ENOS

Enabling Onshore CO_2 Storage

Spring School announcement
Advanced course on geological storage of carbon

ENOS 2nd Spring School on CO_2 Geological Storage

Date & place: May, 22nd to 29th 2019 at Hontomin, Spain

The overall objective of this *ENOS Spring School on CCS in Spain* is to communicate knowledge, understanding of CO2 geological storage and aspects of CO2 that is required to respond to our climate is warming at an alarming and unprecedented rate, and we have an urgent duty to respond and meet the growing demand for near zero emission. In this pursue special emphasis will be placed on the European context.

- **Students shall arrive Wednesday 22nd noon or early afternoon**
- **Transfer Wednesday 22nd afternoon to Sotopalacios Hostal, Sotopalacios city, near Burgos and Hontomin.**
- **Departure from Hontomin Wednesday May 29th morning and arrival Madrid early afternoon**

Figure 1. Burgos a city in northern Spain and the historic capital of Castile (left). Sotopalacios Hostal, Sotopalacios city (right)

Figure 2. Hontomín Technology Development Plant, Northern Spain

Programme of Study: The ***ENOS*** *Spring School on CO_2 Geological Storage* shall provide the theoretical and practical knowledge on CCS based on recent international research and development work. Vital elements are:

- *Climate change*
- *CO_2 geological storage aspects*
    - *identifying, mapping and completing geological storage sites for the CO_2*
    - *aquifers, enhanced oil and gas recovery*
    - *multiple underground usage, storage without compromising other operations*
- *Assessment of storage capacity*
- *Safety precautions and consideration, information strategy*
- *Injection*
- *Numerical and Analytical Modelling approach*
- *Monitoring and reporting guidelines*
- *Public awareness and involvement to research and deployment*

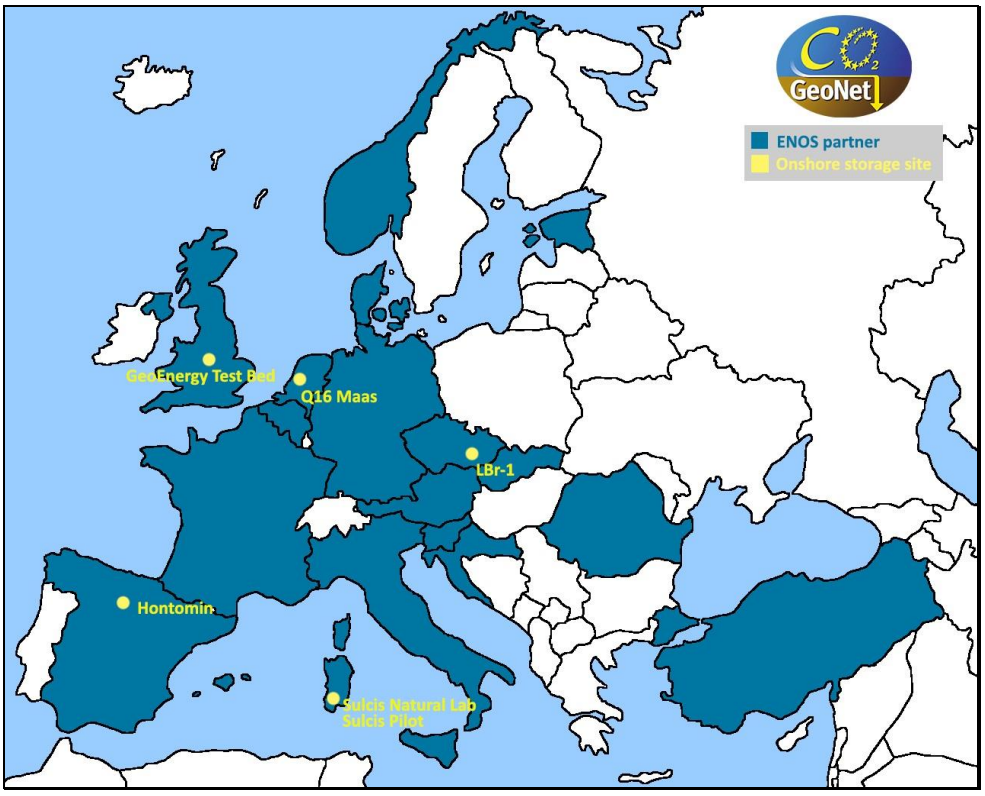
The thematic approach will be lectures, exercises, colloquia, study groups and a storage site visit. Compendia, articles or other material covering most lectures that will be made available to the students during the course.

The ENOS project (ENabling ONshore CO_2 storage in Europe**) - that unites almost 30 research institutes was launched in September 2016. The main objectives of the European Horizon 2020 project are to increase field experience relevant to geological storage of CO_2, refine techniques and tools used for site selection and monitoring and to advance communication between science and society on the geological storage of CO_2. The project will run until August 2020.**

ENOS strives to enhance the development of CO_2 storage onshore, close to CO_2 emission points. Several field pilots in various geological settings will be studied in detail and best practices that stakeholders can rely on will be produced. In this way, ENOS will help demonstrate that CO_2 storage is safe and environmentally sound and increase the confidence of stakeholders and the public in CCS as a viable mitigation option.

CO_2 injection testing

Several onshore research sites will serve to test CO_2 injection. At the storage pilot of Hontomin in Spain, 10,000 tonnes of CO_2 will be injected into a limestone rock layer at a depth of 1,500 m. Key parameters will be studied in order to monitor the evolution of the geological reservoir and to demonstrate that the storage operations have no negative impact on the environment. Innovative injection strategies, designed to optimise storage whilst guaranteeing site safety in the short and long term, will also be tested.



Tests at two other sites will allow project partners to improve techniques to detect CO_2 in the subsurface so that, in the unlikely case that CO_2 leakage were to occur, smaller amounts of CO_2 could be identified more quickly. Such in-situ experiments will also help provide ground truthing for leakage simulations in two different geological settings, one in a shallow aquifer and the other along a fault plane. The first site, an initiative of the University of Nottingham and the British Geological Survey, is a field laboratory near Nottingham, UK, called the 'GeoEnergy Testbed', and the second is the 'Sulcis Fault Lab', located in Sardinia, Italy.
An additional two proposed pilot storage sites, LBr-1 in the Czech Republic and Q16 Maas in the Netherlands, complete the ENOS test site portfolio.

220 Mt of CO_2 already safely stored worldwide

To meet the ambitious target set out in the Paris Agreement to keep the temperature rise well below 2°C, all the tools available for reducing CO_2 emissions, including CO2 Capture, Utilisation and Storage (CCUS), are needed to meet the challenge.

CO_2 Capture and Storage (CCS) is identified by the IPCC as a key climate-change mitigation technology, and in the 2015 Paris Agreement, international leaders agreed to curb the global temperature rise to 2°C above the era prior to mass industrialization, with an aspiration to limit this to 1.5°C. The world has already warmed by around 1°C over the past century, feeling sea level rises, heatwaves, storms and the decline of vulnerable ecosystems such as coral reefs.

The more ambitious 1.5°C goal would require a precipitous drop in greenhouse emissions triggered by a rapid phase-out of fossil fuels. CCS involves the capture of carbon dioxide (CO_2), compression of this CO_2 into a dense liquid form, and its injection deep underground into reservoir pore space

usually in saline formations or depleted hydrocarbon fields. From the 1990s onwards, CCS has been seriously considered and studied as an essential method of reducing emissions to the atmosphere, by which carbon extracted from underground in the form of gas, oil and coal is returned to the deep subsurface in the form of CO2.

CCS is currently the only technology that can greatly reduce CO2 emissions from fossil-fuel-based power stations and other industrial processes such as oil refining and steel and cement manufacture.

It is clear that support for demonstration projects, which are now close to a final investment decision (FID), is extremely important to the future of CCS in Europe. In Spain, CIUDEN (an ENOS partner), is currently undertaking a pilot-scale injection project at Hontomín and if financial investment is obtained, larger, demonstration-scale storage will take place.

Today, after more than 25 years of CCS research, 15 industrial-scale projects are in operation worldwide, with a further six scheduled to join these and 17 new projects currently in preparation. To date, some 220 Mt of CO_2 has been safely stored underground. However, this represents only a small step (0.2 %) towards international 2050 targets. The International Energy Agency (IEA) recommends increasing this volume to 90 Gt of CO_2 stored by 2050, in addition to using all other low-carbon options, in order to keep global warming to the 1.5°C maximum defined by the Paris Agreement that was ratified on 4 November 2016.

ENOS (ENabling ONshore CO_2 storage in Europe) project, coordinated by BRGM (France), was launched in September 2016 and will last for four years. It unites 29 organisations across 17 countries, and is financed by the European Union's H2020 programme with a budget of 12.5 M€ as well as partners' and national funds. ENOS is an initiative of CO_2GeoNet, the European Network of Excellence on the geological storage of CO_2 (www.co2geonet.com).

CO2GeoNet is the European Network of Excellence on the Geological Storage of CO_2, a not-for-profit Scientific Association. CO2GeoNet is a multidisciplinary organization focused on CO_2 storage and independent of political, industrial or societal pressures. CO2GeoNet's mission is driven by non-partisan and independent scientific objectives. CO2GeoNet joins together leading research institutions in the field of CO_2 storage with 13 partners from 7 European countries with more than 300 experts, researchers and postgraduate students, forming an integrated interdisciplinary team of geoscientists and marine, aquatic and terrestrial bioscientists, meaning that the full range of research issues on the impact and security of CO2 geological storage.

The ENOS *Spring School on CO_2 Geological Storage* will be open during one concentrated week – May 23rd to 29th 2019 with arrival and departure from Madrid on May 22nd after noon. Key lecturers will be available throughout the entire week, and – as appropriate – take active part in discussions, and otherwise be available upon students' request.

Language: The official language of the *ENOS Spring School on CO_2 Geological Storage* will be English. This implies that all lectures will be delivered in the English language.

Target group: The target group is young scientists, e.g. PhD students and post docs with background in geology, engineering, geotechnologies. Master students will be considered on free chairs.

Selection and grants: Students eligible to attend the *ENOS Spring School on CO_2 Geological Storage* will be selected upon qualifications that must be duly documented in the application.

The attendance will be free of charge. ENOS funding will be available for transport within Spain and for board. **However, the students themselves will carry direct expenses for travel to Madrid and back.**

In order to receive the *ENOS Studies Diploma* students have to attend the classroom sessions, and take active part in resolving of all exercises.

Due date and application

The due date for submitting the application is by March 31st 2019.

Applicants are required to prepare:

1. An application letter describing our interest in the course,
2. CV,
3. Recommendations from head of department, supervisor or mentor,
4. Applicant's email address.

The forms shall be sent electronically to:

Niels E. Poulsen, GEUS email: nep@geus.dk

The forms must be received no later than 16 pm Central European time on January 3rd 2019.

Please mark the subject field in the mail: Spring School 2019

Why you must attend

The goal is to provide students with diverse backgrounds a broad understanding of the issues surrounding CO_2 geological storage as an effective tool in a wide range of climate change mitigation options and encourage their active participation in this area.

The climate change issue is coined one of the most severe concerns of our time, and has brought leading nations into ambitious ventures in order to reduce their greenhouse gas emissions. The challenge is to provide enough power under a sustainable framework.

Up to now, no green energy source has been identified as being capable of providing very large quantities of "power on demand" at acceptable cost. Fossil fuels are prone to remain the prevalent primary energy source in the foreseeable future in Europe as well as the rest of the world. But, in

response to the climate change issue, the problem of increasing CO_2 emissions from fossil fuels must be resolved urgently.

In this endeavour it is expected that emerging carbon capture and storage (CCS) techniques will become part of the solution. CCS is one of the solutions to reduce carbon emissions and serves as a bridging technology towards a carbon free European energy market.

The course will give an introduction to: Global warming and climate change, greenhouse gasses (methane, CO_2...), sources, capture (focus on CO_2), transport, trap types & storage options, coal seams, depleted hydrocarbon structures, enhanced recovery, deep saline aquifers.

Reservoir geology & rock properties, geological structure, rock type, cap rocks and reservoirs, mineralogy, porosity, permeability, capillary pressure and fluid distribution.

Basic reservoir concepts: Reservoir pressure, reservoir temperature, storage capacity estimation fluid flow through porous media.

Storage concept and mechanism: CO_2 plume, dissolution, diffusion, CO_2 solubility rate, mineralization, geochemical aspects, injection, pressure build up. CO_2 Storage Economics, cost.

Monitoring, numerical modelling, leakage, verification and legislation. Environment, health & safety: Governing regulations, risk.

The location of the Spring School will be near Hontomin, northern Spain

The Hontomin Technology Development Plant (TDP) for CO2 geological storage, located close to the city of Burgos (Spain), is currently the only active onshore injection site in the European Union. It is managed by Fundacion Ciudad de la Energía (CIUDEN) and it has been recognised by the European Parliament as a key test facility.

The principal reservoir/seal pair is formed by Lower Jurassic carbonate rocks (limestones and dolostones) sealed by marls and black shales. The rocks at around 1,500 m depth take the form of a structural dome, where the main seal is the Marly Lias and Pozazal Formations and the reservoir is the Sopena Formation.

ENOS Spring School will provide the opportunity to see the Hontomin storage site, on-going research at the site, its laboratory and monitoring system …

Teachers

- Alexandra Dudu, GeoEcoMar www.geoecomar.ro
- Carlos de Dios, CUIDEN www.ciuden.es
- Karen Kirk, BGS www.bgs.ac.uk
- Niels Poulsen, GEUS www.geus.dk
- Fernanda de Mesquita L. Veloso, BRGM www.brgm.fr

Guest teacher

- Ingo Möller, BGR

http://www.enos-project.eu/

Hontomin, Spain