

GEO ENeRGY

Engagement of GeoEcoMar in ACT (Accelerating CCS Technologies) programme

Work related to the CO₂ geological storage began in Romania with the affiliation of GeoEcoMar to ENeRG in 2002 and continued with participation of the institute in international projects related to CCS: as subcontractor in "CASTOR" project, as partner in "EU GeoCapacity", "CO₂NET East", "Impact of communication", "CGS Europe", "CO₂ StoP" projects as well as in similar national projects: "The National Program of Carbon Capture and Storage for 2011-2020 period" and "Geological storage" section of the Feasibility Study for the "Getica CCS" Demonstration Project. A new project - named ENOS (ENabling ONshore CO₂ storage in Europe) - that unites almost 30 research institutes, including GeoEcoMar as partner, through CO₂ GeoNet Association, was launched in September 2016.

Since 2017 GeoEcoMar is partner in two ACT projects: ALIGN CCUS (Accelerating Low Carbon INdustrial Growth through CCUS) and ECO-BASE (Establishing CO₂ enhanced Oil recovery Business



Advantages in South Eastern Europe). The ACT (Accelerating CCS technology as a new low-carbon energy vector) ERA-NET Cofund Action is a transnational collaboration (Figure 1) on CO₂ Capture and Storage (CCS) technology. The initiative targets mainly the energy sector, but will also have benefits for energy intensive industries. The vision of ACT is to ensure that the energy sector makes a better contribution to climate protection by developing a collection of different CCS technologies ready for commercialization. The ambition of ACT is to facilitate the emergence of CCS via transnational funding aimed at accelerating and maturing CCS technology through targeted innovation and research activities. ACT will be in action for a five-year period from 2016 to 2020.

The second call for proposals was launched recently, on 4th of June 2018. USA and France were added to the list of participating countries <http://www.act-ccs.eu/news-1/>

In the frame of the ECO-BASE project, GeoEcoMar, part of a Romanian consortium together with CO₂ Club and PicOil Info Consult, aims to develop prospective revenue streams and business models for CO₂-EOR (Enhanced Oil Recovery using CO₂ combined with storage) in Romania and, therefore, to support large scale CCUS deployment in the country. The main activities, in which the institute is involved, refer to mapping CCUS potential and creating the roadmap for CCUS implementation for Romania, selection and analysis of an EORStore (CO₂-EOR combined with permanent storage) and also knowledge-sharing and dissemination activities. It is worth mentioning that Romania has a large potential in using the CO₂ for injecting it into oil fields in order to increase the oil recovery (EOR) and for permanent storage.

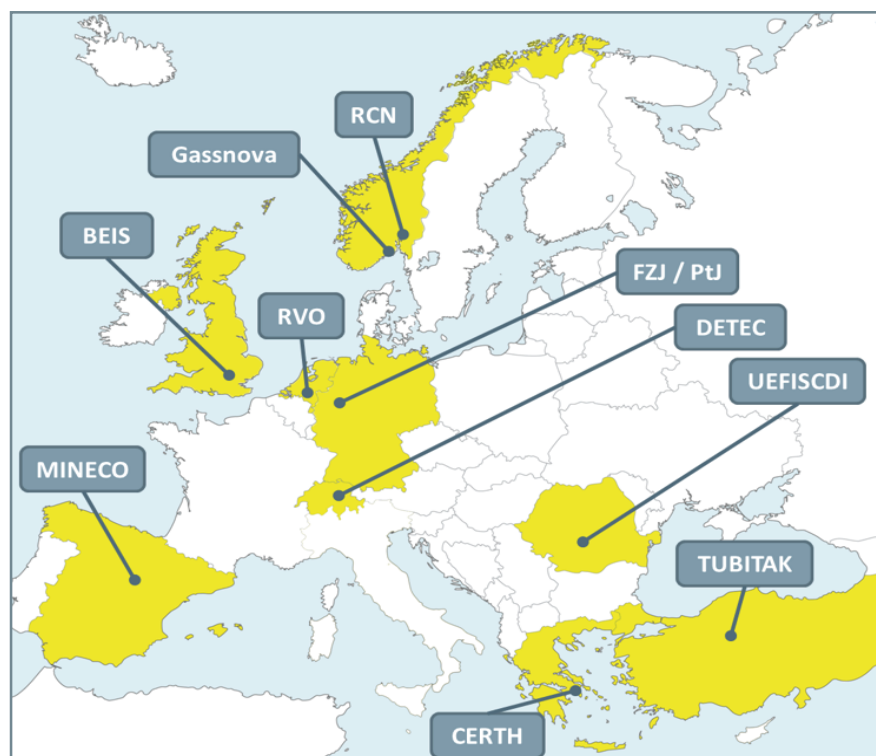


Figure 1. ACT consortium countries and funding agencies for the first call for proposals

In ALIGN-CCUS project, GeoEcoMar, together with CO₂ Club and PicOil Info Consult, will elaborate a blueprint for an industrial cluster from the Oltenia Region. This blueprint will refer to the identification of the most feasible transportation routes for future captured CO₂ and investigate the storage solutions available, including the possibility to use the CO₂ for enhanced hydrocarbon recovery in the region. This will involve assessing CCUS pathways for the Oltenia Region and describing the different pathways concerning CO₂ emission reduction potential, necessary infrastructure, transport routes, storage options, and enhanced hydrocarbon recovery potential. Taking into consideration the multi-modal transport option (pipeline + ship transport), the proximity of Danube river and the open path to the western Black Sea, the focus will also be on identifying and describing the possibilities of using captured CO₂ from the Oltenia region industrial cluster for use in EOR offshore operations or industrial processes in the coastal area.

Constantin Ștefan Sava,
GeoEcoMar, Romania



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Accelerating Low Carbon Industrial Growth through CCUS - ALIGN-CCUS

The ALIGN-CCUS project addresses specific issues across the CCUS chain (Figure 2) for industrial regions in ACT ERA-NET countries, enabling large scale, cost effective implementation of CCUS by 2025. To reach the overall aim of ALIGN-CCUS, the project encompasses a number of focused but interlinked objectives:

- Capture: Enable near-term deployment of CO₂ capture by improving performance and reducing costs
- Transport: Optimising large-scale CO₂ transport
- Storage: Reduce uncertainty in the provision of large-scale storage networks
- Utilisation: Establish the contribution of CCUS as an element for large-scale energy storage and conversion
- Social acceptance: Implementing CCUS in society

ALIGN-CCUS will combine the results from each of these objectives to deliver actionable blueprints in ERA-NET ACT countries: Teesside and Grangemouth (UK), Rotterdam (Netherlands), North Rhine-Westphalia (Germany), Grenland (Norway) and Oltenia (Romania), in which CCUS enables low-emission industries, through geological storage or through utilization of CO₂.

The project contributes to advancing the TRL (Technical Readiness Level) levels of CCUS technologies through long-term CO₂ capture testing campaigns at leading EU research facilities, and the design, construction, operation and



testing a first-of-a-kind full-chain CO₂ capture and conversion project in an industrial environment. A unique CO₂ storage readiness assessment protocol shall be established to accelerate the definition of CO₂ storage capacity, and potential storage locations in the North Sea will be better characterized. ALIGN-CCUS also contributes to societal acceptance issues of CCUS. For the first time, leading social scientists will conduct quantitative research to understand how public perception of CCUS varies depending upon the source of CO₂. The scientific outcomes of ALIGN-CCUS will contribute directly to

the acceleration of CCUS deployment in EU industrial regions, overcoming cluster specific technical challenges.

The participants of ALIGN-CCUS represent the ERA-NET ACT countries of the Netherlands, Germany, Norway, Romania and the United Kingdom. The ALIGN-CCUS consortium is characterised by considerable involvement of industrial companies, which are not only guiding the research, but have committed to directly investing in the R&D and demonstration activities in the project, boosting the credibility of the project's potential for accelerating and maturing CCUS technologies, as the end-users themselves are driving the project forward.

Peter van Os,
Project Coordinator,
TNO, the Netherlands **TNO** innovation
for life

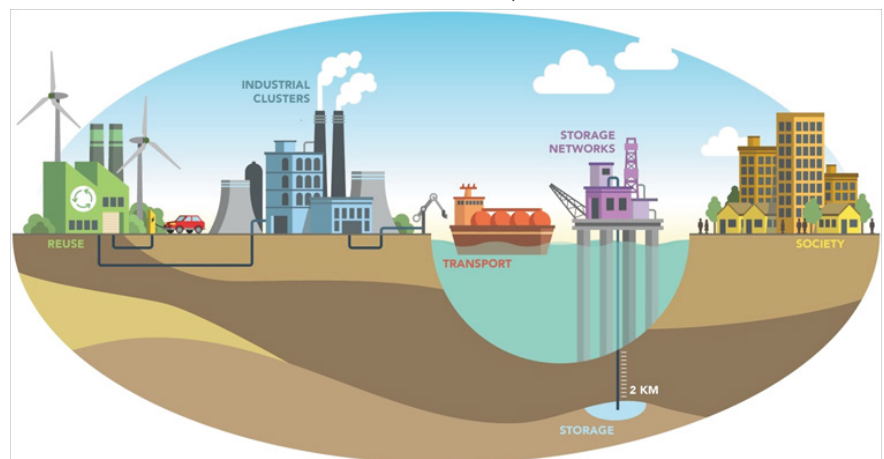


Figure 2. Schematic presentation of the project

ECO-BASE: Establishing CO₂ enhanced Oil recovery Business Advantages in South Eastern Europe

ECOBASE

Enhanced oil recovery with storage

Commercial utilization of CO₂ is one of the mechanisms to create a business case for CO₂ storage, and CO₂-EOR is currently the only process capable of continuously utilizing and later storing large volumes of CO₂. ECO-BASE will develop revenue streams and business models for CO₂-EOR in South-Eastern Europe (SEE) therefore supporting large scale CCUS deployment. The project is carried out locally in SEE countries: Turkey, Romania and Greece with support from TNO, the Netherlands and IRIS, Norway. The project team will access the whole revenue stream and focus on optimization of the CO₂-EOR

combined with permanent storage (EORStore) as an undividable process.

The four key activities of the project are:
1. Mapping CCUS potential in SEE and establish regional EORStore roadmaps, resulting also in the identification of most promising case studies for further analysis.

2. Creating a business case for selected EORStore case studies. The objectives are to model and optimize EORStore, access technical, legal and regulatory incentives and bottlenecks.

3. Knowledge sharing and transfer between North West Europe (NWE) and SEE and beyond to boost and support CCUS activities in participating countries. This activity refers to organizing courses for young specialists and

arranging knowledge transfer to various stakeholders of CCUS community. An attempt to involve other countries of the Black Sea region (Bulgaria, Ukraine, Georgia, Russia) will be made.

4. Public awareness and acceptance. Creating a favorable atmosphere for CCUS development among all stakeholders is crucial – there have been projects stopped or cancelled due to "total lack of local support". The ECO-BASE is aiming at liaising with existing organizations (like CO₂-GeoNet) and projects (like ENOS) in order to organize public events and raise awareness and acceptance of EORStore.

Roman Berenblyum,
Project Coordinator,
IRIS, Norway



Radioactive waste disposal research in Czech Geological Survey

As the administrator and owner of large geoscientific datasets from the whole territory of the Czech Republic, the Czech Geological Survey (CGS) is involved in numerous applied research projects dealing with various kinds of use of the underground rock environment, including those related to geo-energy. The recently solved issues of utmost national importance include high-speed railway tunnels, reassessment of mineral resources, assessment of geothermal energy potential, and, last but not least, location of a deep radioactive waste repository.

The high-level radioactive waste (HLW) in the Czech Republic is produced mainly in 2 nuclear power plants. Its repository is presently planned to be situated in crystalline rocks (granitic plutons or high-grade metamorphites of amphibolite to granulite facies grade) at ca. 500-600 m depth and should be built by 2065. Presently, 9 localities are being explored using surface based geological and geophysical methods. From these, 4 localities will be selected for detailed research and exploration, which will in the end lead to selection of 2 final localities – a main one and an alternative one in 2025.

In the 9 localities under characterisation, the Czech Geological Survey is engaged in geological and hydro-geological exploration, subsequent data processing and creation of 3D geological models. The scarcity, heterogeneity and complexity of available archived and newly acquired geological data do not allow for any semi-automatic techniques of model construction; the models need to be created purely manually.

The 3D geological models (example in Figure 3) created for the HLW repository purposes in CGS cover a broad spectrum of scales and lithotectonic environments. Concerning scale, they range from meters in the case of outcrop fracturing quantification for Discrete Fracture Network models, to regional scale covering areas of hundreds square kilometres and up to 1.5 km depth. They depict structurally complex high-grade metamorphic units that exhibit several episodes of pervasive ductile deformation, partial melting and emplacement of magmatic bodies, as well as simple overlying sedimentary formations. An integral part of the model production is also an initial assessment of model credibility, used especially for purposes of safety analysis of the supposed deep radioactive waste repository in individual candidate localities.

Another type of the repository-related research is focused on in-situ experiments and multidisciplinary projects that are

presently conducted in the Bukov Underground Research Facility (www.pvpbukov.cz/en/about-urf) on the 12th level of the former uranium mine Rožná (at cca 600 m depth) in high-grade metamorphic rocks.

Based on the 3D geological models, 3D hydraulic and transport numerical simulations are performed to estimate groundwater flow and possible leakage paths of radionuclides from a hypothetically damaged HLW repository to the Earth surface. Additionally, the models are used by engineering companies in CAD-type SW as natural limits for technical design of the underground repository facilities.

Acknowledgments: The research is supported by the Czech Radioactive Waste Repository Authority.

Jan Franěk,
Czech Geological Survey

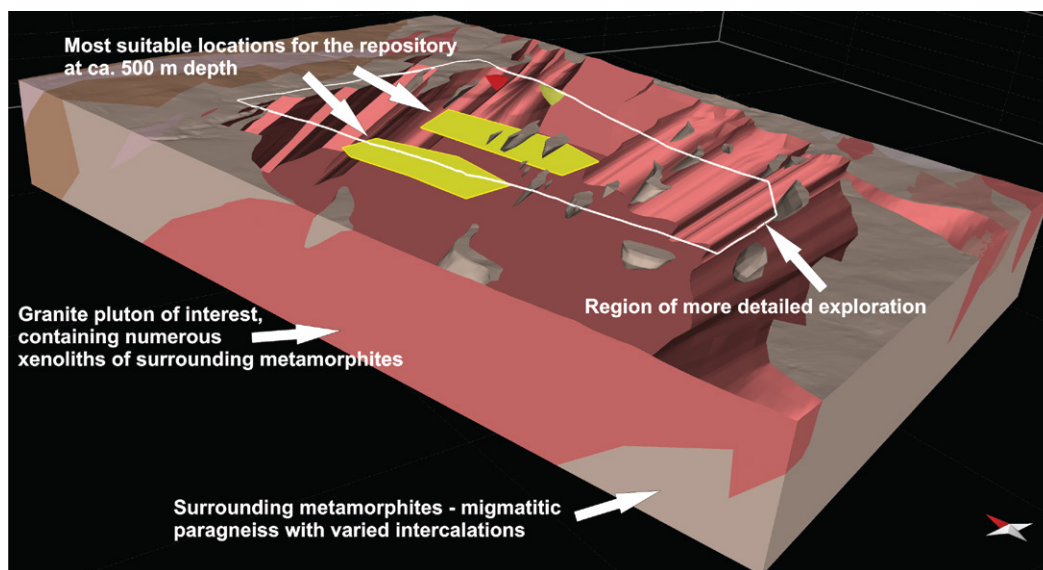


Figure 3. 3D geological model describing geometry of lithologies at one of the potential HLW repository sites. Extent of the model is 12.3 x 8.3 x 1.5 km. Surface of the granitic pluton of interest (in pink colour) is removed to show its interior down to 1.5 km depth. Yellowish polygons define the most suitable locations for the repository at ca. 500 m depth. Fault planes are not shown.

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.

ENeRG president is Dr. Vit Hladik from Czech Geological Survey, vít.hladik@geology.cz

ENeRG secretariat is run by the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Croatia. Contact person: Zeljka Kurelec, zeljka.kurelec@rgn.hr

ENeRG website: <http://www.energnet.eu> is maintained by Tallinn University of Technology, Contact person: Dr. Alla Shogenova, alla.shogenova@ttu.ee

ENeRG Newsletter – GEO ENeRGY

The Newsletter is published by Department of CO₂ Geological Storage, GeoEcoMar, Romania.

Editor: Dr. Alexandra Dudu, alexandra.dudu@geoecomar.ro

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Language review: Dr. Gillian E Pickup

Heriot-Watt University, UK, G.Pickup@hw.ac.uk

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ENeRG engaged with PESS 2018

PETROLEUM ENGINEERING SUMMER SCHOOL

INTER-UNIVERSITY CENTRE
DUBROVNIK, CROATIA

INTERACTIVE SEMINARS - WORKSHOP 45 & 46

WS 45

June 4th - 8th 2018

Making petroleum industry greener

WS 46

June 11th - 15th 2018

1. Petroleum Services Workshop
2. Energy Business & Natural Gas Value Chain

ENeRG contributed to the organisation of the Petroleum Engineering Summer School (PESS 2018) at the Inter University Centre (IUC) in Dubrovnik between 4th and 15th of June 2018. The Summer Schools have been organised by the University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering (UNIZG-RGNF) – the Croatian member of ENeRG, for more than 30 years (the first PESS was held in 1987). Their subjects, invited lecturers and attendees have been evolving during the years, depending on what has been perceived to be the most interesting theme in this always developing profession. The basic format has,

however, remained much the same – two weeks, each with a workshop of specific title (usually one upstream-oriented and one downstream-oriented) and with a marked possibility of interaction between the attendees and lecturers. The guest speakers or lecturers always used to be outstanding professors and experts from the USA, Europe and other regions.

The following theme was highlighted in the first week – MAKING PETROLEUM INDUSTRY GREENER (WORKSHOP 45, 4 – 8 June 2018). The common denominator of this part was how to revitalize mature fields with the contemporary EOR methods by injection of CO₂, taking the climate change issues into account as well. While the first part of the workshop was mostly dedicated to Enhanced Oil Recovery, its second part focused on issues related to reduction of carbon dioxide emissions.

The last day of the workshop was in gestion of the ENeRG network, in liaison with the Horizon 2020 project ENOS (Enabling Onshore CO₂ Storage). Vit Hladik from CGS opened the day with a lecture "Rationale and principles of CCS", then Bruno Saftić from UNIZG-RGNF gave a talk "CO₂ geological storage options" and in the final part there was a most comprehensive lecture by Serge van Gessel from TNO titled "Energy Storage: opportunities and challenges from a subsurface perspective". The pauses between the lectures were frequently prolonged due to the vivid discussions, most notably between the students and lecturers but also between the lecturers from the USA and from Europe comparing different approaches and development on the two continents in almost every aspect of EOR technology and CO₂ geological storage related circumstances, plans, commitments and achievements.

Out of a total of 65 workshop participants, 26 were graduate students (18 from the USA and 8 from Croatia) and 39 were petroleum engineering or petroleum geoscience professionals (19 from Croatian companies, 10 from other countries and 10 affiliated with the University of Zagreb – Faculty of Mining, Geology and Petroleum Engineering itself).

The second week of PESS (WORKSHOP 46, 11 - 15 June 2018) consisted of two parallel courses - PETROLEUM SERVICES and ENERGY BUSINESS & NATURAL GAS VALUE CHAIN. Details of both workshops and other information about PESS can be found at <http://www.rgn-ness.com/>

Bruno Saftić,
UNIZG-RGNF, Croatia



The ENeRG Network – Country Representatives

BOSNIA AND HERZEGOVINA

Prof Sanel Nuhanovic
University of Tuzla
sanel.nuhanovic@untz.ba

BULGARIA

Prof Georgi V. Georgiev
Sofia University
gigeor@abv.bg

CROATIA

Prof Bruno Saftić
University of Zagreb
bruno.saftic@rgn.hr

CZECH REPUBLIC

Dr Vit Hladik
Czech Geological Survey (CGS)
vit.hladik@geology.cz

DENMARK

Dr Niels E. Poulsen
Geological Survey of Denmark
and Greenland (GEUS)
nep@geus.dk

ESTONIA

Dr Alla Shogenova
Department of Geology,
Tallinn University of Technology
(TTUGI) alla.shogenova@ttu.ee

FRANCE

Dr Isabelle Czernichowski-
Lauriol
BRGM
i.czernichowski@brgm.fr

GREECE

Dr Apostolos Arvanitis
Institute of Geology & Mineral
Exploration (IGME)
arvanitis@igme.gr

ITALY

Ing Sergio Persoglia
National Institute of
Oceanography and
Experimental Geophysics (OGS)
spersoglia@ogs.trieste.it

LITHUANIA

Prof. Saulius Sliupa
Nature Research Centre
sliupa@geo.lt

MOLDOVA

Dr Igor Nicoara
Institute of Geology and
Seismology
nicoaraigor@gmail.com

POLAND

Dr Adam Wojcicki
Polish Geological Institute
awojci@pgi.gov.pl

ROMANIA

Dr Constantin S. Sava
National Institute for
Marine Geology
and Geoecology –
GeoEcoMar
savac@geoecomar.ro

RUSSIA

Prof Alexander Ilinsky
VNIGRI
alex.ilinsky@bk.ru

SLOVENIA

Marjeta Car
GEOINŽENIRING d.o.o.
m.car@geo-inz.si

TURKEY

Dr Çağlar Sinayuç
Middle East Technical
University
Petroleum Research
Center
caglars@metu.edu.tr

UK – Scotland

Dr Gillian Pickup
Heriot-Watt University
G.Pickup@hw.ac.uk