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CO₂GeoNet actions in Europe for advancing CCUS through global cooperation

Isabelle Czernichowski-Lauriol^{a,b,*}, Roman Berenblyum^{a,c}, Sabina Bigi^{a,d}, Marjeta Car^{a,e},
Marie Gastine^{a,b}, Sergio Persoglia^{a,f}, Niels Poulsen^{a,g}, Cornelia Schmidt-Hattenberger^{a,h},
Rowena Stead^{a,b}, Ceri J Vincent^{a,i}, Ton Wildenborg^{a,j}

^aCO₂GeoNet Association, 3 av. Claude Guillemin, BP 36009, 45060 Orléans Cedex 2, France

^bBRGM, 3 av. Claude Guillemin, BP 36009, 45060 Orléans Cedex 2, France

^cIRIS, Prof. Olav Hanssensvei 15, 4021, Stavanger, Norway

^dSapienza University of Rome, P.le U. Pilozzi 9, 00038 Valmontone, Rome, Ital

^eGEOINZENIRING, Dimiceva 14, 1000 Ljubljana, Slovenia

^fOGS, Borgo Grotta Gigante, 42/C, Sgonico (Trieste), Italy

^gGEUS, Øster Voldgade 10, DK-1350 Copenhagen, Denmark

^hGFZ, Telegrafenberg, 14473 Potsdam, Germany

ⁱBGS, Keyworth, Nottingham NG12 5GG, United Kingdom

^jTNO, Princetonlaan 6, 3584 CB Utrecht, The Netherlands

Abstract

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 CO₂ emissions, including CO₂ Capture, Utilisation and Storage (CCUS), are needed to meet the challenge. Global collaboration is key in advancing CCUS. CO₂GeoNet, a pan-European scientific body on CO₂ geological storage, has gained visibility and recognition in the European and global arenas, participating in research and providing scientific advice, training and capacity building, and information and communication. A summary of CO₂GeoNet's cooperation activities with countries outside Europe and with international bodies is given here. CO₂GeoNet is open to further opportunities as the Association views global cooperation as critical to accelerating the development, recognition and deployment of CCUS as an important and flexible climate change mitigation technology.

* Corresponding author. Tel.: +33-23864-4655; fax: +33-23864-3987.

E-mail address: i.czernichowski@brgm.fr

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1. Introduction

CO₂GeoNet, the European Network of Excellence on CO₂ geological storage, was created in 2004 as a project supported by the 6th EU Framework Programme for Research and Technological Development (FP6) and became an association under French law in 2008. The Association strives to enable efficient and safe CO₂ storage in deep geological formations to combat climate change and ocean acidification. Current membership comprises 29 research institutes spanning 21 European countries. This large and unique pan-European scientific body has a valuable and independent role to play in enabling the deployment of the CO₂ capture and storage (CCS) technology in Europe and in other parts of the world. Opportunities for CO₂ use in connection with capture and storage are also of interest where they can accelerate large scale CO₂ storage and climate change mitigation.

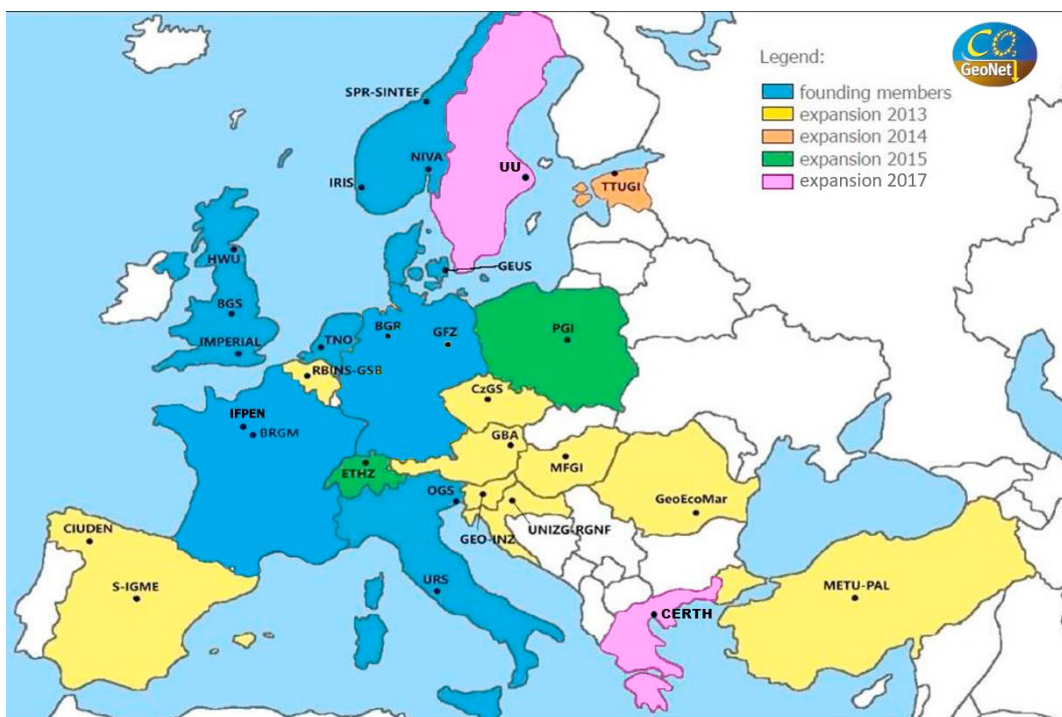


Fig. 1. The membership of the CO₂GeoNet Association in 2018.

CO₂GeoNet activities include research, scientific advice, training, information & communication [1,2,3,4]. This paper gives a summary of the latest activities in these four areas and highlights current cooperation actions with countries outside Europe and with international bodies.

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 CO₂ emissions, including CCUS, are needed to meet the challenge and global collaboration is key.

2. Research activities

Being a network composed of research institutes and universities, research is at the heart of CO₂GeoNet, feeding all its activities. Two European research projects recently initiated by CO₂GeoNet are currently ongoing: the ENOS project ‘Enabling Onshore CO₂ Storage in Europe’ and the ECOBASE project ‘Establishing CO₂ enhanced Oil recovery Business Advantages in South Eastern Europe’. Both projects strongly rely on international collaboration.

2.1. ENOS project ‘Enabling Onshore CO₂ Storage in Europe’

ENOS started in September 2016 and will last for 4 years with 12.5 M€ of financial support from the European Commission under the Horizon 2020 research and innovation framework programme (H2020) [5]. ENOS is a pan-European project with partners from 17 countries, under the coordination of BRGM (France). The project tackles the specificities and challenges for deep geological storage onshore, which is important as Europe cannot rely solely on North Sea offshore storage in order to reach its commitment of an overall reduction of GHG emissions of at least 80% by 2050. The objective of ENOS is to enable the development of CO₂ storage onshore in Europe by:

- Developing, testing and demonstrating key technologies specifically adapted to onshore contexts in the field at pilot and field laboratory sites.
- Demonstrating the benefits of integrating CO₂ geological storage into the socio-economic fabric of territories.
- Contributing to the creation of a favourable technological and societal environment for onshore storage across Europe.

In order to accelerate CCS deployment, ENOS supports several knowledge sharing activities involving international cooperation:

- *Storage site twinning programme*: partnerships were successfully established between European injection or study sites in ENOS and other onshore sites across the world. The purpose of this programme is to set up strong partnerships and to enable knowledge sharing to the mutual benefit of the storage site operators. To date, the established site twinings are (a) between Hontomín pilot (Spain) and Otway pilot (Australia) through CO2CRC, (b) between Hontomín pilot (Spain) and Michigan Basin Project site (USA, part of the Midwest Regional Carbon Sequestration Partnership – MRCSP) through Battelle, and (c) between LBr-1 oil field (Czech Republic) and Wellington oil field (USA) through the Kansas Geological Survey.
- *Leakage simulation alliance*: Many research organizations have set up (or are planning to) sites that simulate migration in the shallow subsurface/leakage in order to better understand the shallow migration and test new sensors to identify and quantify CO₂. All sites have different geological and surface conditions and all will provide valuable data and research outputs in order to mitigate the risk of unwanted CO₂ migration. Therefore ENOS is setting up a network of these sites with the purpose of sharing experimental set-up and practical information, as well as scientific results. The participating ENOS sites are the GeoEnergy Test Bed (UK) and the Sulcis fault lab (Italy) whilst the external sites include the Carbon Management Canada (CMC) Field Research Station in Alberta (Canada), the K-COSEM and KIGAM sites (South Korea), the shallow injection project at the Otway site (Australia), and the CO₂MOVE site (Brazil). In addition, the CO₂ Field lab site in Svelvik (Norway) has joined the alliance.

2.2. ECOBASE project ‘Establishing CO₂ enhanced Oil recovery Business Advantages in South Eastern Europe’

ECOBASE started in 2017 and will run until 2020 with 1.2 M€ of financial support from the H2020 specific ERA-NET Cofund ACT programme (Accelerating CCS Technologies). ECOBASE also benefits from a significant

amount of national funding. The partnership involves five countries (Norway, Netherlands, Greece, Romania, Turkey) and is coordinated by IRIS (Norway). The project will develop detailed and integrated roadmaps for CCUS, including CO₂ EOR-Storage, in South-East Europe. ECOBASE will focus on mapping regional potential, business cases for site development, knowledge transfer and researching aspects of public awareness. Key technical milestones are: inventory and mapping of sources and sinks in South-East Europe and the establishment of regional source-sink clusters and CCUS roadmaps; optimised EOR-Store methodology for the most promising cases from inventory to revenue streams; preparation for pilot projects and generalized lessons learned.

International cooperation is under development. ECO-BASE partners will actively work to establish collaboration with existing and ongoing CCUS demonstration projects around the world.

3. Scientific advice activities

As an independent and multidisciplinary scientific body, CO₂GeoNet represents the scientific voice of Europe on CO₂ geological storage and interacts with many stakeholders in Europe and globally to accelerate the development of CCUS climate change mitigation technology. Activities include the preparation of position papers and scientific documents to respond to controversial issues, and expert advice to the European Commission and other bodies when needed. At global level, CO₂GeoNet is providing scientific advice through specific agreements with several organisations.

Since 2013, CO₂GeoNet has been an accredited observer organisation of UNFCCC, in the category “Research Institution NGO” (RINGO), and can therefore organise events at the Conference of the Parties (COP), both in the negotiation zone and in the public access zone. A major effort was made at COP21 in Paris in 2015, COP22 in Marrakech, and COP23 in Bonn in November 2017, in cooperation with other institutions. Participation at COP24 in Katowice (Poland) in December 2018 is currently being planned.

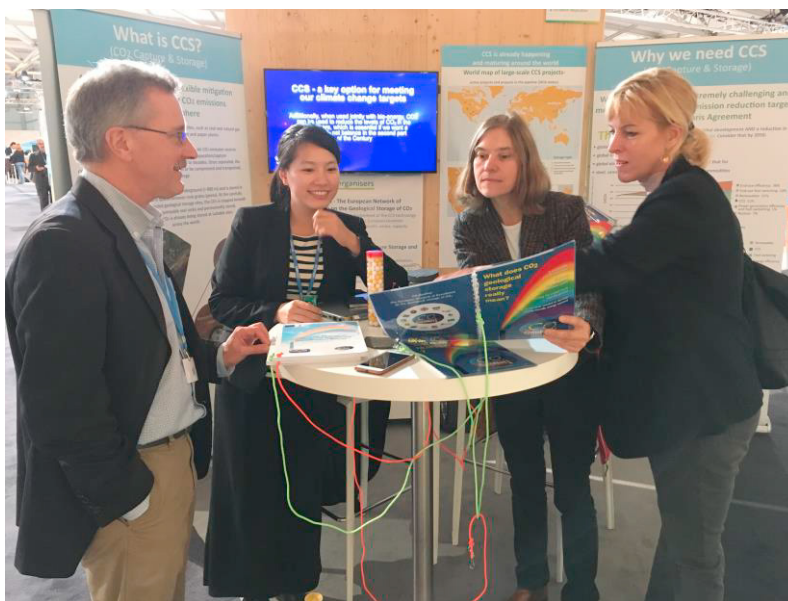


Fig. 2. Discussion at the CO₂GeoNet/TCCSUA booth at COP23 in Bonn (photo courtesy G. von Goerne)

CO₂GeoNet signed a Memorandum of Understanding (MoU) in 2008 with the IEA Greenhouse Gas R&D Programme (IEAGHG). The Association and IEAGHG exchange information on CCS development and promote each other's activities. Joint activities are also planned such as the co-organisation of side-events at the COP conferences. IEAGHG is invited each year to participate in the CO₂GeoNet Open Forum in Venice and is member of the CO₂GeoNet Advisory Body.

Since early 2014, CO₂GeoNet has been a Category A Liaison organization to the ISO TC265 Technical Committee that is establishing standards for carbon dioxide capture, transportation and geological storage. CO₂GeoNet contributed to the ISO 27914:2017 standards on CO₂ geological storage published in October 2017 and will contribute to a new paper on ‘Quantification and Verification’ currently under development.

CO₂GeoNet has been a Carbon Sequestration Leadership Forum (CSLF) recognized project since the FP6 founding contract. In 2016 CSLF appointed CO₂GeoNet, together with the UK CCS Association (CCSA), as regional stakeholder Champion for Europe. During 2017 CO₂GeoNet and CCSA sought input from European stakeholders via a questionnaire and the organization of the first CSLF Regional European Stakeholder meeting, and prepared a summary that fed the key CSLF messages for Ministers, together with the summaries coming from the Americas, the Mid-East & Africa, and the Asia regions. In 2018 CO₂GeoNet became a CSLF Allied Organization, and will therefore be invited to CSLF Technical Group meetings to present the Association activities and future plans. These presentations serve to assist the Technical Group to more effectively plan its own future activities and input from the CSLF will also guide CO₂GeoNet actions.

In 2016, CO₂GeoNet became an Associate Member of the Climate Technology Centre and Network (CTCN), which promotes the accelerated transfer of environmentally sound technologies for low carbon and climate resilient development at the request of developing countries. CO₂GeoNet presented a poster on CCS at the CTCN “First of a Kind” Climate Technology Scoping Workshop held in Copenhagen in May 2017, and provided in-kind advisory support to CTCN on possible CCS projects in Nigeria. A selection of CO₂GeoNet materials is uploaded into the CTCN knowledge management system (KMS3; an online portal/library).

CO₂GeoNet was an Associate Member of the Global CCS Institute (GCCSI) from 2014 to 2017. From 2018, as GCCSI has modified its statutes and changed to an advocacy role, targeting decision makers and opinion formers, CO₂GeoNet is now exploring collaboration opportunities around this new focus. As in previous years, GCCSI was invited to participate in the 2018 CO₂GeoNet Open Forum in Venice and will continue to sit on the CO₂GeoNet Advisory Body.

In 2017, CO₂GeoNet started a collaboration with the Taiwan Institute of Carbon Capture Storage and Utilisation Association (TCCSUA). A joint booth on CCS in the negotiations blue zone at COP23 attracted many visitors. TCCSUA also translated the CO₂GeoNet brochure ‘*What does CO₂ geological storage really mean?*’ in both Chinese traditional and Chinese brief languages, upgrading to 30 the number of languages currently available. TCCSUA also presented at the 2018 CO₂GeoNet Open Forum and collaboration is also planned at COP24.

4. Training and capacity building activities

The CO₂GeoNet strategy is to foster the training of upcoming generations of scientists that will be needed for the widespread deployment of the CCS technology.

In 2017, an Erasmus Agreement was signed between university members of CO₂GeoNet: La Sapienza university of Rome (Italy), TTUGI university in Tallinn (Estonia), METU-PAL university in Ankara (Turkey), and UNIZG-RGNF university in Zagreb (Croatia). Calls will open in 2018 to initiate students’ mobility. The Erasmus+ Programme is a European funding programme that offers university students the opportunities to study or undertake an internship in another country for 2-12 months. Exchanges are set up between participating universities, which guarantee recognition by the home university of courses successfully passed abroad.

In 2018, CO₂GeoNet was again a co-organiser of the Sixth Annual International Sulcis CCS Summer School held in June in Carbonia, Sardinia Island, Italy. CO₂GeoNet also hosted the Sulcis School workshop on Enhanced Oil Recovery (EOR) and presented in the Storage session on the state of play for CO₂ storage, advanced monitoring technologies and new drilling techniques.

The ENOS project currently provides funding for training and knowledge sharing activities. A Spring School for young scientists, dedicated to onshore CO₂ geological storage and the implementation of the EU Directive was run during a full week in May 2018 in Latera, Italy. Two e-books with nine e-lectures have been prepared during 2017. These form part of a suite of 10 lectures covering climate change, storage capacity, site selection, monitoring and modelling of storage sites and regulatory and social aspects of CCS. Nine e-lectures are now available through the ENOS website, the last one will soon be uploaded. It is also planned that a coordinated Master and post-graduate programme on CCS will be completed in summer 2018 with the first tranche of students to start in early 2019.

5. Information and communication activities

CO₂GeoNet has positioned itself as the European scientific voice on CO₂ storage and places great emphasis on the dissemination of integrated scientific research results to non-specialist audiences, and the fostering of dialogue between CO₂ storage researchers, CCS stakeholders and society.

The CO₂GeoNet lighthouse event is the annual Open Forum in Venice. In 2017 the 12th edition was entitled “Driving CCS towards implementation” while in 2018 the topic was ‘Growing CCS for a sustainable future - linking local actions for a global solution’. The Open Forum offers a unique opportunity to meet and interact directly with Europe’s largest group of researchers on CO₂ geological storage, attracting a wide range of stakeholders, including representatives from the EC, industry, regulators, public authorities, NGOs, and the research community. The involvement, support and engagement of many major global players contributes greatly to the success of the event.

Thanks to the support of the ENOS project, CO₂GeoNet organised a journalist workshop in Venice adjacent to the 2018 Open Forum to raise awareness on CCS and encourage communication between scientists and journalists. A short report will be made available soon through the ENOS website.

The CO₂GeoNet website (www.co2geonet.eu) is the leading dissemination tool of the Association. Most content is available to the public, including presentations and videos from each Open Forum and the material shared at the COP climate conferences. The Association newsletter “CO₂GeoNet Highlights” is published electronically on the website three times a year and is distributed to a wide audience via the Association mailing list. CO₂GeoNet’s views and activities are also regularly presented at international conferences and workshops.

6. Conclusion

CO₂GeoNet celebrates its 10th anniversary in 2018 as a legal entity. The Association, representing the European scientific body on CO₂ geological storage, has gained visibility and recognition in Europe and globally. CO₂GeoNet membership is still expanding, as is the Association’s multidisciplinary expertise and activity portfolio. International collaborations continue to grow. This cooperation is considered essential, as climate change is a global issue. Global cooperation is required to accelerate the development, recognition and deployment of CCS as an important and flexible climate change mitigation technology. The additional consideration of opportunities for CO₂ use may enhance the business case and facilitate wider implementation of CO₂ storage. CO₂GeoNet is looking forward to its next decade which looks exciting in terms of development of CO₂ capture, transport, storage and use clusters at territorial level and in terms of increased global cooperation.

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References

- [1] Czernichowski-Lauriol I., Persoglia S., Riley N. On-going joint research activities within the CO₂GeoNet European Network of Excellence on CO₂ geological storage, in Proceedings of the GHGT-8 International Conference on Greenhouse Gas Control Technologies - Trondheim - Norway - 18-22/06/2006, 6 pp.

- [2] Czernichowski-Lauriol I., Arts R., Durand D., Durucan S., Johannessen P., May F., Olivier M.-L., Persoglia S., Riley N., Sohrabi M., Stokka S., Vercelli S., Vizika-Kavvadias O. CO₂GeoNet, the unique role of the European scientific body on CO₂ geological storage. GHGT-9 International Conference on Greenhouse Gas Control Technologies, Washington, USA, Nov. 2008. *Energy Procedia* 1 (2009). p. 2043–2050.
- [3] Czernichowski-Lauriol I., Stead R. Developments of CO₂ geological storage in Europe and the role of CO₂GeoNet. GHGT-12 International Conference on Greenhouse Gas Control Technologies, Austin, USA, Oct. 2014. *Energy Procedia* 63 (2014). p. 8107 – 8115.
- [4] Czernichowski-Lauriol I., Berenblyum R. , Bigi S., Car M. , Liebscher A., Persoglia P., Poulsen N., Stead S., Vercelli S., Vincent C., Wildenborg T. (2017). CO₂GeoNet perspective on CO₂ Capture and Storage: a vital technology for completing the climate change mitigation portfolio. GHGT-13 International Conference on Greenhouse Gas Control Technologies, Lausanne, Switzerland, Nov. 2016. *Energy Procedia* 114 (2017), p. 7480 – 7491.
- [5] Gastine M., Czernichowski-Lauriol I., Berenblyum R., de Dios J.C., Audigane P., Hladik V., Poulsen N., Vercelli S., Vincent C.J., Wildenborg T. ENOS: Enabling onshore CO₂ storage in Europe: fostering local and international cooperation around pilot and test sites. GHGT-13 International Conference on Greenhouse Gas Control Technologies, Lausanne, Switzerland, Nov. 2016. *Energy Procedia* 114 (2017), p. 5905 – 5915.