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GEO ENeRGY

CO_2 geological storage highlighted as key climate solution at COP21

TOUS ENSEMBLE POUR LE CLIMAT

cop21.gouv.fr #COP21

COP21 (UNFCCC 21st "Conference of the Parties") took place in Paris in December 2015. A global climate agreement was reached by 196 countries. This historical agreement gives the appropriate political global framework for mitigation and adaptation actions. The challenge is even greater than expected before the event, as the ambition is to limit the rise in temperature to 1.5°C, as requested by delegates from island states and poor countries particularly vulnerable to climate change. Here you can see this crucial wording in the agreement: "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change".

The 1.5 degrees can accelerate the use of energy efficiency and renewable energy. COP21 sent a strong signal to investors to a rapid phase-out of coal, oil and other fossil fuels and switch to 100% renewable energy by 2050 - although not mentioned as a specific goal. Prior to COP21 the national voluntary contributions could only render 2.7°C reduction in temperatures. It is obvious that there is a large gap between 2.7°C and the “well below” 2°C target adopted by the Paris Agreement. It is now even more essential to accelerate CO_2 reduction by taking all potential mitigation options on board seriously, i.e. energy efficiency, fuel switching and augmenting renewables, and also CO_2 Capture and Storage (CCS).

The CO_2GeoNet Association on CO_2 geological storage provided technical support to COP21, as an accredited UNFCCC Research NGO. CO_2GeoNet (co)organized three side events and two booths on CCS in Climate Generations Areas (open to the public) and in UNFCCC Negotiation Zone (open to official delegations only). For more information see http://cop21.co2geonet.com/.

From CCS and CO_2 geological storage perspective, the discussions in Paris brought forward four notable aspects, as follows:

- important positioning of CCS in the light of the commitment of “well below” 2°C by 2100,
- opportunities for developing countries to use CCS as one of the key mitigation technologies,
- urgency to decarbonize also heavy industry with CCS,
- role of CCS in negative emission scenarios, trapping the CO_2 from the atmosphere (e.g. through the coupling with biomass energy).

Reductions in CO_2 emissions in the power sector can be achieved by energy efficiency and renewables, although fossil fuels will still play a role at least for back-up. However, CCS is the only technology that can deliver emission drop in various CO_2-intensive industrial sectors, where CO_2 arises from production of cement, iron and still, paper and pulp, fertilisers etc. In reality, about one fourth of all CO_2 global emissions are due to chemical processes in these plants. Man has used cement, iron, fertilizers, etc. for decades and there is no realistic option to replace these products in the near future. CCS is vital for reducing industrial emissions and is therefore an essential part of the solution following the COP21 commitments.

COP21 represents a global transnational political summit, yet not exclusively. It is worth mentioning that various NGOs performed meaningful actions and have influenced the negotiators to reach the ambitious result. CO_2GeoNet is proud of being part of this scene. Now it is essential to transpose the political commitment into effective actions on decarbonisation of national economies. Stimulating investments in CCS is momentous in these endeavours. The encouraging news is that by end 2015 fifteen large-scale integrated CCS projects were in operation worldwide, in March 2016 the first large-scale CCS facility was launched in Japan, and by 2017 additional seven large-scale CCS projects are under construction and are expected to be fully operational. This demonstrates that the technology is in action worldwide.

On 22 April 2016 (Earth Day), political leaders from 175 countries - including China, US and UK - signed the Paris Agreement and are now expected to ratify the Agreement, representing around 93% of global emissions. Time for action has come!

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The Newsletter content

Scottish research into CO_2 storage

There is great potential for storage of CO_2 in geological formations under the North Sea, and much research on CO_2 capture, transport and storage (CCS) has been carried out in Scotland over the past decade. In 2005, a research partnership, Scottish Carbon Capture and Storage (SCCS) was formed. Partners include the British Geological Survey (BGS), Heriot-Watt University and the Universities of Edinburgh, Aberdeen and Strathclyde, and it is currently funded by the Scottish Funding Council. Members of SCCS form a multi-disciplinary team, which studies the whole CCS process, from capture to storage. In this article, we focus on research into the geological storage of CO_2.

Several studies have been undertaken to investigate the optimum locations to store Scotland's CO_2. The results of the first study, "Opportunities for CO_2 Storage around Scotland" (2009) indicated that saline aquifers under the North Sea had sufficient capacity to store CO_2 captured from fixed-sources in Scotland for 200 years. There is also storage capacity in hydrocarbon fields, including the potential for enhanced oil recovery (EOR) using CO_2 injection. This report introduced the idea of "storage hubs" as a means to minimise the cost of CO_2 storage projects.

The second report, "Progressing Scotland's CO_2 Storage Opportunities" (2011), focussed on the storage potential of the Captain Sandstone aquifer (Figure 1). It was estimated that this formation could store CO_2 from Scotland's power stations and industrial sites for 15 to 100 years, and that CCS in Scotland could generate 13000 jobs.

This research was extended in the CO_2Multistore project ("Optimising CO_2 Storage in Geological Formations; a Case Study Offshore Scotland", 2015), which considered the effects of multiple CO_2 storage sites and how pressure build-up due to CO_2 injection at one site could affect neighbouring hydrocarbon reservoirs and other CO_2 storage sites. If more than one injection location is planned for a site, a regional study is required to determine the maximum operating pressure at an individual site.

Recently, researchers have been investigating the potential for CO_2 EOR in the North Sea ("CO_2 Storage and Enhanced Oil Recovery in the North Sea", 2015). An SCCS joint industry project was funded by industry partners as well as the Scottish Government, Scottish Enterprise and The Crown Estate, and one company donated a reservoir model for the study (Figure 2). Money gained from producing oil can reduce the cost of the storage. Results showed that there was a synergy between oil recovery and CO_2 storage – greater oil recovery means greater CO_2 storage capacity. However, to get the maximum benefit from CO_2 EOR, high pressure must be maintained so that the CO_2 mixes with the oil.

Unfortunately, the UK Government cut the £1 billion funding which had been offered to companies for setting up large-scale CCS projects. Two projects had been short-listed. The first was a joint venture between SSE (Scottish and Southern Energy) and Shell. A new power station was to be built at Peterhead in Scotland, and the CO_2 would be piped and stored in Shell's Goldeneye Field, a former gas condensate field. The second project was the White Rose Project, in which CO_2 would be captured from a power station in Yorkshire and stored in the Southern North Sea.

Despite the withdrawal of government funding for CCS projects in the UK, many politicians and researchers are certain that CCS is necessary to achieve the require reduction of CO_2 in the atmosphere, and we are determined that CCS will go ahead in the future.

Additional information about SCCS and the outputs from the research projects mentioned above can be found at www.sccs.org.uk.

Gillian E Pickup
Heriot-Watt University

Fig. 1 The location of the Captain Sandstone aquifer. Source: British Geological Survey, SCCS Conference Report, 2015, http://www.sccs.org.uk/expertise/reports

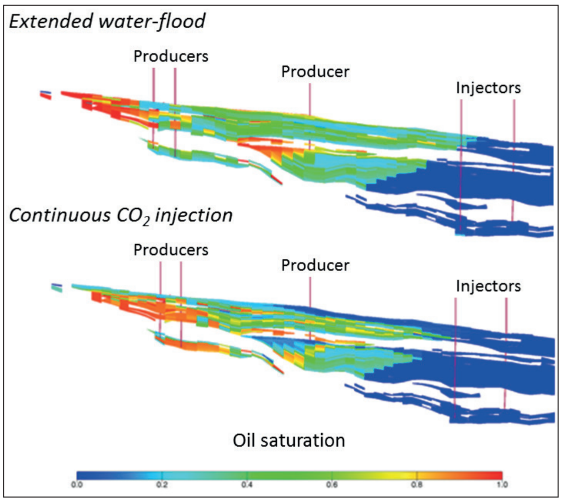

Fig. 2 Cross-section of a reservoir model showing a comparison of water flooding with CO_2 injection. The red colour illustrates areas with remaining oil. Source: Joint Industry Project on "CO_2 storage and Enhanced Oil Recovery in the North Sea", SCCS, 2015

GeoPower: Basic subsurface information for the utilization of geothermal energy in the Danish-German border region

The Interreg 4a GeoPower project developed a planning basis for the Interreg Region South Denmark–Schleswig (that is in the northern part of the South Permian Basin) for utilization of geothermal energy, as well as for storing energy from renewable sources in the underground in the form of compressed air or hydrogen.

The goals were to promote the utilization of geothermal energy in the region; develop a better understanding of the geology across the border between Denmark and Germany; produce an optimized geological basis for planning of exploiting the region.

In the region geothermal exploitation occurs only in the Sønderborg heating plant. One reason is the high investment costs for deep drilling, and risk that the geothermal reservoir cannot be utilized sufficiently.

Project work

Since the beginning of the 20th century, about 1500 deep boreholes have been drilled and about 1200 seismic profiles obtained, for the purpose of oil exploration. Based on these data and other available geological information, 12 main geological horizons were mapped. The produced digital 3D model shows the relative complexity of the underground structure and it allows us to study fictitious boreholes and to locate possible geothermal reservoirs depth and thickness (Fig. 3).

Good geological conditions for geothermal energy are permeable or fractured, water-bearing rock layer at a depth of 800–2500 m. It is usually sandstone, where the presence, depth, and thickness varies in the region due to the complex structure of the subsurface. Two sandstone formations have been examined for geothermal exploitation, Buntsandstein and Gassum/Rhät formations.

The reservoir formations are composed of alternating layers of sandstone, clay and limestone. A sandstone layer must be at least 15 meters thick for geothermal use. The reservoir formations were analysed using borehole logs to determine composition of sandstone layers versus claystone layers. Most sandstone layers in the region meet the minimum requirements regarding thickness.

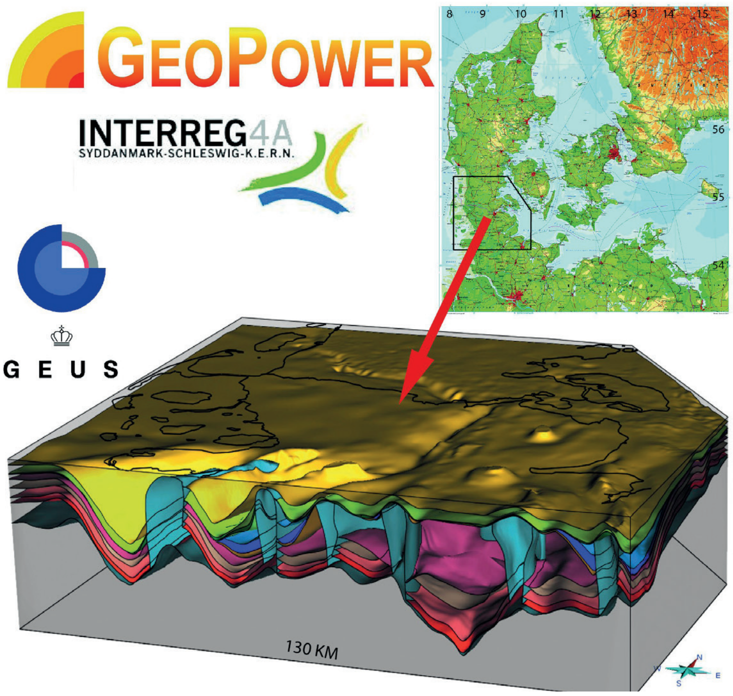

Fig. 3 Geological 3D model of the project area

The GeoPower project partners :

- Department of Geoscience, Aarhus University
- GEUS - Geological Survey of Denmark and Greenland
- Institute of Geoscience, Christian-Albrechts-Universität Kiel
- LLUR - Geologischer Dienst Schleswig-Holstein in Landesamt für Landwirtschaft, Umwelt und ländliche Räume

GeoPower also developed a 3D temperature model with temperature maps for geological sections and constant depth maps (1 km, 2 km, etc.). Near salt structures were characterised by significant temperature variations (up to 10 °C warmer). In almost the entire project area the temperature at the top of each reservoir formations is high enough for geothermal heat supply (heat-flow values are in the range: 72–84 mW/m^2).

Energy storage

To cover short-term needs power plants with compressed air storage are especially suitable, where the excess electrical energy is stored in the form of compressed air in caverns. To cover longer-term needs, hydrogen storage systems can be an especially good solution, where the excess power is used for the production of hydrogen.

For the preliminary studies to establish caverns for the storage of energy, structures with a maximum depth of the salt cavern of about 1,300 m (natural gas and hydrogen storage) and 800 m (compressed air storage) were mapped using data from the geological maps and structure maps in the geotectonic Atlas of NW-Germany.

Project results are now available at GeotIS (www.geotis.de) and www.umweltdaten.landsh.de/nuis/upool/gesamt/geologie/geopower_2015.pdf

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ENeRG – European Network for Research in Geo-Energy

ENeRG – European Network for Research in Geo-Energy is an informal contact network open to all European organisations with a primary mission and objective to conduct basic and applied research and technological activities related to the exploration and production of energy sources derived from the Earth's crust.
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Croatian national strategy for low-carbon development

The Croatian Ministry of Environmental and Nature Protection created recently an ambitious Low-Carbon Strategy for the nation's development up to 2030 and 2050. The strategy points the way for a transition towards a sustainable competing economy. The entire project has been prepared and co-ordinated by the EKONERG – Energy and Environmental Protection Institute from Zagreb (Fig. 4). 90 technical measures have been established which can be applied to reduce emission in all sectors: energy, industry, transport, households and services, agriculture, land use, land use change and forestry, waste management, product use and fugitive emissions. These measures were tested in the three main scenarios: Reference Scenario (LCR), Gradual Transition Scenario (LC1) and Strong Transition Scenario (LC2).

The Reference Scenario - LCR presumes a technological advance and an increase of shares of renewable energy sources and energy efficiency based on the market situation and already established target energy standards. Emissions stay approximately at the same level as today, with possible increase in the period after 2040. The share of renewable energy sources reaches 26.3%. The Gradual Transition Scenario – LC1 incorporates the goals of emission reduction within the boundaries of the internal scheme of the EU, as well as the goals of the international long-term agreement to keep the temperature increase within 2°C (COP 21). The emission reduction is achieved with the application of a series of cost-effective measures, promotion of energy efficiency and use of renewable energy. A sharp rise in CO_2 prices is foreseen, up to 100 EUR/t CO_2 in 2050. The share of renewable energy in 2030 would reach 32.8%, and in 2050 it could be 46.5%. In regard to 1990 the greenhouse gas emission is reduced by 40% in 2030 and by 57% in 2050. The Strong Transition Scenario - LC2 has the goal of achieving an 80% reduction in emission in 2050, with regard to 1990. A sharp rise in CO_2 prices is presumed along with energy efficiency measures. *The reduction is not possible without the application of CO_2 capture and geological storage technology in thermal power plants.* With the application of measures known today, 77% of emission could be reduced. The remainder to 80% refers to new technologies.

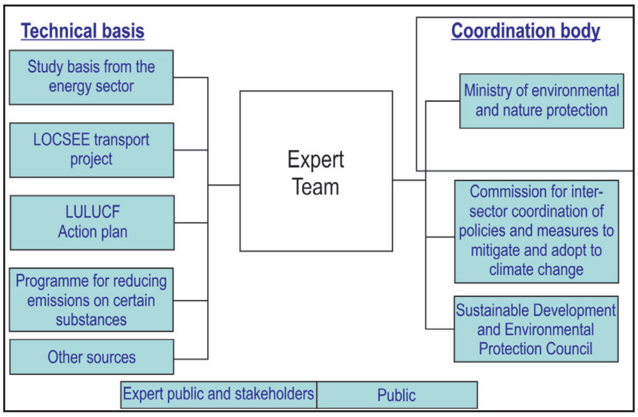

Fig. 4 Organization of the project implementation

EKONERG – Energy and Environmental Protection Institute

The scenarios LC1 and LC2 are very similar until 2030, so if the Republic of Croatia were to start with the Gradual Transition Scenario, it would have time to shift to the Strong Transition Scenario. Future economic benefits are seen primarily in energy renovation of buildings, biomass and biogas facility construction, manufacturing equipment for renewable energy use, development of production capacities for electric vehicles, manufacturing biomass from agricultural waste and fast-growing plants, advanced energy system and network construction, development of sustainable transport infrastructure, manufacturing non-road vehicles *and development of infrastructure for transport and storage of CO_2.* May be the most important are 80000−100000 new jobs, half of which could be realised in Croatia.

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