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CO_2GeoNet perspective on CO_2 Capture and Storage: a vital technology for completing the climate change mitigation portfolio

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Abstract

As a UNFCCC accredited Research NGO, CO_2GeoNet has been deeply involved in bringing the science behind CO_2 storage and the rationale for Carbon dioxide Capture and Storage (CCS) to a wide range of stakeholders (including the general public) before, during and after the COP21 Climate Conference in Paris. Key messages on CO_2 storage, informed by dialogue with numerous stakeholders, are presented here. The overarching conclusion is that collaboration is needed at an EU and a global level to deploy CCS, a viable and flexible technology ready to play an essential role in completing the climate change mitigation portfolio.

Peer-review under responsibility of the organizing committee of GHGT-13.

Keywords: CCS ; Renewables ; Biomass ; Geothermal ; Network of Excellence ; FP7 CGS Europe ; H2020 ENOS ; RINGO ; COP21 ; COP22

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1. Introduction

CO_2GeoNet, the European Network of Excellence on CO_2 geological storage, was created in 2004 as an EU PF6 project and became an association under French law in 2008. The Association strives to enable efficient and safe CO_2 storage in deep geological formations to combat climate change and ocean acidification. With a current membership of 26 research institutes spanning 19 European countries, activities include research, scientific advice, training, information & communication [1,2,3].

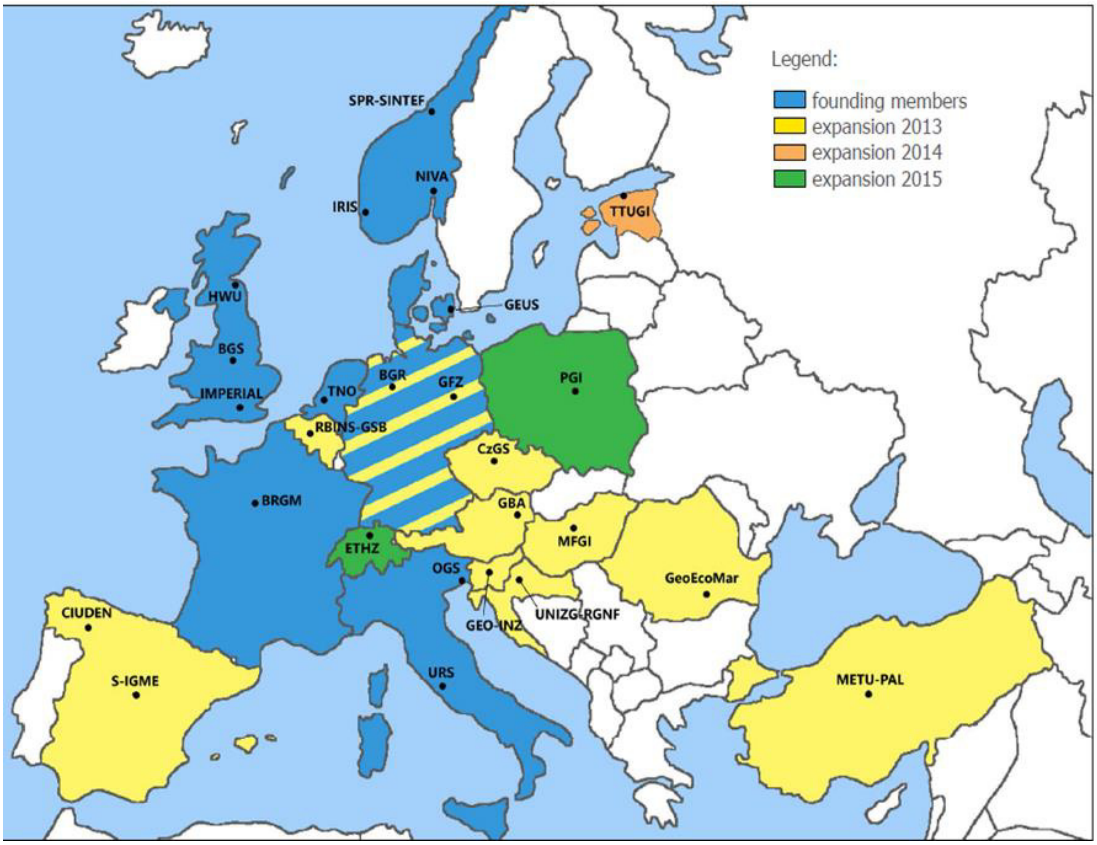


Fig. 1. The current membership of the CO_2GeoNet Association.

CO_2GeoNet, as a pan-European scientific body, has a valuable and independent role to play in enabling the deployment of the CO_2 capture and storage (CCS) technology, when and where it is needed in Europe and in other parts of the World. CO_2GeoNet is highly active on the international scene, through a cooperation agreement with the IEA Greenhouse Gas R&D Programme (IEAGHG), as an Associate to the Global CCS Institute (GCCSI), a Carbon Sequestration Leadership Forum (CSLF) recognized network, a Liaison organization in the ISO CCS Technical Committee, a UNFCCC accredited Research NGO (RINGO), and more recently as a member of the Climate Technology Centre and Network (CTCN).

The COP21 Climate Conference in Paris in December 2015 was an important milestone and CO_2GeoNet was deeply involved, before, during and after this conference, in bringing the science behind CO_2 storage and the rationale for CCS to a wide range of stakeholders including the general public. Key past events are presented below as well as a summary of key CO_2GeoNet messages resulting from dialogue with stakeholders. This is followed by

upcoming CO_2GeoNet activities, with an invitation to closely collaborate at the EU and the global level to ensure CCS can play its role as a viable and flexible technology in the climate change mitigation portfolio.

2. CO_2GeoNet dialogue with stakeholders around the COP21 Climate Conference in Paris

CO_2GeoNet has been very active over the past two years in response to the COP21 conference, enabling many interactions between the European science community and a diverse range of stakeholders to raise awareness of and show the potential role CCS can play as a valuable climate change mitigation technology. All presentations, summary reports and short videos are available on the CO_2GeoNet website at www.co2geonet.eu.

2.1. 10th CO_2GeoNet Open Forum 'CO2 storage – the cornerstone of our low carbon future', Venice, May 2015

Each year in Venice, CO_2GeoNet organizes the Open Forum, an event dedicated to discussion of all aspects of geological storage of CO_2. The 10th anniversary of the CO_2GeoNet Open Forum was celebrated on 11−12 May 2015 in Venice by gathering researchers from the global CCS community to present the latest advancements in the science and technology of CO_2 geological storage including research achievements, policy, public outreach and business development. In 2015, emphasis was placed on European - North American knowledge sharing, with the active participation of the European Commission and the US Department of Energy. The event offered the opportunity to take stock of the progress towards large-scale deployment of CO_2 geological storage and to discuss the way forward in Europe and globally.

2015 is considered as a watershed year for CCS. The UNFCCC COP21 Conference in Paris in December 2015 was an important milestone: if the agreement is fully ratified by all parties and translated into global policy, then pathways for CCS to fulfil its potential for emission abatement will emerge.

The following points were highlighted by presentations and discussions as being crucial to this process [4]:

- Clear and sustained political support remains essential for wide deployment of CCS and building a CCS business case.
- We have now reached the knowledge threshold necessary to start CO_2 storage, but research and development still has a vital role to play in lowering costs and minimising remaining uncertainties.
- It's a learning curve, the more pilots and demonstration projects we do, the 'easier' it will get.

(a) 

(b) 

Fig. 2. (a) Opening of the 10th CO_2GeoNet Open Forum in Venice; (b) Participants in front of St Mark's Church.

Two workshops following the Open Forum were jointly organised by CO_2GeoNet, the European Commission, the US Department of Energy and the European Energy Research Alliance (EERA). They focused on two issues of the CCS value chain: '*Sharing knowledge on demonstration of CO_2 capture technologies*' and '*What is needed for assuring CO_2 storage capacity?*'.

2.2. International Scientific Conference 'Our Common Future under Climate Change', Paris, July 2015

CO_2GeoNet co-organized a session entitled '*Negative emissions for climate change stabilization & the role of CO_2 geological storage'*, together with the Mercator Research Institute on Global Commons and Climate Change (MCC) from Berlin, Germany. This session was focused on negative emissions in response to the findings of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC): in order to achieve the targeted temperature increase of maximum 2°C (which equates to 450 ppm CO_2eq in the atmosphere), it is likely that CO_2 will need to be actively removed from the atmosphere. As the current atmospheric CO_2 concentration is already at 405 ppm, the mitigation measures must be profound considering that some emissions in the food system and our existing infrastructures are difficult or even impossible to reduce to zero.

During the session held on 9 July 2015 in Paris, it was recognized that CCS is currently the only mitigation option to decarbonise the fossil energy sector and carbon-intensive industries such as steel and cement production. CCS is also critical to achieving negative emissions through the underground storage of CO_2 captured at bioenergy plants (BECCS) or by Direct Air Capture (DAC) technologies. Enhanced Weathering and afforestation might also deliver negative emissions. However, all the presented Negative Emission Technologies (NETs) have limits/downsides and none is a magic bullet, so a portfolio approach which combines a number of these mitigation technologies will be needed.

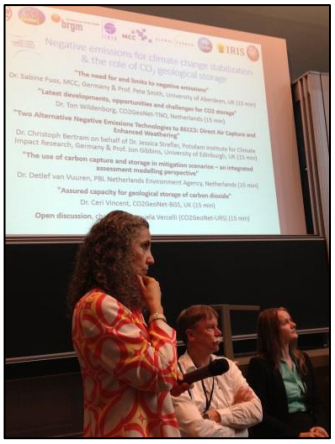
(a)  (b) 

Fig. 3. (a) CO_2GeoNet-MCC session on negative emissions at the CFCC scientific conference in Paris; (b) CO_2GeoNet side event in Caprarola, Italy.

CO_2GeoNet was also a co-organizer of three officially recognised side events that took place elsewhere in Europe. The first one took place in Caprarola, Italy, on 20 June 2015 and was entitled '*A dialogue for developing synergies for sustainable energy production: how can biomass, hydrogen and CCS work together to mitigate climate change?*'. The aim of this event was to foster science – society dialogue and to develop energy synergies. The second side event took place in London, UK, on 1 July 2015 and was entitled '*What geological CO_2 storage can bring to mitigating climate change - UK research perspective*'. The main aims of the event were to increase dialogue between key stakeholders and to develop new research partnerships. The third side event took place in Rome, Italy, on 13 July 2015 and was titled '*The potential contribution of CO_2 Geological Storage to climate*

change mitigation, both globally and in Italy'. The goal of the event was to illustrate the potential application of CCS in Italy, to outline the state-of-the-art on CCS technology and to stimulate interest and debate on the potential contribution CCS can make to Italy's future greenhouse gases emission cuts.

2.3. CSLF Technical Group and Ministerial Meeting, Riyadh, November 2015

CO_2GeoNet was invited to give a presentation entitled '*Update on CO_2GeoNet and CGS Europe Projects*' at the 6th CSLF Ministerial Meeting, held on 1-5 November 2015 in Riyadh, Saudi Arabia. CO_2GeoNet had the opportunity to contribute to the final CSLF Ministerial Communiqué '*Moving Beyond the First Wave of CCS Demonstrations*'. During the five-day event, CO_2GeoNet also organised a booth where brochures, videos and material relating to its activities were displayed. The Arabic language version of the CO_2GeoNet brochure 'What does CO_2 geological storage really mean' was particularly appreciated and widely distributed.

The FP7 CGS Europe project, which was an initiative of CO_2GeoNet, received the CSLF Global Achievement Award in recognition of its advancement of CCS technologies. CGS Europe was a collaborative venture, involving 34 research institutes from 28 countries in Europe, with extensive structured networking, knowledge transfer, and information dissemination activities. Building upon the previous FP6 CO_2GeoNet project, also recognized by CSLF, the goal of the CGS Europe project was to develop an independent and durable pan-European scientific body on CO_2 geological storage. The CGS Europe Project has successfully reached this goal and many partners have continued to collaborate after the project finished by joining and enlarging the CO_2GeoNet Association. Major achievements of the project included increased international collaboration on CO_2 geological storage activities and production of key documents on CCS: the state-of-play in Europe on CO_2 geological storage [5], opportunities for CO_2 storage pilot projects across Europe [6], state-of-the-art monitoring techniques [7], site selection and characterisation methods [8], and a review of directives and regulatory regimes [9].

Fig. 4. (a) Presentation of CO_2GeoNet and CGS Europe activities in Riyadh; (b) CSLF Award to the CGS Europe project.

2.4. COP21 Climate Conference, Paris, December 2015

The 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC), which took place in Paris-Le Bourget from 30 November to 11 December 2015, represented an important opportunity to communicate the potential role for geological storage of CO_2 in a low carbon future to decision makers, the general public and other key stakeholders.

As a 'Research Institution Non-Governmental Organisation' (RINGO), CO_2GeoNet was able to access the negotiation 'blue zone' to organise and participate in knowledge sharing activities. On 1 December 2015 CO_2GeoNet co-organised the UNFCCC CCS side event entitled '*Carbon Capture and Storage (CCS): Achievements*

and Opportunities for Developing Country Involvement', together with IEAGHG, the University of Texas at Austin, and the Carbon Capture and Storage Association (CCSA). On 8 December 2015 CO_2GeoNet presented on '*North Sea Basin CO_2 storage opportunities*' at the CO_2 storage side event held in the Bellona Pavilion. On 10 December 2015 CO_2GeoNet led on a side event in the EU Pavilion on '*The role of CCS (Carbon dioxide Capture and Storage) in mitigating climate change*'. During the two weeks, CO_2GeoNet co-organised a booth on CCS which received many visitors, particularly from developing countries.

The activities in the open access 'climate generations areas' were also very important for CO_2GeoNet as they offered an excellent opportunity to communicate the science supporting geological storage of CO_2 to a wider audience. CO_2GeoNet organised a side event in French on 2 December 2015 entitled '*CO_2 Capture and Storage: a proven and safe technology vital for completing the climate change mitigation portfolio*'. At the CO_2GeoNet-led booth, hands-on experiments were presented during the two weeks to the visitors to better explain how CO_2 is safely stored deep underground and what happens in the reservoir. Posters prepared by our co-organisers illustrated the full CCS process. The CO_2GeoNet brochure 'What does CO_2 geological storage really mean' was displayed in 28 languages.

All the information presented at COP21 with more detail on the CO_2GeoNet events is available through our dedicated website http://cop21.co2geonet.com/.

(a) 

(b) 

Fig. 5. (a) CCS side event in the COP21 negotiation zone, Dec. 1st, 2015; (b) CCS side event in the COP21 public zone, Dec. 2nd, 2015.

2.5. ATEE Conference 'Coupling CO_2 storage and Renewable Energy as part of integrated territorial energy and climate plans', Orléans, March 2016

This event was co-organised by CO_2GeoNet with the French ATEE Technical Association Energy Environment and took place in BRGM headquarters in Orléans, France, on 30 March 2016. The event focused on coupling CO_2 storage with bioenergy and geothermal energy, and considering its application to regional contexts and small emitters. Coupling CO_2 storage with geothermal energy could offer the possibility of renewable heat production, while coupling it with biomass energy could enable removal of CO_2 from the atmosphere, therefore generating negative carbon emissions.

The outcomes of the COP21-related events that were organized in Paris by CO_2GeoNet were presented, as well of the results of two national CO_2 storage feasibility studies based on the case study of Artenay sugar biorefinery north of Orleans. The feasibility studies were carried out through the now completed CPER Artenay project [10] funded between 2008 and 2010 by a contract between the State and Region « Centre - Loire Valley » (storage of CO_2 in a dense form), then through the recent CO_2-DISSOLVED project [11] funded by the French National Research Agency (ANR), which ended in late April 2016 (storage of CO_2 in a dissolved form, coupled with the recovery of geothermal energy). Presentations were followed by discussions on opportunities to integrate CO_2

storage into regional policies and to carry out a CO_2 storage pilot project, which could be coupled to geothermal and biomass energy, in a region like the « Centre - Loire Valley » Region.

The main outcomes were as follows:

- CO_2 geological storage is a solution that can be integrated into national and regional climate-energy plans, whether CO_2 is stored in a dense or a dissolved form.
- CO_2 storage in dissolved form, combined with the production of geothermal heat, is a new concept well suited to small CO_2 emitters and decentralised solutions.
- Coupling biomass energy with CO_2 storage offers a real opportunity to form a carbon sink.
- Preliminary studies suggest that storing CO_2 from the case study of Artenay sugar biorefinery could be viable for a CO_2 price of around € 30 per tonne on the carbon market. As this is not currently the case, investment is not yet justified for this project.
- Small-scale pilots are good drivers for stimulating research and innovation and for informing potential operators, public authorities, lawyers and the general public.
- CO_2 storage is currently not well integrated in the Regions' Strategies for Smart Specialisation, which is a prerequisite to benefit from the European Structural Funds (ERDF). Synergies between regional, national and EU funds would help pilots to emerge.
- In order to integrate CO_2 storage in the regional research and innovation priorities, it is important to inform regional politicians about this technology and to make the knowledge accessible. Policy makers will need information on safety, risks, economic profitability, the creation or maintenance of jobs.
- In conclusion, the implementation of a CO_2 storage pilot in France in a deep saline aquifer, possibly combined with renewable biomass or geothermal energy production, offers a route for French academic and industrial players to fine-tune CO_2 storage technologies and to prepare themselves to deploy the technology domestically and abroad when economic conditions are more positive, particularly when a minimum carbon price in the market has been fixed.

All presentations and the Summary Report in French [12], with an executive summary in English, are accessible through the CO_2GeoNet website.

2.6. CO_2GeoNet input to the EC Consultation on the CCS and CCU Issues Paper of the SET Plan, April 2016

CO_2GeoNet responded in April 2016 to the European Commission by providing advice on the Issues Paper titled *'Renewing efforts to demonstrate carbon capture and storage (CCS) in the EU and developing sustainable solutions for carbon capture and use (CCU)*', which corresponds to Action 9 (out of 10) of the European Strategic Energy Technology Plan (SET Plan). The key CO_2GeoNet recommendations, unanimously supported by its members, were as follows:

- For developing a Storage Atlas in Europe, it must be clear that site assessment needs to be performed using a universally agreed methodology. This may require access to more data and acquisition of new data, and to dynamic calculations of storage capacity.
- The Storage Atlas should be aligned with other activities on sustainable use of the subsurface for geo-energy applications.
- A portfolio of storage sites with bankable storage sufficient for at least the first two decades of storage is urgently needed.
- CO_2 storage pilots should be planned in areas and in storage media that have upscaling potential, or that can be used to test specific, complex aspects of storage. The pilot projects should be aligned with the activities for the storage atlas.
- Transport and storage (T&S) may need to be developed initially on a regional scale from the start, though this should be part of a national strategic plan. Cross border infrastructure should be a central issue and taken into account when constructing the first T&S elements as part of the first CCS project.

- Member States should be urged to develop Master Plans for CCS, according to the COP21 Paris Agreement, by 2020 at the latest. These Master Plans should include feasibility of national storage demonstration and/or commercial scale projects or projects in collaboration with other countries if national storage options are limited.
- A reliable business model, regulatory framework and public acceptance are crucial aspects for successful deployment of CCS. Member States and the EC need to support the implementation of CCS up to the time that it can be deployed at full commercial scale. They should provide the financial and regulatory frameworks during the pilot and demonstration scale level of CCS.
- Public acceptance is particularly important in densely populated onshore areas. The use of multimedia tools for dissemination of information to the public should be intensified as well as improved monitoring techniques to increase the confidence of the public in CO_2 storage.

2.7. 11th CO_2GeoNet Open Forum 'Increasing the momentum for CO_2 storage', Venice, May 2016

The objective of the 11th Open Forum, held on 9−10 May 2016 in Venice, was to discuss the science supporting geological storage of CO_2 and the way forward for increasing the momentum for CCS in Europe and globally. It took place only a few months after COP21, while enthusiasm for action was still fresh. 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 CCS, are needed to meet the challenge. Delays in reducing emissions will result in greater climate change impacts, higher costs and limited future choices. The CCS community needs to intensify its endeavours for widespread implementation of CCS.

The key messages for CCS coming out of the Open Forum are as follows [13]:

- Political support remains essential for wide deployment of CCS and building a CCS business case. This support is an important part of improving the business case for CCS.
- CCS is a flexible technology, ready to be progressively deployed to reduce emissions from the industrial and power sectors.
- CCS can play an important role in achieving negative emissions through CO_2 removal from the atmosphere via sustainable biomass with CCS or direct capture of CO_2 from the atmosphere and storage in the deep subsurface.
- Strategic development and investment are required in order to grow integrated CCS infrastructures.
- Flexibility needs to be built into CCS projects and infrastructure in order to be responsive to the needs of stakeholders, such as systems with intermittent energy sources and CO_2 sources from different sectors, as well as to respond to funding opportunities.
- Research and Development (R&D) needs to enable continuous refinement of storage site performance and reduce costs of emission reduction technologies. R&D is an important collaboration opportunity for Member States.
- Dialogue, knowledge sharing and capacity building activities are key to advancing CCS. It's a learning curve, the more pilots and demonstration projects we do, the 'easier' it will get.
- To develop implementation plans at national and regional levels for the reduction of greenhouse gas emissions well before 2050, dialogue and concerted action are needed now between the various communities working on mitigation technologies, in particular on CCS and renewables, as well as with energy system planners, decision makers and the general public at the national and regional level.

Several workshops following the Open Forum were jointly organised by CO_2GeoNet, the European Energy Research Alliance (EERA), Gassnova and the REPP-CO_2 project. The workshops considered in more detail three aspects of CO_2 storage, which related to '*Final closure, liability and transfer of responsibility of the storage site*', '*Enabling Transport and Storage Networks to Serve Distributed Capture Projects – The Missing Link?*', and '*CO_2 Storage Pilot Projects in Europe*'.

(a) 

(b) 

Fig. 6. (a) Opening of the 2016 CO_2GeoNet Open Forum; (b) Presentation of the Czech storage pilot project.

2.8. CO_2GeoNet session at the 43rd IAH International Congress, Montpellier, September 2016

The congress, entitled 'Groundwater and society: 60 years of IAH', was organized by the International Association of Hydrogeologists (IAH) in Montpellier, France, on 25-29 September 2016. CO_2GeoNet organized a session on CO_2 storage entitled '*CO_2 storage in deep saline aquifers and potential impacts on shallow aquifers*'. Main topics discussed were:

- CCS status in Europe and globally, with a focus on storage in deep saline aquifers.
- Possible impacts on potable groundwater resources in case of a CO_2 leak from a deep storage reservoir: laboratory experiments, controlled release field experiments, modelling, monitoring.
- Modelling of processes in the CO_2 storage reservoir, in both the near and far field.

The session highlighted good progress had been made on the understanding of fine scale phenomena and on the development of monitoring and modelling techniques.

3. Summary of CO_2GeoNet key messages, developed through continual interaction with stakeholders

The perspective from the CO_2GeoNet European Network of Excellence on CO_2 geological storage can be summarized by the following key messages, which were informed by over 10 years of joint research and interaction with numerous stakeholders during all the events described above.

- CCS is a viable technology to reduce emissions resulting from fossil fuel combustion and industrial processes and even an opportunity for negative emissions through integration with renewable energy from biomass (BECCS) or direct air capture. This makes CCS a very flexible technology to mitigate climate change.
- The longer the deployment of key mitigation technologies is delayed, the more expensive and the more challenging it will be to keep global temperature change below 2°C. CCS provides a timely, highly scalable and cost effective pathway to pursuing this much needed step-change action.
- The Paris Climate Agreement, including the highly challenging objective to try to limit global warming to 1.5°C, requires even stronger efforts in CCS technology development, transfer of knowledge and capacity-building. Developed countries have the responsibility to provide support to developing countries for enabling the use of CCS.
- CO_2 can be stored safely and efficiently in deep geological formations. Currently, through 22 large-scale projects in operation worldwide, over 20 Mt of CO_2 are captured from power and gas production and injected into saline aquifers and hydrocarbon reservoirs each year, with 50 Mt already securely stored.
- More demonstration and pilot projects in a wide range of geological settings, with both knowledge-sharing and public outreach activities, are needed in Europe and worldwide to rapidly advance CCS technology.

- The importance of further research activities focused on decreasing costs and increasing the reliability and efficiency of methods and tools for the characterization, operation, monitoring, and closure of storage sites, as well as for creating synergies with other uses of the subsurface and avoiding conflicts of use, is clear.
- In addition to large storage sites offshore, smaller and distributed storage sites onshore closer to emitters offer more flexibility to regions for managing their CO_2 emissions locally while contributing to local economic development, with possible combination of CCS with other local activities such as renewable biomass and geothermal energy, CO_2 use, or capture of atmospheric CO_2.
- Assurance of storage capacity is a crucial boundary condition for the broad commercialization of CCS technology. Sufficient storage potential is available, but needs to be certified in terms of sustainable injection rates of CO_2, such that 'bankable' storage space is available when needed. This certification can be executed in a staged manner over future decades. It is imperative to start new storage operations now in high-potential regions where there is enough certified storage capacity for at least the next decade.
- CCS is a ready-to-go climate change mitigation technology that countries or operators who still wish to make the choice to use fossil fuels, even partially, should have the duty to implement. Returning the carbon back into the underground where it was extracted is a virtuous loop for protecting the environment and the climate.

4. Upcoming key CO_2GeoNet activities to enable the use of CCS as a climate change mitigation technology

Important research and knowledge sharing activities are planned for the coming months. The main activities planned so far are presented below.

4.1. H2020 ENOS project 'Enabling Onshore CO_2 Storage in Europe'

The ENOS project, an initiative of CO_2GeoNet, 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 programme. ENOS is a pan-European effort with 17 involved countries, tackling the specificities and concerns about onshore CO_2 storage, which is needed 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 CO_2 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 CO_2 geological storage into the socio-economic fabric of the concerned territories.
- Contributing to the creation of a favourable technological and societal environment for onshore storage across Europe.

More details are given in [14].

4.2. COP22 Climate Conference, Marrakesh, November 2016

Following the successful participation of CO_2GeoNet at the COP21 conference in Paris at the end of 2015, plans are underway to undertake knowledge sharing activities at COP22 in Marrakesh, Morocco, 7–18 November 2016. As a recognised UNFCCC observer organization, CO_2GeoNet will be active in the blue negotiation zone through an exhibit during the two weeks and a side event on 8 November entitled '*Opportunities for Africa in Carbon Capture and Storage (CCS)*'. CO_2GeoNet will again collaborate with IEAGHG, the University of Texas at Austin, and the Carbon Capture and Storage Association (CCSA). This year, the focus will be to highlight opportunities for CCS in Africa, progress towards deployment in Africa and global CCS developments relevant for Africa, both onshore and offshore. The exhibit will promote CCS as a recognized technology to achieve greenhouse gas emission reductions and helping to reach the Paris Agreement targets. Steps for CCS pilot project development and new opportunities for technology transfer will also be explored. CO_2GeoNet will also be present in the green zone open to the public

through a side event on 10 November entitled '*Carbon dioxide Capture and Storage (CCS): what it's all about and why we need it'*.

4.3. CO_2GeoNet session at AGU Fall Meeting, San Francisco, December 2016

The annual American Geophysical Union (AGU) Fall Meeting is one of the largest earth and space science meetings globally. For the next edition on 12–16 December 2016 in San Francisco, the AGU Program Committee adopted CO_2GeoNet's initiative to organise a session entitled '*Lessons learned from CO_2 Geological Storage research in Europe: natural laboratories, site characterisation, monitoring, modelling, and advances in understanding associated processes*'. Amongst the many issues covered, recent European CCS research projects and activities conducted at demo, pilot, and industrial scale, will be presented and discussed.

4.4. 12th CO_2GeoNet Open Forum, Venice, May 2017

The CO_2GeoNet Annual Open Forum will take place on 8-12 May 2017 in Venice. Several workshops will also be jointly organised during that week by CO_2GeoNet with other initiatives and projects. A special focus will be given to the H2020 ENOS project. Stakeholders from Europe and the rest of the world will be invited to present and discuss CO_2 geological storage with Europe's largest community of CO_2 geological storage researchers.

5. Conclusions

After more than two decades of research in Europe and worldwide, CCS is gaining visibility and credibility as a viable and flexible climate change mitigation technology. But efforts to enable this technology need to be sustained. The Paris Climate Agreement, including the highly challenging objective to try to limit global warming to 1.5°C, requires rapid and determined efforts in CCS technology development, knowledge transfer and capacity-building. CO_2GeoNet is committed to contribute to enabling CO_2 storage by performing high quality research and offering independent advice, in order to support implementation of CCS in Europe, in developing countries and the rest of the world as a key component of integrated energy and climate plans. CO_2GeoNet will continue to collaborate with CCS networks and initiatives at global, European, national, regional and local levels as well as continuing dialogue with all types of stakeholders to support advancement of CCS technology. CO_2GeoNet welcomes new members to complement the multi-disciplinary expertise needed for the future of CO_2 geological storage.

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