Agenda

ENOS in short

ENOS sites

Demonstrating key technologies

Engaging Researchers with local population

Supporting deployment
ENOS IN SHORT
Need for CCS onshore

- EU commitment of an overall reduction of greenhouse gas emissions of at least 80% by 2050
- This means storing 3 to 13 billion tonnes of CO$_2$ across Europe by 2050
- Europe cannot rely solely on the North Sea, despite its great and readily available storage potential.
- Need onshore storage, relatively near the emission points, to reduce the costs of CCS, enable territories to manage their CO$_2$ emissions locally, and build lasting public confidence in CCS as a mitigation option that can also contribute to local economic development.
- To reach ambitious goal of greenhouse gas emission reduction, while ensuring the security, flexibility and competitiveness of energy supply, deployment of onshore CO$_2$ storage will be crucial.
Enabling CO$_2$ storage onshore in Europe

By building on past experiences and national initiatives to support CCS

By developing and field testing key technologies adapted to onshore applications;

By engaging the local population in the storage research and projects, without which project development is impossible.

By Creating a favourable environment for onshore storage across Europe:

- support knowledge sharing to maximise the benefits of site demonstrations,
- integrate research results and creating best practices from real-life experiments,
- support preparation of new pilot projects and upscaling to demonstration,
- bring innovation to society through dialogue and communication,
- promote CCS through training and education.
Developing and field testing key technologies

- Demonstrating through practical experience that injection operations can be run safely and efficiently onshore, which is key for optimising operations and to enable a positive regulatory environment;

- Ensuring that estimated matched storage capacities are sufficiently reliable and also affordable to verify, which is needed to enable investment in projects and therefore the deployment of CCS;

- Demonstrating our capacity to understand, detect and manage potential leakage risks, which is key for regulatory issues and to demonstrate storage is environmentally sound and safe for human health;

- Integrating CO₂ storage into the local economic activities so that the benefits are also reflected at the local scale, which is vital to enable the deployment of CCS;
# Project Fact Sheet

## 29 Partners (parties and third parties) in 17 countries:

<table>
<thead>
<tr>
<th>Europe: CO2GeoNet</th>
<th>Italy: NHAZCA, OGS*, Sapienza University of Rome*, Sotacarbo</th>
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<tbody>
<tr>
<td>Austria: GBA*</td>
<td>Norway: IRIS*</td>
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<td>Belgium: GSB-RBINS*</td>
<td>Romania: GeoEcoMar*</td>
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<td>Croatia: UNIZG-RGNF*</td>
<td>Slovakia: SGUDS</td>
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<td>Czech Republic: Czech Geological Survey*</td>
<td>Slovakia: GEOINZ*</td>
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<tr>
<td>Denmark: GEUS*</td>
<td>Spain: CIEMAT, CIUDEN*, IGME*</td>
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<td>Estonia: TTUGI*</td>
<td>The Netherlands: TNO*</td>
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<td>France: BRGM* (Coordinator), Flodim, Geogreen, IDIL</td>
<td>Turkey: METU-PAL*</td>
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<td>Germany: BGR*</td>
<td>UK: BGS*, Heriot Watt University*, Silixa, University of Nottingham</td>
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## Duration: September 2016 – August 2020

## Budget: 12.5 M€ of EC contribution. National funding supporting infrastructure development.
ENOS SITES
Working on actual sites

Leakage simulation:
- GeoEnergy Testbed
- Sulcis fault lab

Pilot CO₂ storage:
- Hontomin

Pre injection studies:
- Q16 maas
- LBR 1

26.04.2018
Hontomín Technology Development Plant, Spain

Unique onshore pilot injection site in the EU, recognized by the European Parliament as a key test facility (E.P. Resolution 2014)

Deep saline aquifer comprised of fractured carbonates with low porous matrix permeability

Injection well (HI) and observation well (HA) reaching the depth of 1600 m

Well monitoring (P/T sensors, deep sampling, DTS, DAS, ERT and hydrophone array)

In ENOS: Test of different injection schemes, iDAS-VSP, deep sampler,

Development of monitoring data integration solutions and alert systems
The UK GeoEnergy Test Bed (GTB)

The GTB is a research facility initiated by the British Geological Survey and the University of Nottingham comprising an instrumented borehole array (depth c. 200m)

The GTB will:

- **Improve understanding** of impacts and processes in the shallow subsurface
- Enable development and testing of **in innovative monitoring technologies**
- Provide ground truthing for advanced simulation software

For **ENOS**, the GTB will be used to advance innovative monitoring technologies and techniques for detection of fluid migration in the shallow subsurface and leakage

The GTB site represents a £6M investment to support new and emergent geo-energy sectors critical for a sustainable energy future (including £2.5M UK government-funding through the ERA project)
Field laboratories – Sulcis Fault Lab (SFL)

CO₂ will be injected into a fault zone (depth c. 250-300 m) to better understand impacts of CO₂ leakage.

SFL will test the sensitivity and effectiveness of monitoring technologies and techniques designed and developed by ENOS partners.

SFL infrastructure is **funded by Sardinian Region and National funds** – (Center of Excellence for Clean Energy and Research on Electric System)

The SFL project has multiple purposes:

- **Study CO₂ migration through faults**;
- **Examine water-gas-rock interactions including potential changes of groundwater quality**;
- **Study behaviour & changes in rock / fault parameters** by monitoring micro-seismicity and technical rock characteristics;
- **Test geochemical and geophysical monitoring tools** (in-house manufactured and low cost CO₂ sensors)
- Develop a **robust groundwater monitoring strategy**
LBr-1, Czech Republic

Depleted hydrocarbon field in the Czech part of the Vienna Basin, produced mainly in the 1960s

Tertiary sandstones at ca. 1100 m depth

Planned ENOS activities:

• Assessment of leakage risks through abandoned wells and faults, including possible shallow groundwater contamination

• Scenarios for CO$_2$-driven Enhanced Oil Recovery (CO$_2$-EOR) and its integration with CO$_2$ storage

• Study on regional CO$_2$-EOR potential of the Vienna Basin

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Q16-Maas, the Netherlands

Condensate-rich gas field in Triassic sandstone reservoir

Production started in April 2014, finished end of 2019

ROAD project with enhanced recovery and storage: Cancelled!

Potential for seasonal buffering after primary production

Support seasonal CO₂ buffering concept for use in greenhouses

- To make efficient use of waste CO₂: match supply and demand
- Support geothermal energy development in horticulture sector
- Decrease use of CHP installations

Stakeholder: OCAP transports CO₂ to greenhouses by pipeline

- Technical and economic feasibility
- Involvement of citizens; public engagement
- Roadmap for buffer implementation

Storage Location
Q16-Maas
Depth: -2 500 m
Storage capacity: 2-4 Mt
DEMONSTRATING KEY TECHNOLOGIES
Ensuring safe storage operation

**Objective:** Demonstrate safe and environmentally sound injection management by:

- Testing **injection strategies**
- Providing tools for injection and reservoir **monitoring**
- Providing monitoring data integration solutions and **alert systems**

**Expected outcomes:**

- History matching for site conformance
- Cost-effective injection strategies in a tight fractured reservoir
- Mitigation techniques and reduction of uncertainties for induced seismicity
- Reservoir monitoring tools (Validation of Silixa’s IDAS as part of a 3D seismic survey, Deep sampler)
- Development of Workflow to integrate operation, monitoring and modelling data into risk management and alert system
Ensuring storage capacities and cost-effective characterization

Further investigate potentialities of next-generation ‘high resolution’ reservoir modelling to assess impact of heterogeneities on CO₂ storage capacities;

Quantify the reliability of storage capacities estimates by developing A reliability index for capacity assessment;

Lower characterisation costs through (i) the validation of methodology to optimise exploration program, and (ii) the development of front-end engineering study for low cost drilling.
Managing leakage risks for protection of the environment and groundwater

**Advance and validate** surface and downhole monitoring technologies relevant to onshore storage, including for groundwater protection

**Improve understanding** on the impacts of leakage and of potential leakage pathways (geological faults and boreholes) to enable a more effective monitoring strategy

**Produce best-practice guidelines** for a monitoring strategy that integrates the newly advanced ENOS technologies and techniques with state-of-the-art commercially available tools

**Real-life experience** from field laboratories and sites where CO$_2$ is naturally seeping to the surface used to realise these aims (and data made available for future research)
Integration of CO₂ storage with local economic activities

Creating incentives and local benefits for CCS and demonstrating value of CO₂ by integrating storage technology with other activities,

Seasonal buffering in Q16-Maas, the Netherlands
  - Technical design of buffer chain and assessment of operational conditions
  - Assessment of contamination of CO₂ in reservoir prior to back-production
  - Design of cleaning facilities; removal of impurities for use in greenhouses
  - Economic viability of buffering compared to other forms of CO₂ supply

CO₂-EOR design for the LBr-1 oil field
  - Optimize the design for maximum CO₂ storage without impacting oil production
  - Economic viability of CO₂-EOR in Europe
ENGAGING RESEARCHERS WITH LOCAL POPULATION
Engaging with local communities

**Finding solutions together:** direct input of the population in making sense of the technology

**Systematic exploration** of technical challenges together with members of the public to identify the “good conditions” for onshore storage

**Listening to all points of view:** collaboration with citizens and stakeholders for producing socially sensitive best practices

**Public info tool:** a communication infrastructure for storage pilots
Planned work

- Establishing communication channels between researchers and citizens and developing a common language.
- Setting up of citizen groups in 4 areas (Hontomin, Sulcis, Nottingham, Rotterdam) with locally tailored approach.
- During two years, interacting with citizens on CO₂ storage research development
- Integrating social aspects and citizens’ input in best practice documents
- Develop an online information tool to improve accessibility to CO₂ storage research information
SUPPORTING DEPLOYMENT
International Collaboration

- Site twinnings (等相关)
- Leakage simulation Alliance (等相关)
- Experience sharing workshops on specific topics open to all
  (tomorrow 14:00 advanced characterisation techniques)
- Establishing contacts with European initiatives

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Preparing for future projects

- Identification of **storage pilot opportunities** in Europe,
- Planning of further **development** of ENOS sites
- **Roadmap** for identified synergies for CO₂ storage and CO₂ utilisation
Capacity building

- Intensive training weeks for early career scientists (once a year)
- Building of an international master degree in CO₂ storage
- E-lectures for the general (but interested) public

(available online)
Interactive tailoring of project outcomes for target audiences

Best practices for onshore storage in Europe

ENOS project team

R&D

Authorities

End-User Committee

Developments
Demonstrations

Feedback

Industry

NGO’s, public

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For information please contact enos@brgm.fr
visit www.enos-project.eu to get access to all events, documents and results.