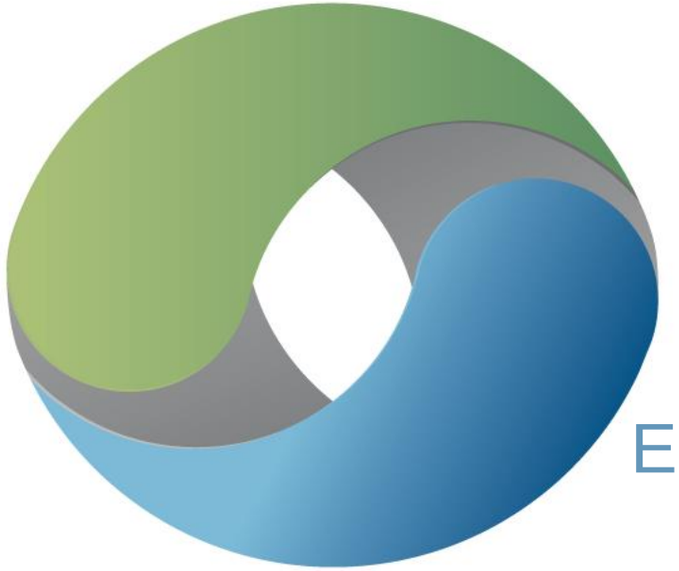


ENOS

Enabling Onshore Storage in Europe

Presentation To CSLF Projects Interaction and Review Team

26.04.2018

ENOS

Agenda

ENOS in **short**

ENOS **sites**

Demonstrating **key technologies**

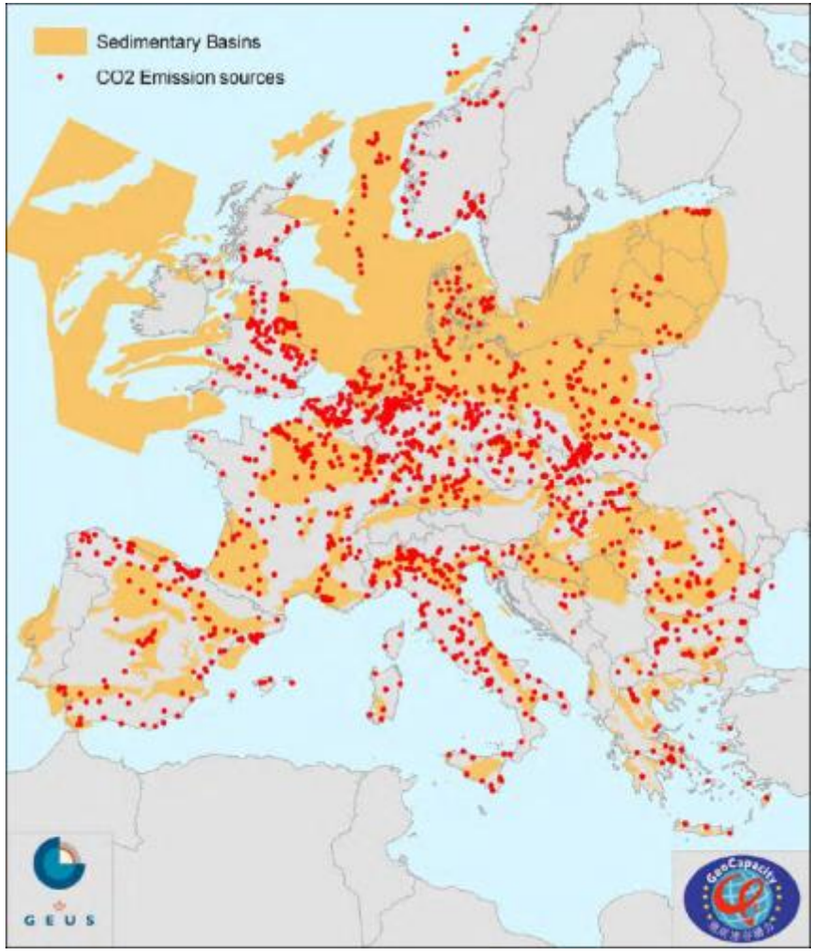
Engaging Researchers with local population

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 CO_2 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:

Europe: CO2GeoNet	**Italy: NHAZCA, OGS*, Sapienza University of Rome*, Sotacarbo**
Austria: GBA*	**Norway: IRIS***
Belgium: GSB-RBINS*	**Romania: GeoEcoMar***
Croatia: UNIZG-RGNF*	**Slovakia: SGUDS**
Czech Republic: Czech Geological Survey*	**Slovenia: GEOINZ***
Denmark: GEUS*	**Spain: CIEMAT, CIUDEN*, IGME***
Estonia: TTUGI*	**The Netherlands: TNO***
France: BRGM* (Coordinator), Flodim, Geogreen, IDIL	**Turkey: METU-PAL***
Germany: BGR*	**UK: BGS*, Heriot Watt University*, Silixa, University of Nottingham**

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 CO_2 storage:

Hontomin

Pre injection studies:

Q16 maas

LBR 1

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

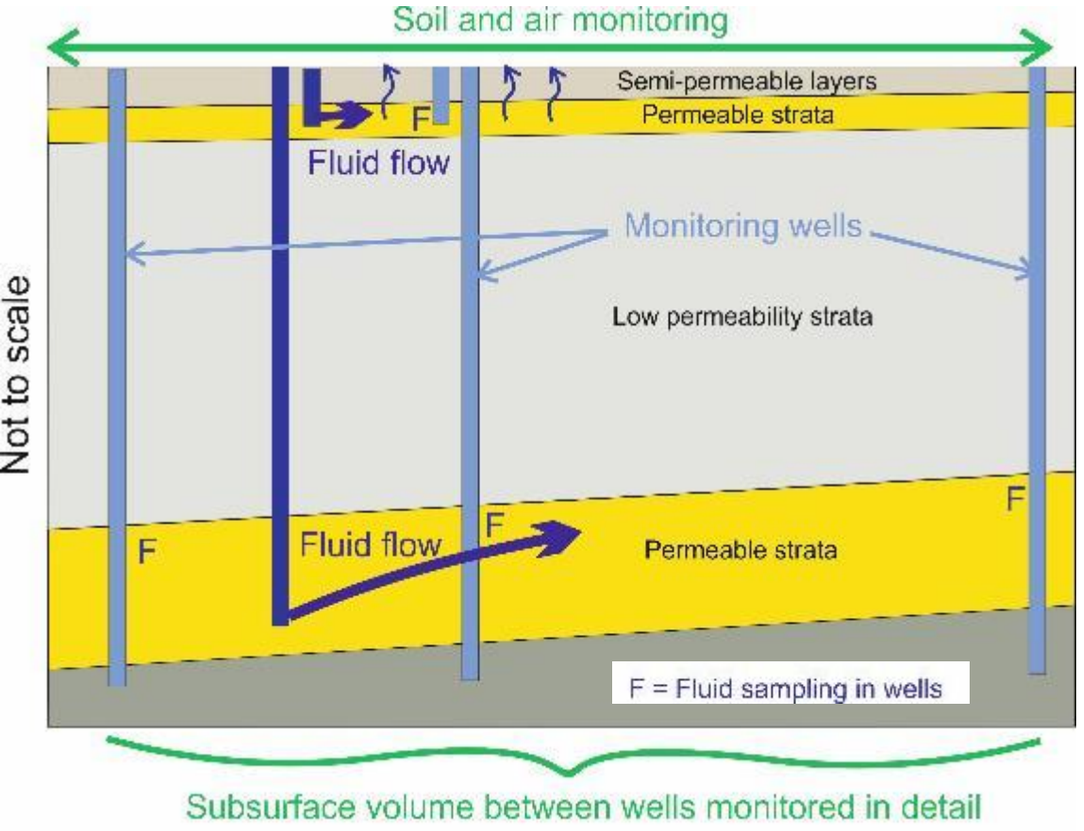
Well monitoring (P/T sensors, deep sampling, DTS, DAS, ERT and hydrophone array)

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 **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**

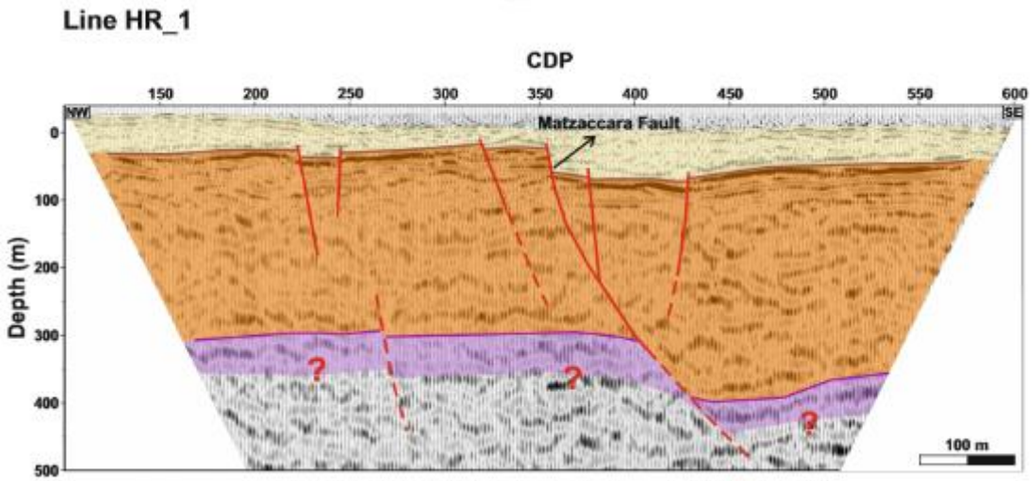
The GTB site represents a £6M investment **to support new and emergent geo-energy sectors critical for a sustainable energy future** (including £2.5M UK government-funding through the ERA project)

Field laboratories – Sulcis Fault Lab (SFL)

CO_2 will be injected into a fault zone (depth c. 250-300 m) to better understand impacts of CO_2 leakage.

SFL will test the sensitivity and effectiveness of monitoring techonologies 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 CO_2 **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 CO_2 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

Q16-Maas, the Nederlands

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!

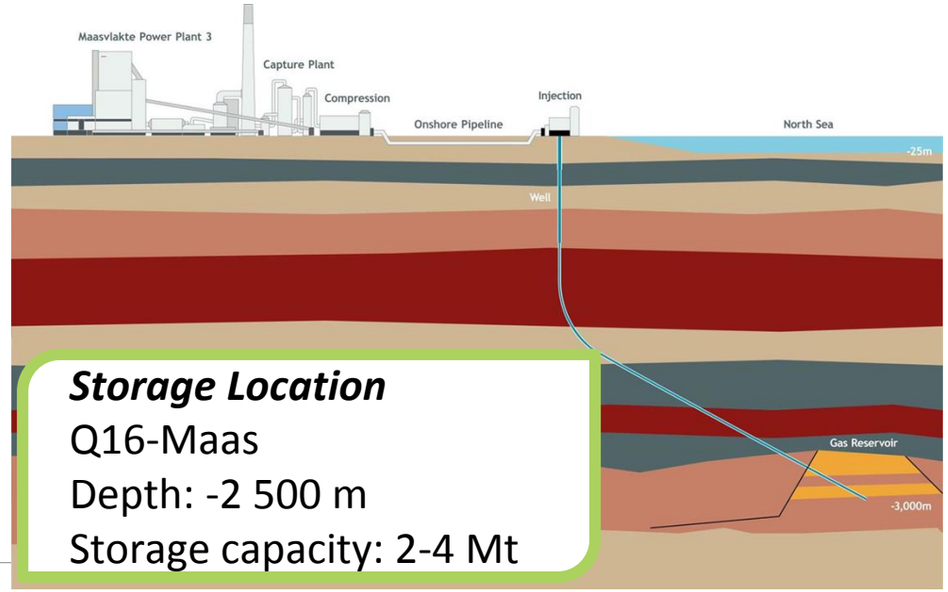
Potential for **seasonal buffering** after primary production

Support **seasonal CO_2 buffering concept** for use in greenhouses

- To make efficient use of waste CO_2: match supply and demand
- Support geothermal energy development in horticulture sector
- Decrease use of CHP installations

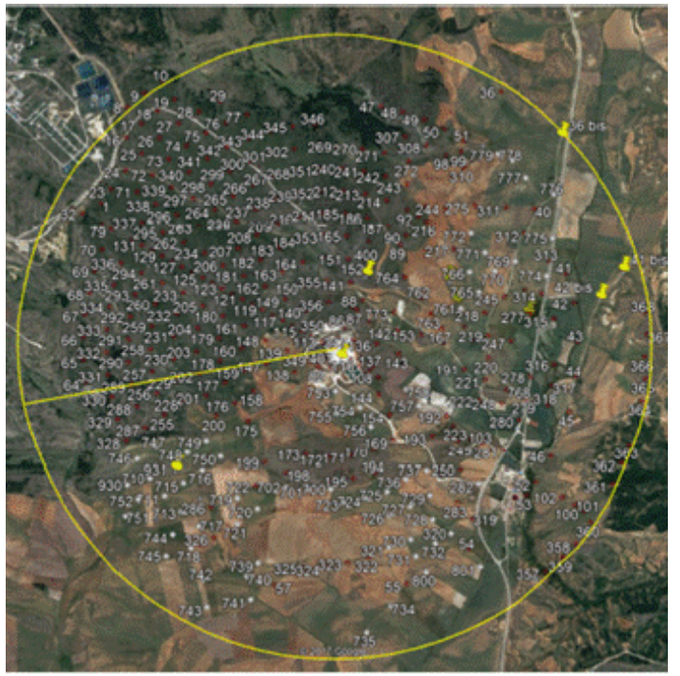
Stakeholder: OCAP transports CO_2 to greenhouses by pipeline

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



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 CO_2 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 CO_2 storage with local economic activities

Creating **incentives** and **local benefits** for CCS and **demonstrating value of CO_2** 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 CO_2 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 CO_2 supply

CO_2-EOR design for the LBr-1 oil field

- Optimize the design for maximum CO_2 storage without impacting oil production
- Economic viability of CO_2-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 CO_2 storage research development
- Integrating social aspects and **citizens' input in best practice documents**
- Develop an online information tool toImprove **accessibility** to CO_2 storage research information

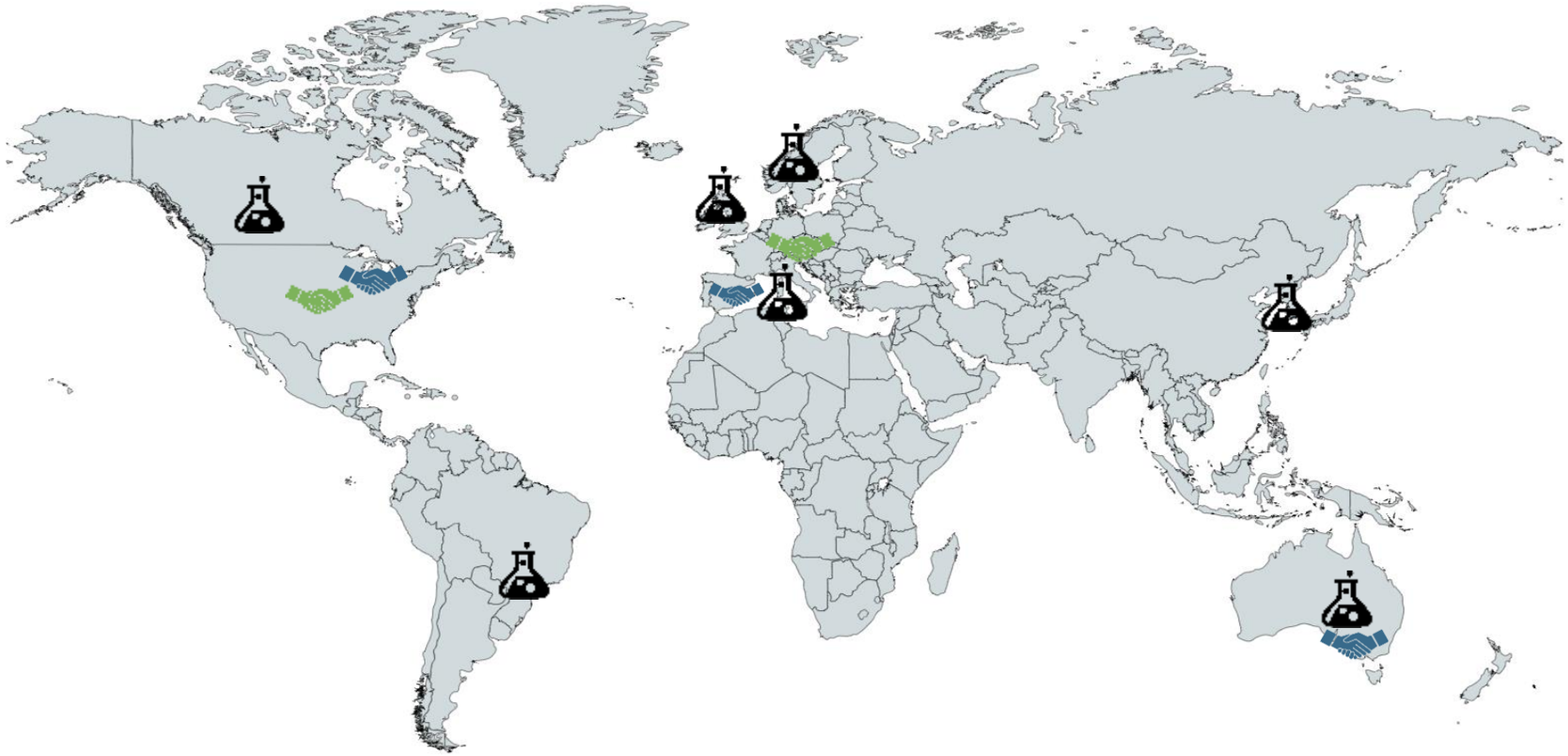
SUPPORTING DEPLOYMENT

International Collaboration

- Site twinnings (🤝)
- Leakage simulation Alliance (⚗)
- Experience sharing workshops on specific topics open to all

(tomorrow 14:00 advanced characterisation techniques)

- Establishing contacts with European initiatives



Preparing for future projects

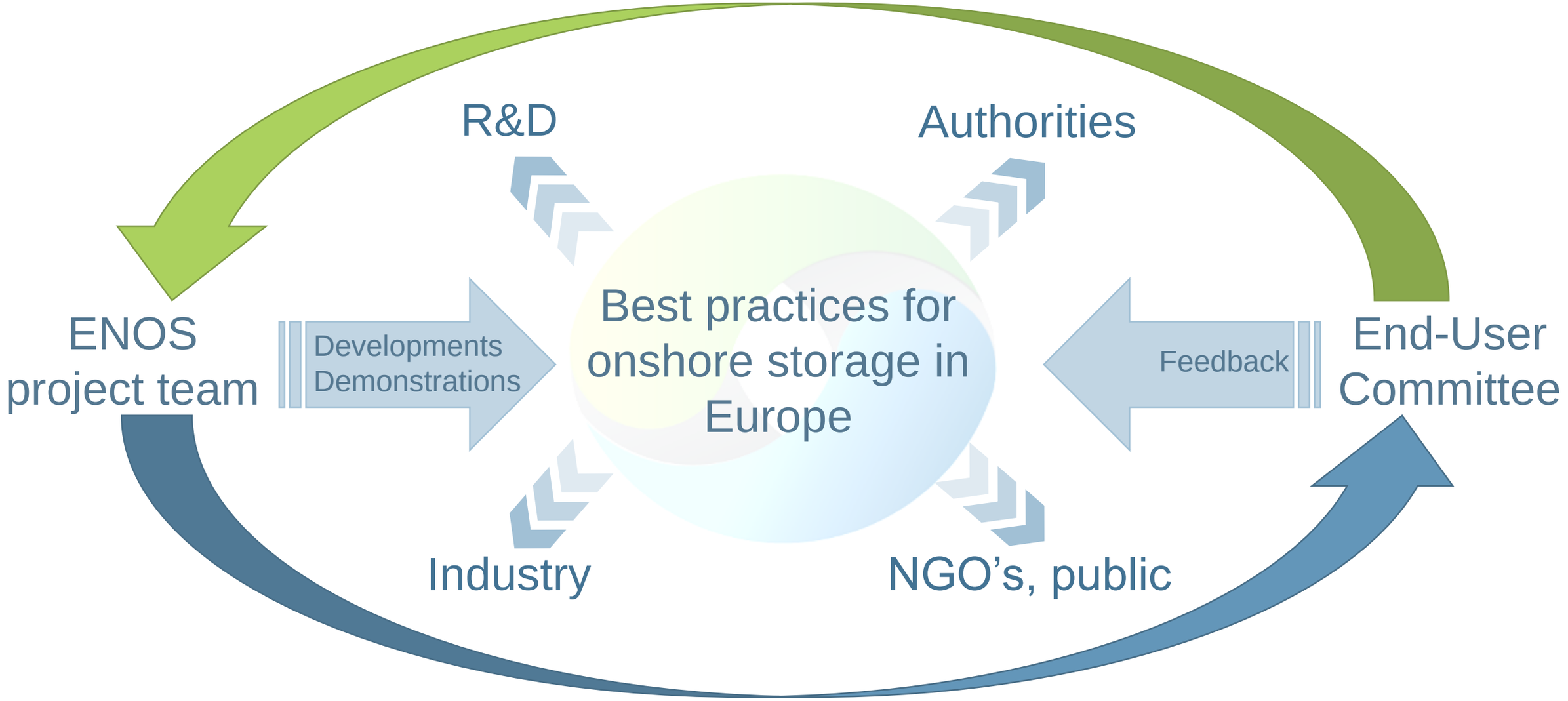
- Identification of **storage pilot opportunities** in Europe,
- Planning of further **development** of ENOS sites
- **Roadmap** for identified synergies for CO_2 storage and CO_2 utilisation

Capacity building

- Intensive training weeks for early career scientists (once a year)
- Building of an international master degree in CO_2 storage
- E-lectures for the general (but interested) public

(available online)

Interactive tailoring of project outcomes for target audiences



For information please contact enos@brgm.fr

visit www.enos-project.eu to get access to all events, documents and results.

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Enabling Onshore CO_2 Storage

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