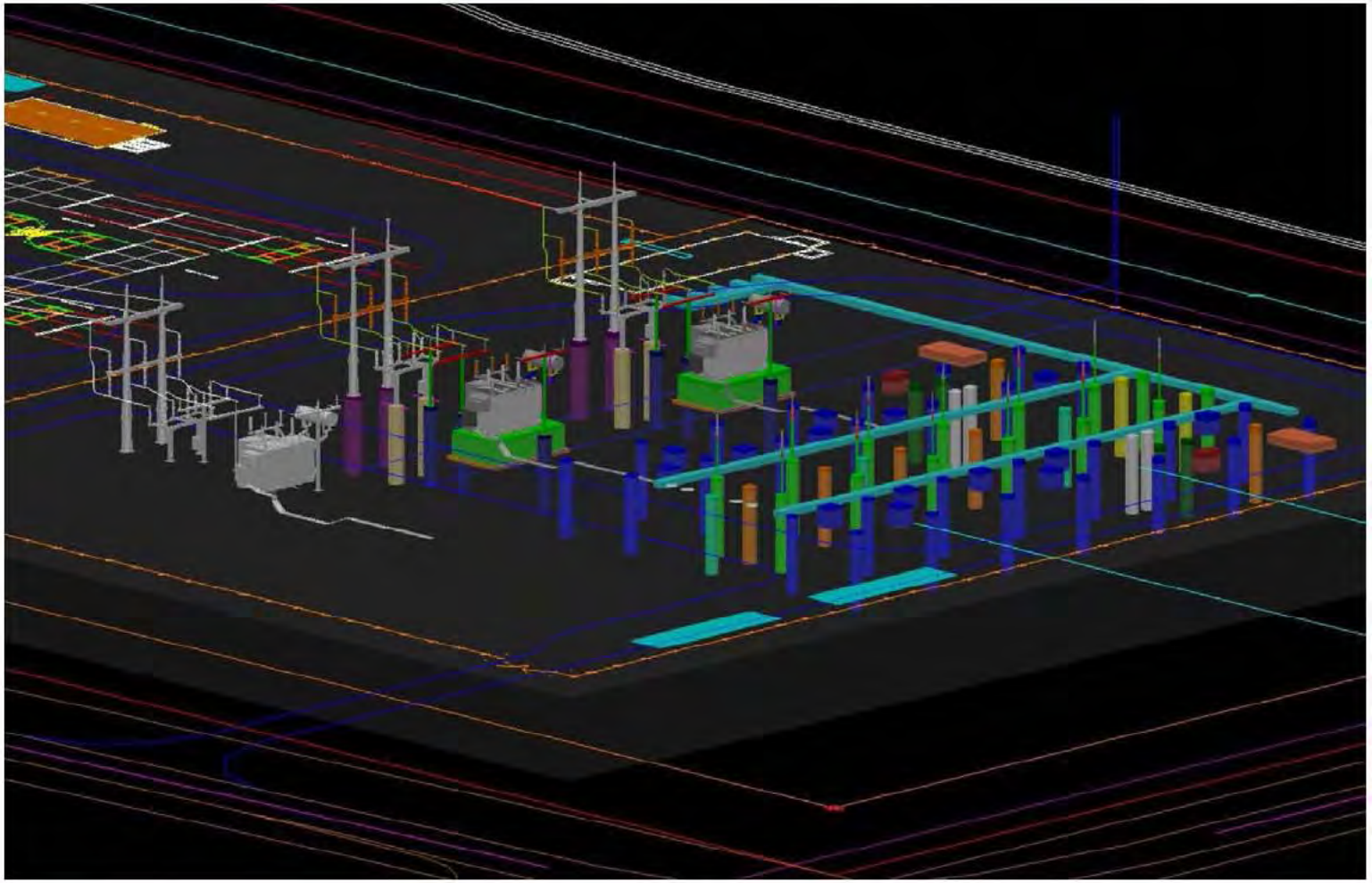
(Courtesy of Schlumberger Carbon Services)



Return to Contents Page

HANS 100 MW Substation – 3D Model

(Courtesy of Archer Daniels Midland Company)



Return to Contents Page

Transformers at the HANS Substation

(Courtesy of Archer Daniels Midland Company)

Return to Contents Page

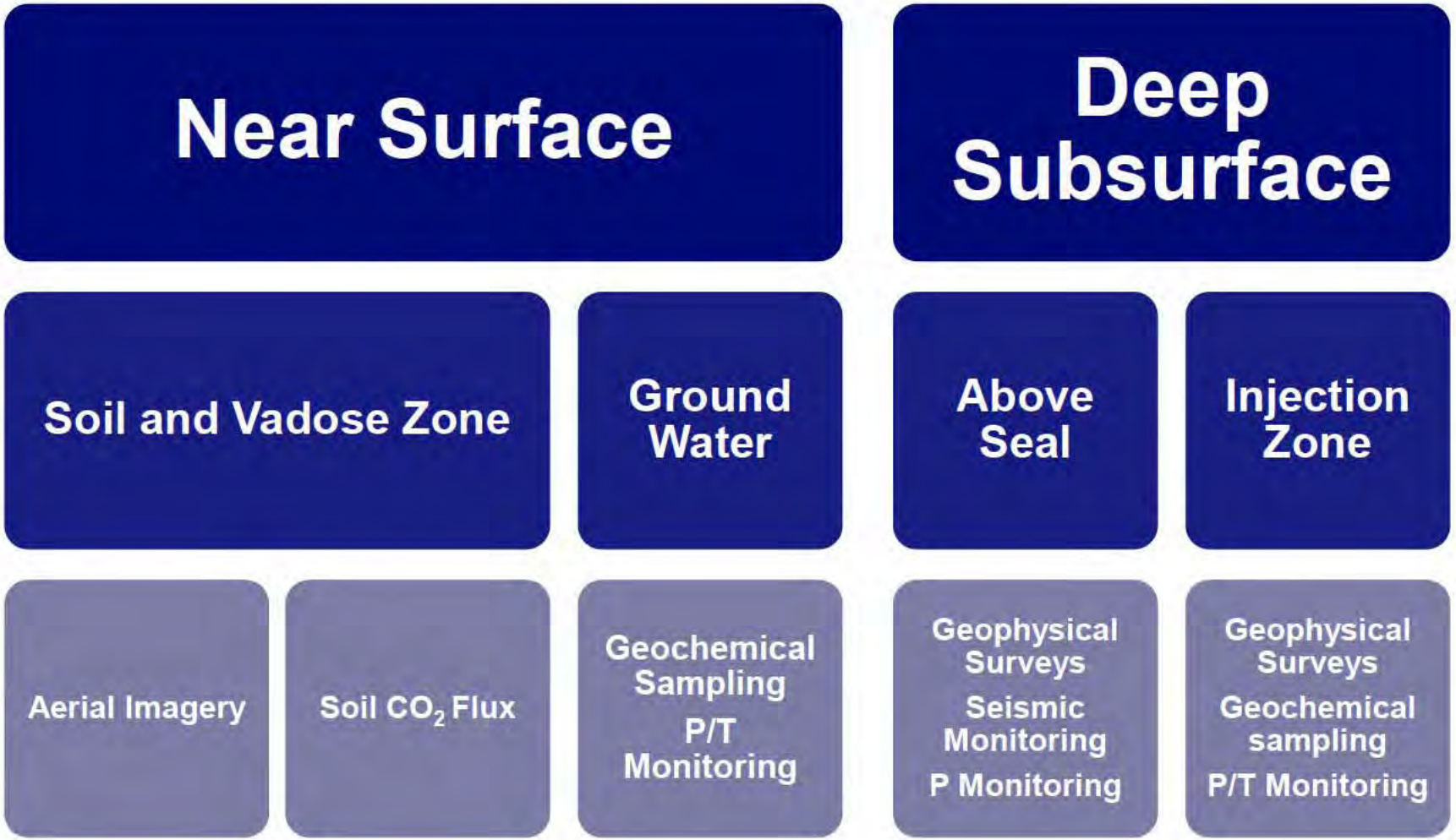
Circuit Switches for the North Substation Expansion

(Courtesy of Archer Daniels Midland Company)

Return to Contents Page

Environmental Monitoring: Planned Framework

(Courtesy of Illinois State Geological Survey)



Return to Contents Page

Soil Gas and CO_2 Flux Networks

(Courtesy of Illinois State Geological Survey)

Return to Contents Page

National Sequestration Education Center

(Courtesy of Richland Community College)

Return to Contents Page

Project Partners at the Opening of NSEC

(Courtesy of Richland Community College)

Return to Contents Page

Community Outreach-CO_2 Experiments for 2013 Summer Students

(Courtesy of Richland Community College)

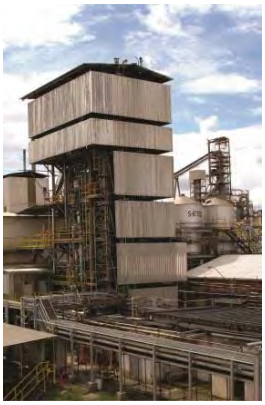
Return to Contents Page

CO_2 Capture Project (CCP) images

Please find x3 CCP project images below. Please can you use the captions/owner acknowledgements provided. If you need these images in a different format please contact Kate Adlington Kate.Adlington@pulsebrands.com / +44 (0)7824 359112.

1. Once-Through Steam Generators (OTSG). Fire bag oil sands facility, Alberta, Canada. Image courtesy of Suncor.

2. Petrobras research facility in Parana, Brazil. Image courtesy of Petrobras.



3. PS InSAR. Surface deformation results over the area of the injection well and the artificial reflectors from the SqueeSAR monitoring. Image courtesy of TRE.

Return to Contents Page

Fort Nelson- Advanced logging and pressure testing on exploratory well (2/12)

Return to Contents Page

Fort Nelson- Advanced logging and pressure testing on exploratory well (2/12)

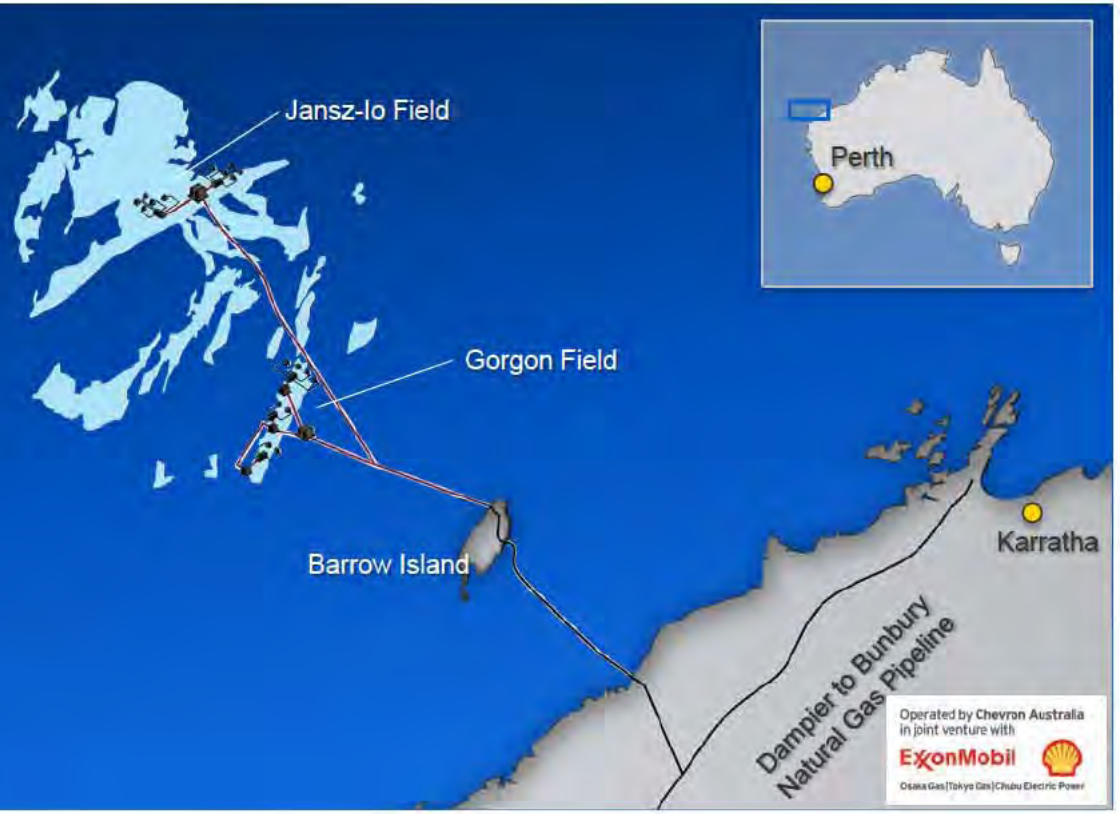
Return to Contents Page

Chevron-operated Gorgon Project

- AUD $52 billion investment
- 3 x 5.2 MTPA LNG trains
- A domestic gas plant with capacity of 300 terajoules per day
- Carbon Dioxide (CO_2) Injection Project

Joint Venture Participants

- Chevron (47.3%)
- ExxonMobil (25%)
- Shell (25%)
- Osaka Gas (1.25%)
- Tokyo Gas (1%)
- Chubu Electric Power (0.417%)



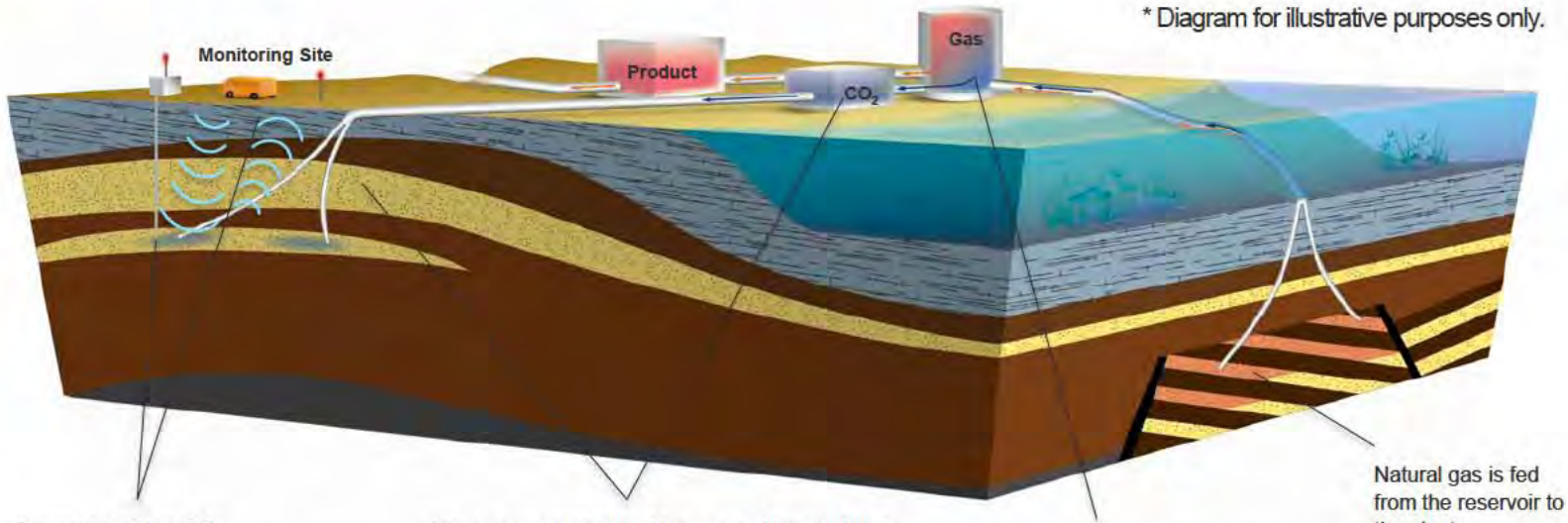
Return to Contents Page

Chevron-operated Gorgon Project

Liquefied Natural Gas (LNG) Plant Site

Return to Contents Page

Chevron-operated Gorgon Project
Carbon Dioxide Injection Project



* Diagram for illustrative purposes only.

Movement of the CO_2 underground is monitored by repeated seismic surveys and surveillance wells.

CO_2 is compressed and transported by pipeline to one of three drill centres where it is injected more than 2 kilometres into the Dupuy Formation beneath Barrow Island.

Naturally occurring CO_2 is separated from the inlet gas.

Natural gas is fed from the reservoir to the plant.

Australian Government
Department of Resources, Energy and Tourism

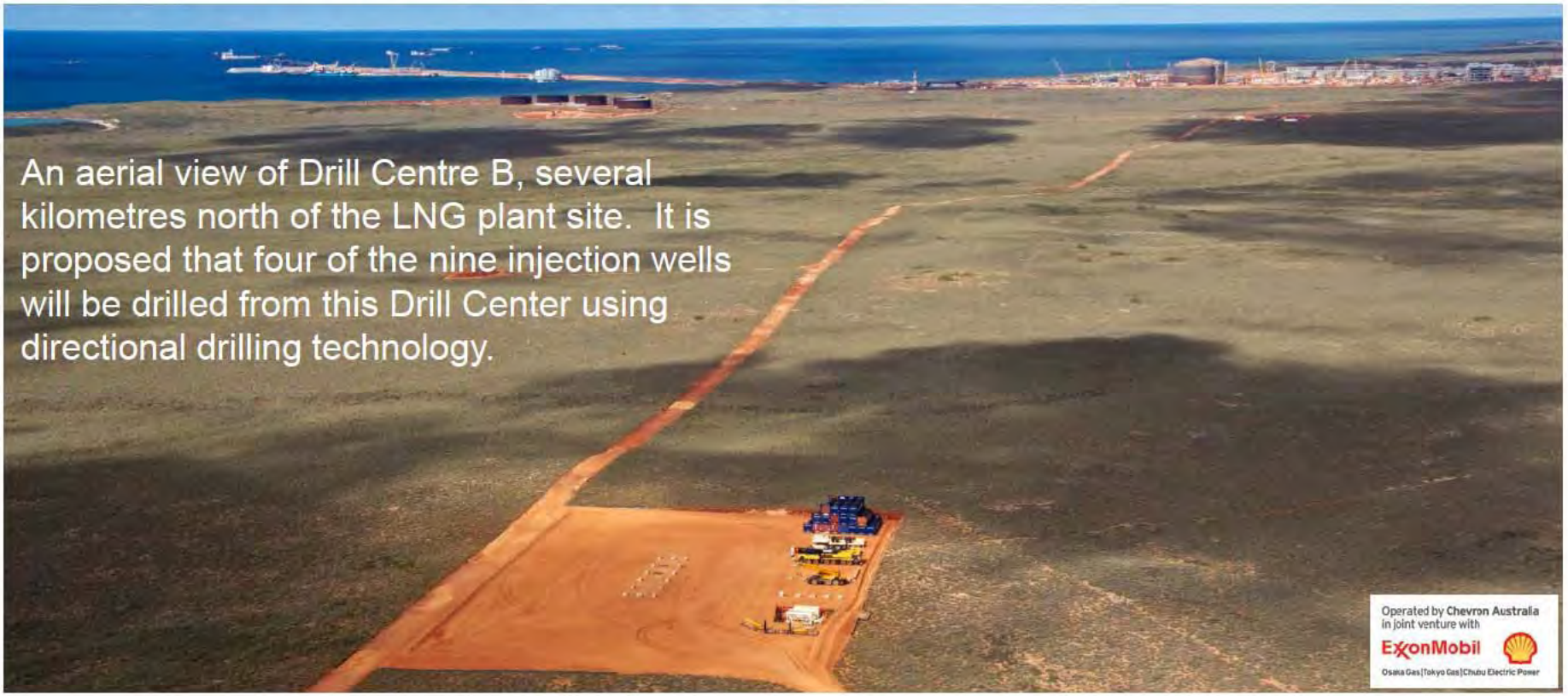
The Australian Government has committed $60 million to the Gorgon Carbon Dioxide Injection Project as part of the Low Emissions Technology Demonstration Fund (LETDF).

Operated by Chevron Australia in joint venture with ExxonMobil, Osaka Gas | Tokyo Gas | Chubu Electric Power

Return to Contents Page

Chevron-operated Gorgon Project

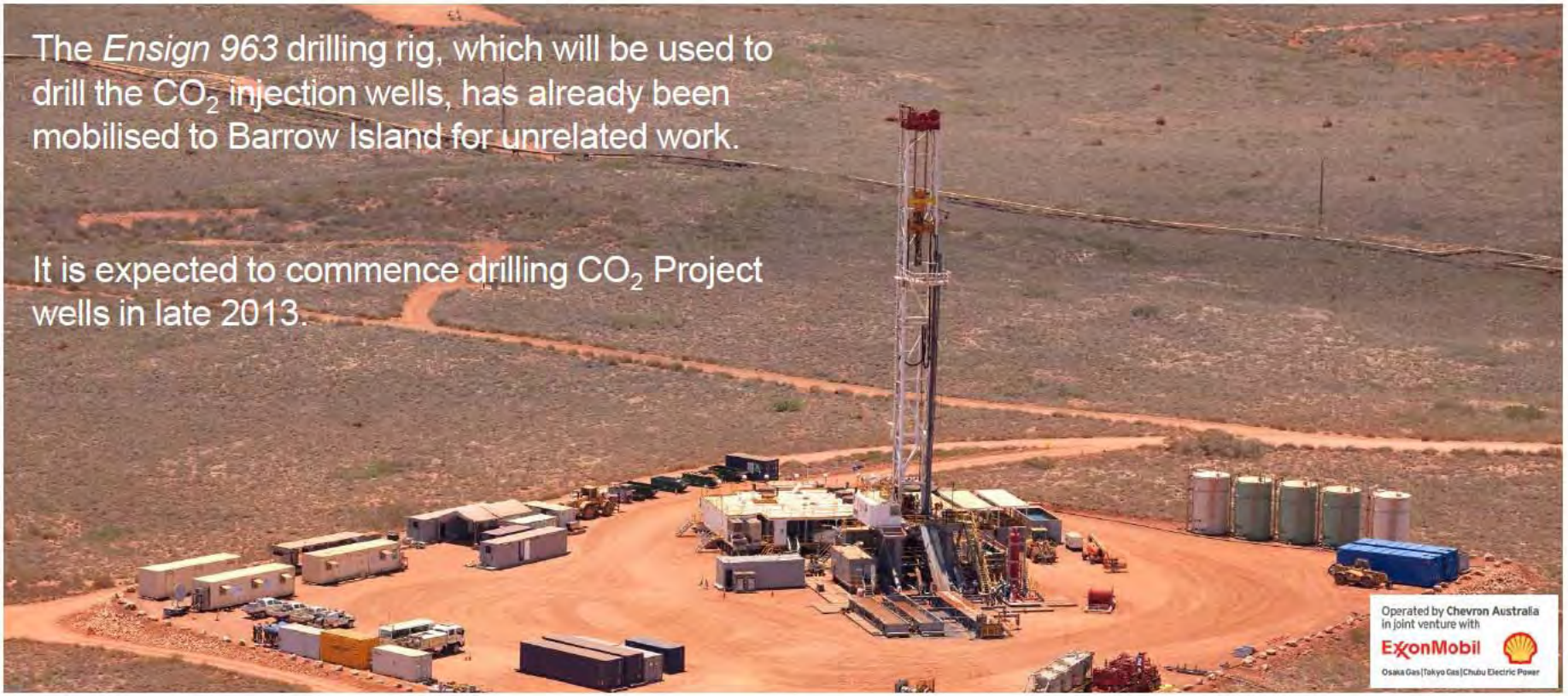
Carbon Dioxide Injection Drill Centre



Return to Contents Page

Chevron-operated Gorgon Project

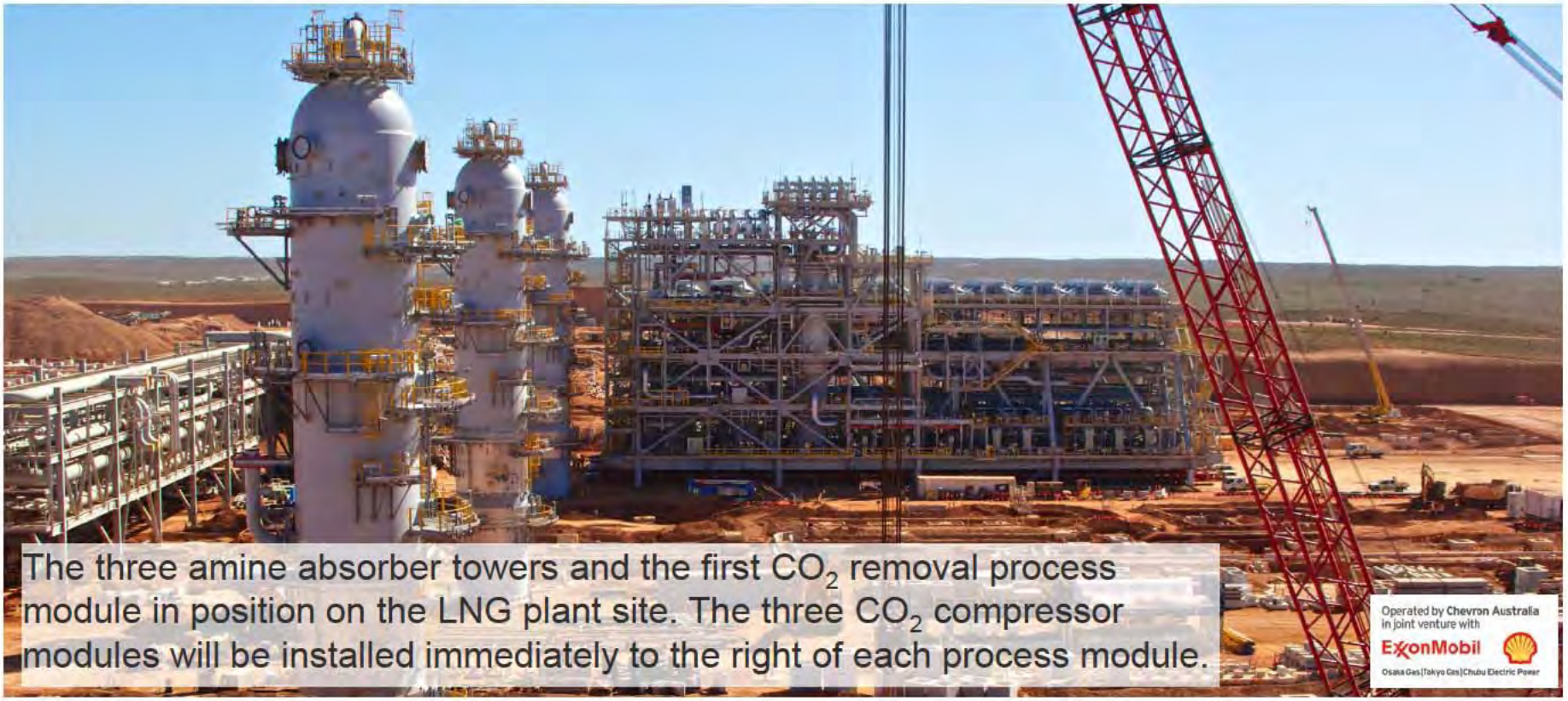
Ensign 963 Drilling Rig



Return to Contents Page

Chevron-operated Gorgon Project

Liquefied Natural Gas Plant Site



The three amine absorber towers and the first CO_2 removal process module in position on the LNG plant site. The three CO_2 compressor modules will be installed immediately to the right of each process module.

Return to Contents Page

Research Institute of Innovative Technology for the Earth

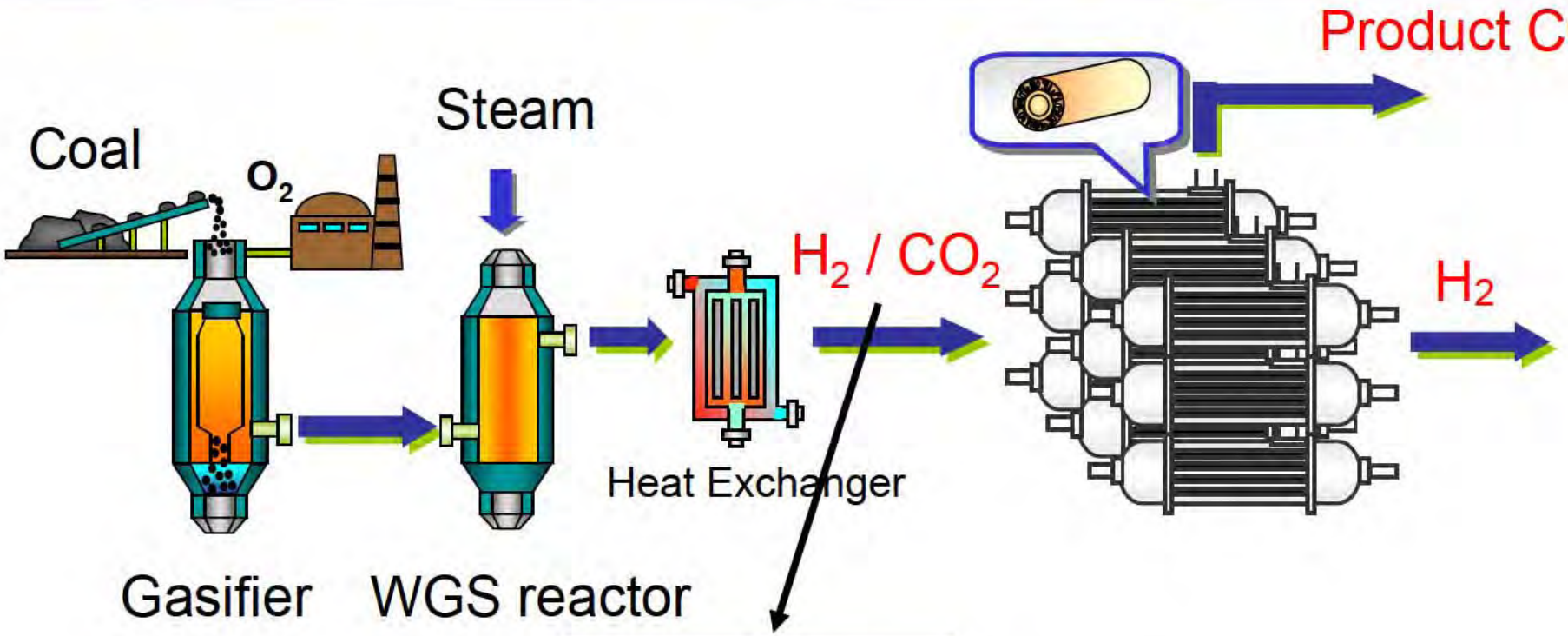
Research Activities on Carbon Capture in Chemical Research Group

Kenichi Ikeda, Ph.D.
Chem. Res. Gr., RITE

Sep. 1st, 2013

Return to Contents Page

High pressure CO_2 Capture for IGCC



2 to 4 MPa
ca. 40%CO_2

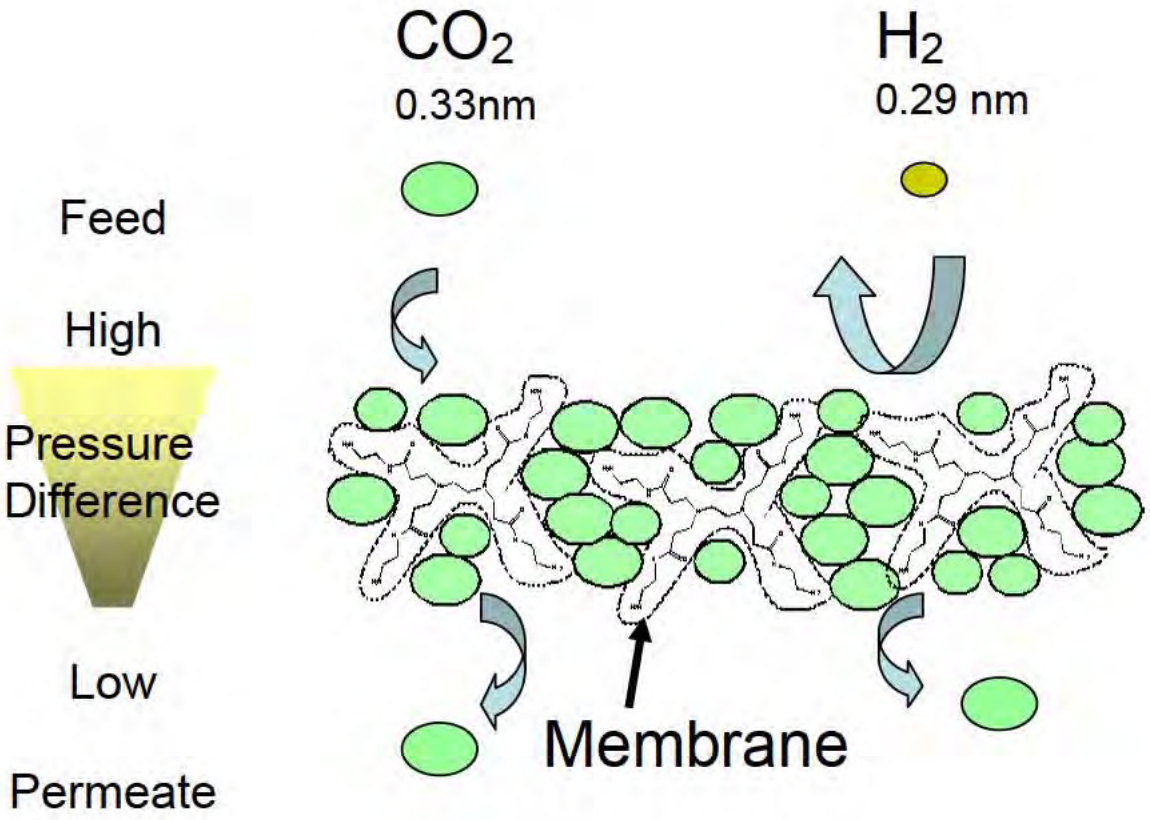
CO_2/H_2 Separation

Advantage in Membrane Separation

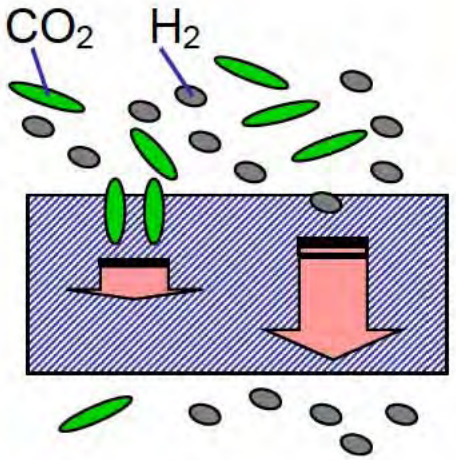
Insufficient Selectivity

Return to Contents Page

Concept of CO_2 Molecular Gate Membrane



Conventional Polymeric Membrane:



CO_2/H_2 Selectivity < 10

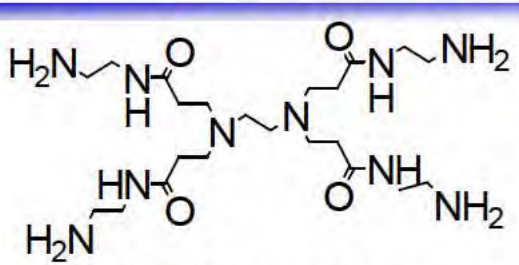
CSLF Project: CO_2 Separation from Pressurized Gas Stream

Project Coordinator: Japan / RITE

Project Partner: USA / DOE/NETL

Return to Contents Page

Dendrimer Membrane for CO_2 Capture from Pressurized Gas Stream

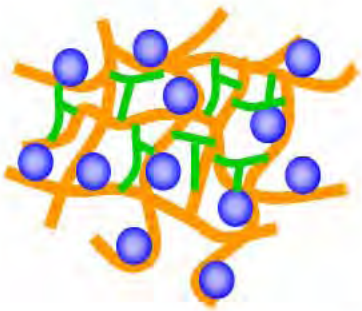


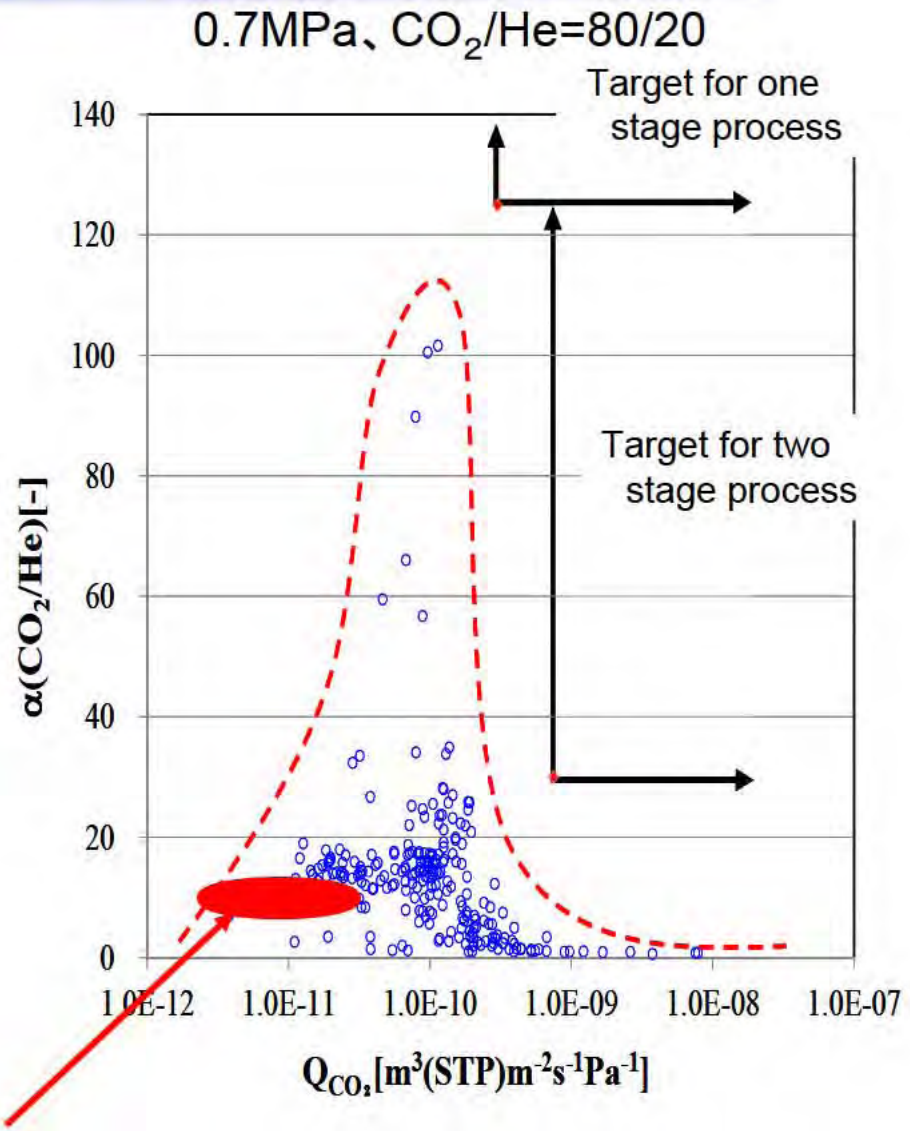
O-OH-PAMAM

+

PVA Additive

Curing

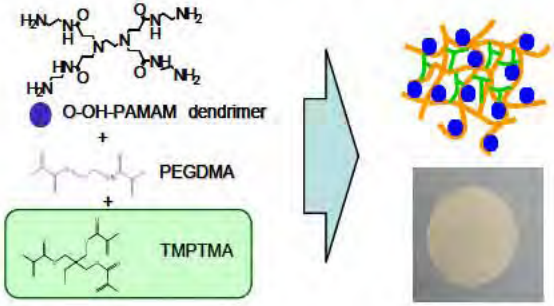




H. Lin B. Freeman *et al.*, *Science*, 311, 639-642

Return to Contents Page

Cooperation with private companies (Development of Membrane module)



- Materials
- Membrane preparation
- Structure

Mutual Cooperation

Membrane materials (acrylate/ PVA)

Development of Membranes
(Kyoto Lab. & Kurashiki Lab.)

RITE Kuraray

Mutual Cooperation

- Process adaptability
- Durability
- Separation mechanism

Effective R&D by mutual cooperation

Molecular Gate Membrane module Technology Research Association

Membrane cross-section and Proto-type module

Development of membrane modules
(Ibaraki Lab.)

Nitto Denko

Mutual Cooperation

- Membrane module
- Module structure
- Durability

Simulated WGS gas mixture separation test system

Development of separation system
(Futtsu Lab.)

Nippon Steel Engineering

Return to Contents Page

Dendrimer Membrane for CO_2 Capture from Pressurized Gas Stream

RITE
Research Institute of Innovative Technology for the Earth

In the IGCC-CCS process, CO_2 separation membranes will play an important role for reducing CO_2 capture costs.

Estimates indicate that the CO_2 capture costs from a pressurized gas stream using a membrane might be 1500 JPY/ton- CO_2 or less.

Based on these materials such as Dendrimer and PVA, modification of membrane thickness control etc. are ongoing to improve CO_2 separation performance further.

Return to Contents Page

CO2 Technology Centre Mongstad

Return to Contents Page

CO2 Technology Centre Mongstad

Return to Contents Page

Return to Contents Page

CGS Europe

Pan-European coordination action on CO_2 Geological Storage (Coordination and support action)

SEVENTH FRAMEWORK PROGRAMME

Project duration: 3 years (Nov. 2010 – Oct. 2013)

24 Partners (including the CO2GeoNet Association), representing 34 research institutes over 28 countries

Coordinator: BRGM – Isabelle Czernichowski-Lauriol

Return to Contents Page

Objective

- **To build a credible, independent and representative pan-European scientific body of expertise on CO_2 geological storage that will:**
  - instigate a durable networking of research capacity on CO_2 storage in Europe
  - liaise and coordinate its activities with other stakeholders, including the ZEP Technology Platform
  - help reduce the existing gap between the 'forerunner' countries, and the 'follower' countries
  - contribute to the large-scale demonstration and industrial deployment of CCS
  - support the implementation of the EU Directive on the geological storage of CO_2

Return to Contents Page

Building on the CO_2GeoNet adventure

Created as a FP6 Network of Excellence in 2004

Transformed into a non profit scientific Association under French law in 2008

Activities:

- Joint research
- Scientific advice
- Training
- Information and communication

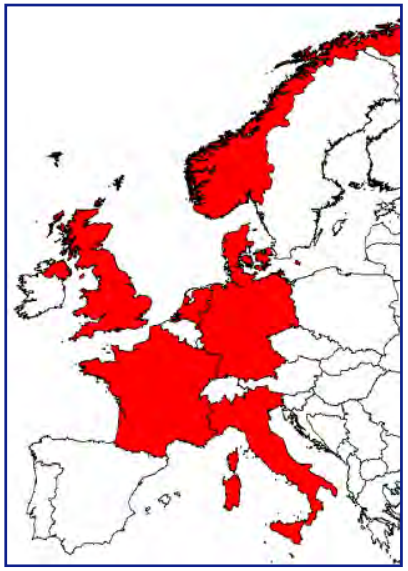
International recognition:

- CSLF-endorsed network
- Member of GCCSI
- MoU with IEA-GHG

Return to Contents Page

Expanding CO_2GeoNet to the whole Europe

From CO_2GeoNet…

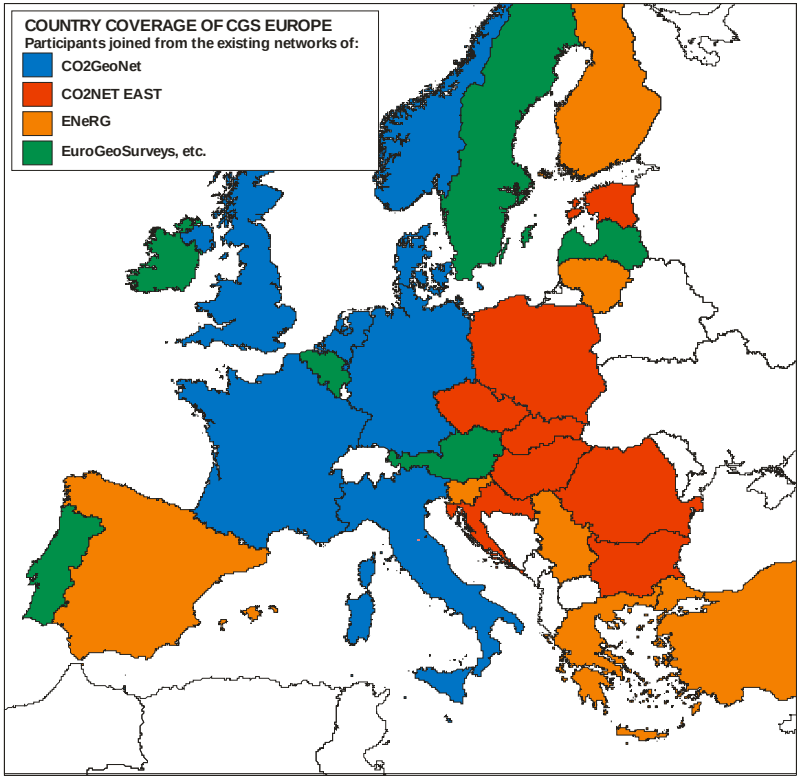


7 countries, 13 institutes
GEUS, BRGM, IFPEN, BGR, OGS, URS, TNO, NIVA, IRIS, SINTEF, BGS, Heriot-Watt, Imperial College

NOW

16 countries, 24 institutes

…to CGS Europe



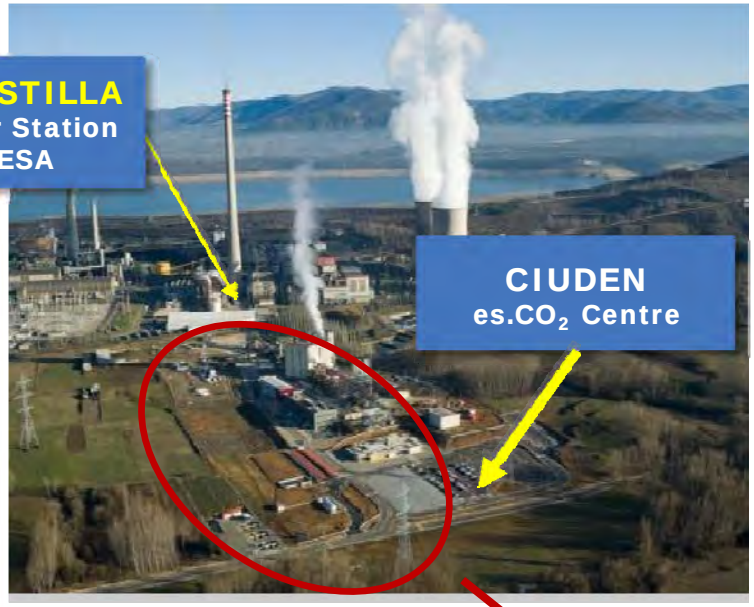
24 Members States and 4 Associated Countries (Croatia, Norway, Serbia, Turkey)
34 Research Institutes (including CO_2GeoNet members as 3rd parties)

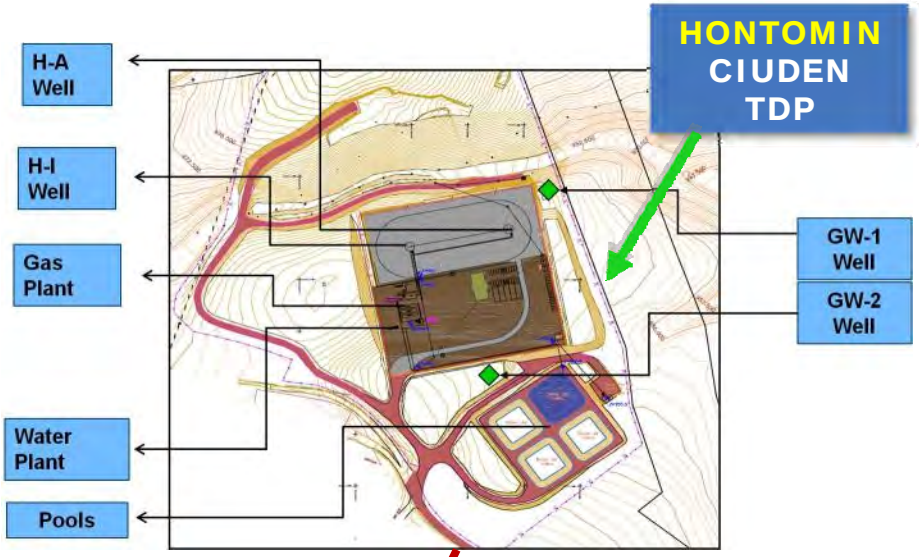
Return to Contents Page

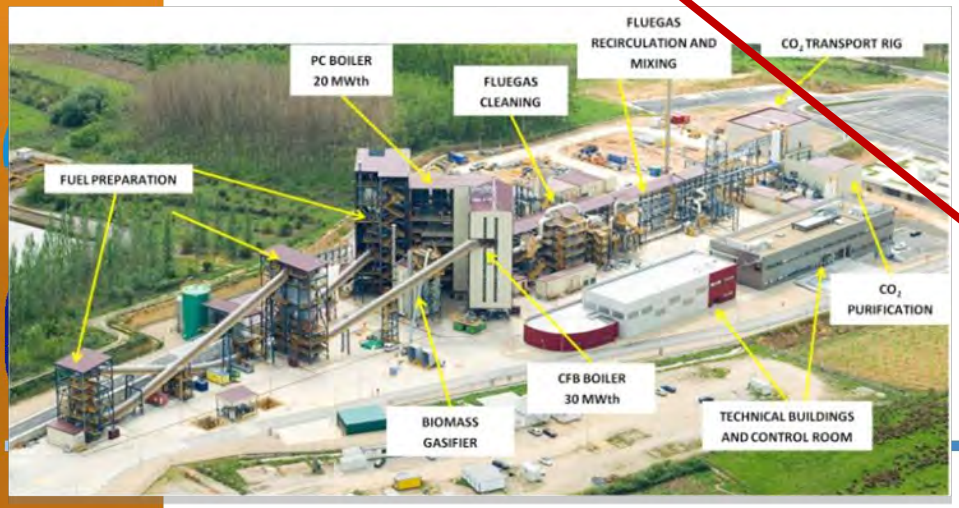
Some of the new members .....

CIUDEN - Fundación Ciudad de la Energía

IGME - Instituto Geológico y Minero de España



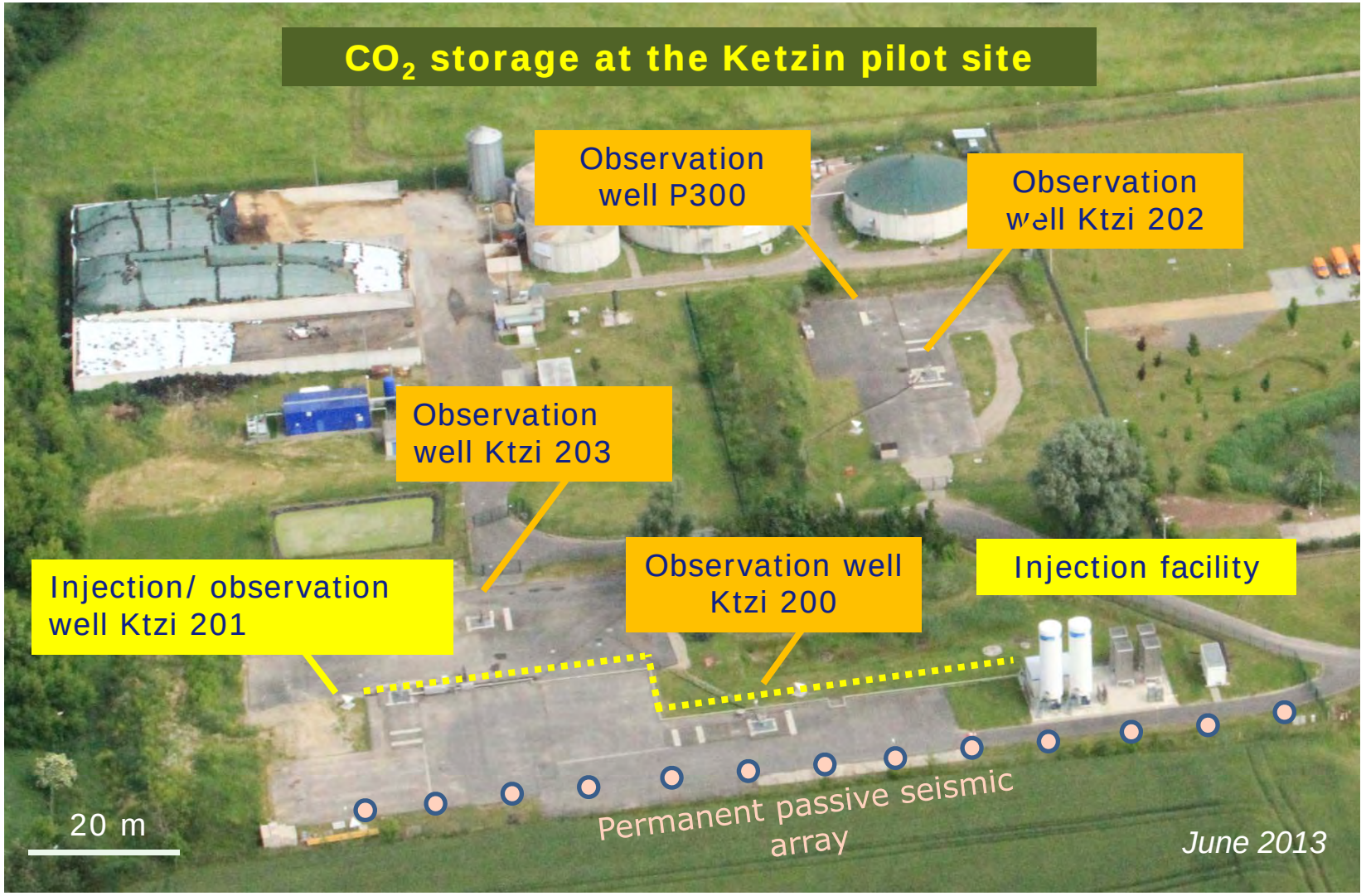




Return to Contents Page

Some of the new members .....

GFZ - German Research Centre for Geosciences



Return to Contents Page

CGS Europe Strategy

Focus on **Knowledge Management**

➔**Knowledge Development**: joint research through alignment of institutes' research programmes and external support, knowledge-sharing workshops, staff-exchange programme

➔**Knowledge Repository**: collect, structure, summarize knowledge for easy use

➔**Knowledge Dissemination**: Annual Open Forum, CO_2 storage awareness-raising workshops, CO_2 storage Spring School, Brochures, central website with links to national websites

Spread knowledge evenly throughout EU Member States and Associated Countries, in as many EU national languages as possible

Interact with the other CSLF projects

Return to Contents Page

Brochure "What does CO2 geological storage really mean ?" translated in **26 languages**

Arabic ماذا يعنى حقا التخزين الجيولوجي لـ CO2؟
Russian "*Что в самом деле означает геологическое хранение CO2?*"
Finnish "*Mitä hiilidioksidin (CO2) geologinen varastointi tarkoittaa?*"
Turkish "*CO2'nin yeraltı katmanlarında depolanması gerçekte ne anlama geliyor?*"
Bulgarian "*Какво означава в действителност геоложкото съхранение на CO2?*"
Croatian "*Što zapravo znači geološko skladištenje CO2?*"
Czech "*Co to vlastně je geologické ukládání CO2?*"
Danish "*Hvad betyder geologisk lagring af CO2 egentlig?*"
Dutch "*Wat betekent ondergrondse CO2-opslag nu eigenlijk?*"
English "*What does CO2 geological storage really mean?*"
Estonian "*Mida CO2 geoloogiline ladustamine tegelikult tähendab?*"
French "*Que signifie vraiment le stockage géologique du CO2 ?*"
German "*Geologische CO2 - Speicherung - was ist das eigentlich?*"
Hungarian "*Mit jelent valójában a CO2 geológiai tárolása?*"
Italian "*Che cosa significa veramente lo stoccaggio geologico della CO2?*"
Latvian *"Ko īstenībā nozīmē CO2 uzglabāšana zemes dzīlēs?"*
Lithuanian *"Ką reiškia geologinis CO2 saugojimas?"*
Norwegian *"Hva betyr geologisk lagring av CO2 egentlig?"*
Polish "*Podziemne skladowanie CO2 – czym jest tak naprawde?*"
Portuguese "*O que significa realmente armazenamento geológico de CO2?*"
Romanian "*Ce înseamna, de fapt, stocarea geologica a CO2?*"
Serbian " *Šta zaista znači geološko skladištenje CO2?*"
Slovakian "*Čo skutočne znamená geologické ukladanie CO2?*"
Slovenian "*Kaj geološko skladišcenje CO2 pravzaprav pomeni ?*"
Spanish "*¿Qué significa el Almacenamiento Geológico de CO2?*"
Swedish "*Vad innebär egentligen geologisk lagring av koldioxid?*"

Return to Contents Page

Project Website

Return to Contents Page

Project Website

- "Monitoring methods to evaluate storage system performance" - led by CO_2GeoNet-BGR, on line
- "Storage site selection criteria/methodologies and requirements for granting the CO_2 storage site permit" - led by CO_2GeoNet-IFPEN, on line
- "CO_2-storage related directives and regulatory regimes related to operational and safety risks" - led by CO_2GeoNet-Imperial, available from December