



A CO₂GeoNet Initiative

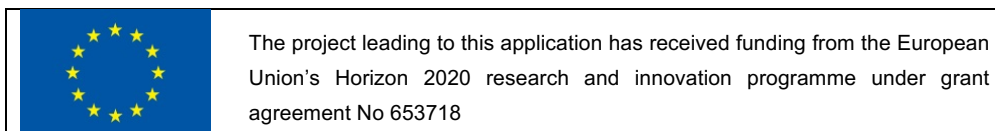
ENOS D7.11 | v1.0

Results of the CO₂GeoNet Open Forum 2019 (ROF2018)

Date 20 June 2019

Author(s) Barbara Merson OGS, Marjeta Car CO₂GeoNet-Geolnz, Rowena Stead BRGM, Sergio Persoglia CO₂GeoNet, Ceri Vincent BGS, Roman Berenblyum NORCE.

Number of pages 19 + appendixes
Number of appendixes 2
Customer EC
Project name ENOS
Project number GA No 653718



Public

Contents

- 1. Introduction3**
- 2. CO₂GeoNet Open Forum 20194**
 - 2.1. CO₂GeoNet Open Forum day 14
 - 2.2. CO₂GeoNet Open Forum day 26
 - 2.3. CO₂ storage stories: learning by doing.....7
 - 2.4. National networking: driving CCS forward9
 - 2.5. Towards commercialization: insights from US and Norway 11
- 3. Event visibility14**
 - 3.1. Announcements and on-line news14
 - 3.2. Open Forum website 15
- 4. Results and key messages from the open forum17**
- Appendix 1 - The Programme.....18**
- Appendix 2 – Key messages19**

1. Introduction

CO₂GeoNet is the European scientific body on CO₂ geological storage. The Association currently comprises 30 research institutes from 21 European countries, and brings together over 300 researchers with the multidisciplinary expertise needed to address all aspects of CO₂ storage. With activities encompassing collaborative research, training & capacity building, scientific advice, information and communication, CO₂GeoNet has a valuable and independent role to play in enabling the efficient and safe geological storage of CO₂. CO₂GeoNet was created in 2004 as a Network of Excellence supported by the EC FP6 programme for 5 years. In 2008, CO₂GeoNet became a non-profit association under French law, active on both the EU and global scene. From 2013, the membership of CO₂GeoNet expanded thanks to the support of the now completed FP7 CGS Europe project. New Members continue to join CO₂GeoNet to further enhance the pan-European coverage and expertise of the Association. The annual CO₂GeoNet Open Forum, now in its 14th year, has become a “must-attend” event for stakeholders, including EU representatives, industry, regulators, public authorities, NGOs, and the research community.

The Open Forum offers a unique opportunity to meet and interact directly with Europe’s largest group of researchers on CO₂ geological storage. This year, a workshop organised by **CO₂GeoNet** and **CSLF**¹ to share lessons learned from practical projects preceded the main forum. Two post-forum workshops also took place, one co-organised by **ENOS**² and one organised by **CLIMIT**³ and **ARI** (Advanced Resources International Inc.).

As with previous editions of the Open Forum, the main theme was chosen to highlight how a growing consciousness is emerging on the relevance of CCUS techniques for achieving the Paris Agreement targets and to stress that CCUS projects have to be deployed globally and as soon as possible.

This concept is also reflected in the sequence of the titles of the last editions of the CO₂GeoNet Open Forums:

OF 2014 – Horizon CO₂ storage

OF 2015 – CO₂, the cornerstone of our low carbon future

OF 2016 – Increasing momentum for CO₂ storage

OF 2017 – Driving CCS towards implementation

OF 2018 – Growing CCS for a sustainable future: linking local actions for a global solution

OF 2019 – Act now for zero emissions: the role for CCUS

----- *** -----

This document presents the Open Forum and the workshops. It also summarises the event visibility and the Key Messages, which emerged from the above events.

All the presentations held in the 14th CO₂GeoNet Open Forum and workshops are available at:

<http://conference2019.co2geonet.com>.

The full programme is included in Appendix 1. The Key Messages are included in Appendix 2.

¹ CSLF; Carbon Sequestration Leadership Forum, a Ministerial-level international climate change initiative focused on the development of improved cost-effective technologies for CCS

² ENOS; ENabling Onshore Storage, a H2020 project that is an initiative of CO₂GeoNet. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 653718

³ CLIMIT; a programme for research, development and demonstration of CCS technologies, carried out in cooperation between the Research Council of Norway and Gassnova

2. CO₂GeoNet Open Forum 2019

Act now for zero emissions - the role for CCUS

2.1. CO₂GeoNet Open Forum day 1

May 7, 2019

The Open Forum opened with a welcome from Sergio Persoglia, the Secretary General of CO₂GeoNet, who highlighted the fruitful collaboration with CLIMIT, ARI, the ENOS project and CSLF - co-organisers of the pre- and post-forum workshops. He also thanked the sponsors of the 14th Open Forum (ClubCO₂, SILIXA, BELLONA, OGS, TCCSUA, RVO, CLIMIT, ARI) and the important international initiatives that endorsed the event: ZEP, IEAGHG, CSLF, EERA-CCS and the EC, through the H2020 funded project ENOS. Around 100 registered participants from 24 countries (including Canada, USA, Japan, Taiwan and Korea) contributed to the successful four working days. After the introduction, Ceri Vincent, president of CO₂GeoNet, summarised the objectives of the Open Forum.

Chris Davies, member of the European Parliament for 15 years, team leader for his political group on the environment committee and rapporteur for the Geological Storage of CO₂ Directive, gave the keynote speech “CO₂ Storage - time to shift gear”. His engaging message started with a fair critique to the CCUS community: “... no more Mr. Nice Guy – we need to be more active and bolder in promoting the need for CCS. Lots of reports, programmes, projects, conferences are around. But we don’t seem to be moving as fast as we should”. “... and we need CCS to reduce emissions from industries that make products we want; we need CCS to provide us with much of the CO₂-free hydrogen that will heat our homes and power our transport. We need CCS to reduce emissions from the power sector; we need CCS to take CO₂ from the air and from the burning of biofuels; we need CCS to compensate for our failure to reduce emissions in other sectors.” “Your work – he added at the end – however specialised and detailed, needs to be used as a means of communicating with the ignorants (and by that I mean policymakers). There is so much to be done and you should be proud of being involved.”

The first session - ***Four years after the Paris Agreement: update on trends and achievements towards climate goals*** – explained the EU perspective regarding the role of CCUS in the Clean Energy Transition with a presentation prepared by DG Research & Innovation. Joelle Rekers, who head of a team on CCS at the Dutch Ministry of Economic Affairs and Climate Policy, illustrated how CCS can tackle industrial emissions in The Netherlands in the short-medium term. Mark Ackiewicz, Director for the Division of Carbon Capture, Utilisation and Storage (CCUS) Research and Development at the U.S. Department of Energy (DOE) presented Carbon utilisation challenges and opportunities. The session closed with a description of the status and challenges of CCS in South Korea presented by Prof Seong-Taek Yun from the Korea CO₂ Storage Environmental Management Research Center.

The second session - ***Leading edge trends in CCUS: utilisation & storage for long-term emission reduction and removal of CO₂*** – focused on running projects and well-advanced plans to introduce CCUS techniques to reduce CO₂ emissions in industry as well as how to give value to CCU chains to improve the business case for CCUS.

The first example, presented by Lars Ingolf Eide, now a consultant after a long career in the Norwegian oil industry, illustrated the development and use of hydrogen (H₂). The demand for Green H₂ (generated by electrolysis using renewables) and Blue H₂ (generated by methane reformation) is expected to grow significantly towards 2050. Fuel switching from natural gas to

Blue H₂ can produce significant CO₂ emission cuts and offers a flexible energy source that works synergistically with intermittent renewables.

Cleaner is a running research project, supported by the EU and coordinated by Martina Fantini. The project intends to prove and optimize the capture of CO₂ in the cement industry through a calcium looping process. The technique will be brought to Technology Readiness Level (TRL) 7 by a new demonstration system connected to an operating 300,000 ton/y cement plant at Vernasca, operated by Buzzi.

Catherine Boccadoro, a Research Director at NORCE (Norwegian Research Centre), presented a Circular Economy concept (a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops). Captured CO₂ can be an important element in many circular value-chains. As an example, she illustrated the evaluation CO₂ from different sources to improve microalgae production of commodities such as lipids, carbohydrates, proteins and other valuable compounds.

The third session ***Plug & Play Storage – how close are we? Providing a transport and storage service*** – considered two main issues: the challenges for starting transport and storage networks in Europe and the road ahead for building on successful CCS project experience to establish business cases for future fully integrated projects.

The point of view of Bellona⁴ on the public good role for CCS in a just transition and a low emission future, was given by Jonas Helseth, the Director of the EU policy office of the Bellona Foundation. Bram Herfkens, Project Manager for CO₂ storage in the Rotterdam CCUS Project, then illustrated the ambitious Porthos project, which will transport the CO₂ from a number of industrial plants in the Rotterdam harbour area to a depleted gas field with proven geological storage structures. The goal is to store more than 37 Mt CO₂ in the short term, with the potential to accommodate more CO₂ from the Netherlands, Germany and Belgium in the long-term.

Laurent Fritz, a senior geologist working at Total E&P Norge AS as a Subsurface Coordinator in the Northern Lights Project and Diego Alejandro Vasquez Anzola, a senior geoscientist and geophysicist working at the Northern Lights project as Shell Subsurface Coordinator, illustrated it is possible to build on successful projects (e.g. Sleipner, Snohvit) when planning new more advanced and fully integrated projects.

Roman Berenblyum, chair of the CO₂GeoNet Executive Committee summarised the key message from the day: speakers and participants talked at length about business cases, life cycle analysis, investable storage, enabling policies to create business environments conducive to CCS, incentives, infrastructure, high TRL technologies and the value of sharing practical experience. There were clear indications of finances mobilisation at least in the USA due to new tax incentives. Moreover, the third session emphasised that large companies are investing a fair share of their R&D budgets to CCS. There was a strong consensus that open and clear communication to public/politicians/industry/philanthropists remains a crucial topic. Framing the conversation and building confidence using already proven and working CCS technology is vital.

⁴ Bellona is an independent non-profit organisation that aims tackle the climate challenge by identifying and implementing sustainable environmental solutions

2.2. CO₂GeoNet Open Forum day 2

May 7, 2019

The first session of the second day was devoted to **Communication: putting people at the centre, engaging and creating benefit for the community**

John Scowcroft highlighted the most common errors researchers commit when trying to communicate with the general public. In addition, sufficient attention is rarely given to the importance of building personal relationships. At the end of his presentation, he gave examples of simple and effective images to explain why we need to care about climate change and suggested the CCS community needs to “build an advocacy army”. Important CCS project members, parliamentarians, diplomats, academia – and “leverage media” need to build enduring relationships with key opinion influencers, broaden the media constituency, refresh the language used and key messages.

Marie Gastine illustrated how the ENOS project is interacting with local communities by engaging with local citizen groups. These local groups are helping produce communication materials to answer the questions most commonly asked by civil society about CO₂ storage. Public engagement and communication is of particular interest for the ENOS project which aims to enable onshore storage of CO₂, potentially near communities.

Samuela Vercelli and Mathew Humphrey then gave further details on ENOS case studies and communication materials. Creating the conditions for people to participate via reciprocal dialogue and training researchers to communicate more effectively with external stakeholders is required to overcome one of the key barriers to deployment of CCS technology, which has up to this point, developed largely in isolation. These concepts have been applied and tested in a series of meetings and sessions and the key learnings confirmed that citizens are engaged and ask complex and informed questions. Moreover, the public participants appreciate that their questions are addressed (either in the meeting, or with more information provided afterwards). By doing so, the citizens demonstrated an increased interest for the technical aspects of CCS as they related to the specific ENOS project more broadly.

Anne-Beth Skrede, of the Norwegian Confederation of Trade Unions, showed a very inspiring movie “Involving trade unions in climate actions to build a just transition”⁵. She shared details from a comprehensive study performed in Norway, which estimated that a European CCS industry could generate 30,000 - 40,000 CCS-related jobs in 2030 and 80,000 – 90,000 jobs in 2050.

The Open Forum continued with Breakout sessions: building on knowledge shared during previous presentations, participants were asked to work together to prepare key messages on CCS that could be shared with the public and other stakeholders. These key messages focused on illustrating how CO₂ storage can contribute to the just energy transition and achieving the climate targets as well as contexts for application of CO₂ storage, possible synergies with renewables and other technologies, relationship with energy storage, etc.

In the following session **Integrating CCS into our low carbon society**, Ingvild Ombudstvedt shared information on the development of technical ISO standard for CCUS and how important standards are in commercialising and transferring technologies.

Jonathan Pearce summarised the preliminary results of the ERA-NET ACT ELEGANCY project. This project considers how to enable a low-carbon economy via hydrogen and CCS. Government and industry studies have been combined to present scenarios of increasing low-carbon growth

⁵ <https://www.youtube.com/watch?v=xwMQref6xhc>

and geographical extent, for capture of CO₂ from industrial processes, and strategies for hydrogen to decarbonise heating and transport.

Another business case study on how CCS can economically benefit the local population, was presented by Mariëlle Koenen, illustrating how CO₂ can be temporarily stored in a suitable geological reservoir offshore Rotterdam and then be recovered and used in greenhouses, thus solving the mismatch in seasonal supply and demand.

Reuse of depleted gas reservoirs and existing wells is a very interesting option for safely storing large quantities of CO₂ and Filip Neele illustrated the result of ERA-NET ACT ALIGN-CCUS, a project evaluating how to expand large-scale storage for industry by exploiting existing infrastructure (wells and pipelines) in the offshore Netherlands.

The final part of the session was devoted to large-scale CCS projects. Yoshihiro Sawada presented on the Tomakomai and other CCS projects in Japan, and Randall Locke presented plans for scaling up CCS in the Illinois Basin. Tomakomai is of a great interest for a number of aspects, including its comprehensive monitoring network with sensors deployed on land and at sea and its location in a populated area. The development of CCS in the Illinois Basin is a case study of how a pilot project storing less than 10 kton CO₂, can then be used to develop demonstration (1 Mton/y CO₂), industrial (3 - 5.5 Mton/y CO₂) and finally commercial scale storage (storing more than 50 Mt/y CO₂).

The overall Open Forum was then closed by Ton Wildenborg, former President of CO₂GeoNet, with his final remarks on the key messages from the Open Forum.

The Key messages from the Open Forum have been prepared and are available through the conference website.

2.3. CO₂ storage stories: learning by doing

*Pre-Open Forum workshop organised by CSLF and CO₂GeoNet
May 6, 2019*

The concept for this joint workshop was developed after the success of the CSLF Technical Group (TG) Meeting, held in Venice last year. During that meeting, CO₂GeoNet updated the CSLF TG on recent Association activities and many of the stakeholders also attended the 13th Open Forum.

CO₂GeoNet is a recognised Allied Association of the CSLF Technical Group and representatives of the CSLF initiative are members of the Scientific Advisory Board of CO₂GeoNet. Thus, there is not only a common aim to increase collaboration, but also a strong consensus on the necessity to share, as much as possible, knowledge on CCS, including from real pilot and demo projects, in whichever part of the world they are running. A natural consequence of this common aim was the idea to co-organise this workshop, by inviting researchers to share practical lessons learned from real projects.

To focus the workshop, presentations were invited to share key learnings around three key topics; seismicity, injectivity issues and effective monitoring networks.

Regarding **Seismicity**, Randall Locke shared lessons learned at Decatur (Illinois Basin), one of the most important USA projects. A comprehensive monitoring network, active for one and a half years before the first CO₂ injection, detected in that period some 7,900 microseismic events (i.e. movements in the subsurface too small to be felt, detectable only with highly sensitive instruments), most related to drilling and well activities or distant surface mining and very distant earthquakes. Microseismic monitoring continued during the CO₂ storage phase,

no seismic events were felt and the microseismic events were grouped in distinct clusters along pre-existing faults/fractures, consistent with regionally known stress trends, mainly in the rocks underneath the storage reservoir. The events catalogue was used to inform operational parameters for the following industrial-scale demonstration project, which will store up to 5 million tons of CO₂ over a period of 3 years. Injection will take place in a shallower part of the sandstone sequence to reduce the amount of microseismic events. Both baseline monitoring prior to injection and monitoring during the injection confirmed predictability and safety of subsurface operations.

Yoshihiro Sawada summarised recent results from the Tomakomai CCS demonstration project in Japan. On 6 September 2018, an earthquake of 6.7 magnitude occurred at a depth of about 37 km, with an epicentre about 30 km in horizontal distance from the CO₂ storage project. This event and aftershocks were monitored with a comprehensive set of sensors, deployed both on land and at sea. This network made it possible to verify the absence of any relationship between the CO₂ injection project and the earthquake. . In addition, despite the strength and proximity of the earthquake, no CO₂ leakage was detected. This event clearly indicated the importance of a rapid and expert response; an independent panel was convened to confirm that there was no link between the earthquake and the CCS project and the technical data with accompanying statement were provided to the public via the project website.

In the second session, **Injectivity**, Carlos de Dios illustrated how alternate injection of CO₂ and brine at the Hontomin storage pilot site can result in impactful injectivity changes. The alternating injection campaigns started during March 2017, as part of the ENOS project, and is aimed to assess how continuous and discontinuous injection strategies can improve the hydrodynamic stability in the carbonate reservoir and/or control storage integrity in long term injection.

John Midgley, referring to his experience at the In Salah demo project, emphasised the importance of building on experience, understanding the storage site as well as monitoring and verification since injection is influenced by production, geology and the history of injection at each well. He also highlighted the wealth of non-geological factors that can influence CO₂ injection including local environmental conditions (weather, sand), management priorities, expertise of engineers operating the facility, clarity of well completion and construction records, well and facility maintenance schedules, cost of oil/gas and CO₂. He also challenged CCS project operators to ask where data has come from and to check the assumptions that feed the site model.

Rachael Moore presented the need to consider the “living subsurface” and how CO₂ and CO₂/H₂S injections can prompt microbial communities to evolve and bloom. In particular, subsurface microorganisms can convert injected CO₂ into biomass; biomass can clog pore space and injection wells; below 120°C microbial monitoring is critical. The Iceland case study indicated that microbial communities from closely spaced wells were quite different. Microbial communities are robust and the issue can’t just be solved with biocides because biocides can’t always be used and because communities evolve quickly.

In the following session, **Monitoring**, Eric Nickel highlighted practical lessons learned on Monitoring, Measurement and Verification (MMV) at Aquistore, a most comprehensive full-scale geological field laboratory for injecting captured CO₂ into a 3.400 m deep saltwater-infused sandstone. The Aquistore Project boasts an impressive MMV Programme, with over 30 technologies installed in the subsurface and above ground. His concluding remarks were that: “Siting” a project is not always entirely a scientific process. Monitoring levels and timing are dependent upon multiple variables; monitoring systems can fail or become useless (especially downhole). There are still many unknowns related to near-well effects of injection

and salt precipitation. Large Consortia take energy to maintain but can be necessary to bring to a project the necessary diverse knowledge base.

Susan Hovorka then highlighted the necessity of optimising monitoring to document storage performance based on lessons learned at SECARB “early” test at Cranfield. She spoke about the contribution of early tests and performance of various monitoring methods, such as Electrical Resistance Tomography, 4-D Seismic, microseismic networks, groundwater sampling, single-well push-pull testing and soil gas monitoring. Considering the limitations tools may have due to interference, cost, cost of analysis, etc., she proposed a method for down-selection of monitoring tools, which draws on her experience from field operations.

The last presentation of the workshop was given by Jim White on the convergence of modelling and monitoring to demonstrate storage site conformance at Sleipner. By mainly using repeated 3D seismic surveys, he showed progress in plume imaging, estimation of CO₂ layer thickness and volume, history matching layer growth and upward migration pathways. According to his experience, history matching is always a requirement (and with time and data, it improves) and conformance criteria definitions are critical to ensure safe operation whilst allowing for subsurface heterogeneity.

The workshop also concluded on importance of choosing adequate monitoring strategy for commercial sites as well as clearly conveying the message that extensive monitoring in research and pilot sites are there to verify and screen monitoring technologies available in order to prepare them for more streamlined commercial applications.

2.4. National networking: driving CCS forward

*Post-Open Forum workshop organised by ENOS and CO₂GeoNet
May 9, 2019*

CO₂GeoNet and ENOS organised this workshop to offer an opportunity for national CCS clubs/associations to join together to drive CCUS forward more effectively by sharing lessons learned and communication strategies.

The aims of this workshop were as follows:

- establish an informal network of national CCS clubs and associations that will enable sharing of experience and future joint actions;
- produce a joint press release from CO₂GeoNet and the national clubs/associations highlighting key issues (topics to be agreed at the workshop);
- discuss possibilities for organising joint events or cooperative actions to promote the uptake of CCS (eg talking with policy makers with support from CO₂GeoNet or other national clubs).

Eva Halland described the organisation and activities of the **Norwegian CO₂ Storage Forum**, established in December 2009 by the Ministry of petroleum and Energy. The forum acts as a contact point for relevant research groups, and has an overview of ongoing activities related to storage on the Norwegian continental shelf, including activities organized by the government, research institutions and industry.

Didier Bonijoly spoke about **Club CO₂**, a forum for exchanges of information and initiatives concerning CO₂ capture, transport, underground storage and re-use (CCUS) in France. It was founded in 2002 at the initiative of ADEME, with the support of IFPEN and BRGM, and in April 2016, the Club CO₂ became an official association. Amongst the many activities, its 28 members – industrial, research and local government players in France – offer technical

advice for ministerial organizations such as CSLF, government bodies such as the French Ministry in charge of national energy policy, and brief missions for Committees of the National Assembly.

GeoEcoMar, the national Institute of Marine Geology and Geoecology, founded the Romanian **CO₂ Club**, in 2007. Andreea Lorena Burlacu, illustrated some of the activities carried out by the national CO₂ Club including preparation and release of periodical publications on CCS, promotion of specific research projects at national and European level, organisation of workshops, seminars and focus groups and support for exchange of information amongst stakeholders from industry, research and policy makers.

Ceri Vincent presented on behalf of Luke Warren (CCSA). She summarised the activities of **CCSA (Carbon Capture & Storage Association)** that was founded in 2006 with 11 members as the first CCS business Association in the world. CCSA represents the interests of its 40 members (oil & gas, power generation, equipment manufacturers, academics, consultancies, regional bodies etc.), in developing the business of Carbon Capture and Storage and seeks to influence policy in UK, EU and internationally.

Ton Wildenborg (TNO) presented on behalf of Jan Hopman (CATO Director), in describing **CATO (Dutch CCS Research and Innovation Network)**. With partners from industry, SMEs, universities and NGOs, it acts as a dissemination network for (inter-)national CCS projects and supports national policy in the development of CCS projects and clusters to cost-efficiently deliver the 2030 CO₂ reduction targets.

Paula Canteli talked about the **Spanish CO₂ Technology Platform Association (PTECO2)**, an initiative developed by Spain's private sector, research centres and universities. It is partly funded by the Ministry of Finance and Competitiveness (MINECO) and contains representatives of that ministry and also of the Ministries of Industry, Energy and Tourism (MINETUR) and Agriculture, Food and the Environment (MAGRAMA). PTECO2's chief goal is to create a favourable environment for investment in R&D and innovation, foster the creation of an innovative business fabric and increase technological capacity in processes for efficiency improvement and CO₂ capture, transportation, storage and utilisation, and to support the rolling out of these technologies in industry.

Sergio Persoglia explained how the **Italian CO₂ Club** started in 2007 as a non-profit association due to the initiative of a group of "founding members". Its mission is to: encourage collaboration between public and private research groups, promote contact and information exchange amongst all stakeholders; transfer and disseminate information through electronic media and organise conferences and seminars. The Italian Club CO₂ members carry out prospective studies based on continuous analysis of the technologies and strategies put in place at international level and promote the Italian technological offer at European and international level.

In the second part of the workshop, the importance of networking activities was emphasized by referring to international experience for which joint efforts have been crucial in delivering meaningful results and technological progress.

Randall Locke illustrated the partnership experiences of the **Midwest Geological Sequestration Consortium (USA)**.

Yoshihiro Sawada shared public outreach activities of **Tomakomai CCS Demonstration Project (Japan)**

The promotion of **Carbon Capture and Storage in Taiwan** was presented by Prof. Chung Huang.

Michael Monea, shared information on the **International CCS Knowledge Center (Canada)**,

a not-for-profit initiative jointly founded by SaskPower and by BHP, a global resource leader. Its mandate is to advance the understanding and use of CCS as a means of managing greenhouse gas emissions, and to share lessons learned from hands-on operations ensures for experienced-based decision making.

2.5. Towards commercialization: insights from US and Norway

*Post-Open Forum workshop organised by CLIMIT (Norway) and ARI (US)
May 9, 2019*

The key idea of the workshop was to provide participants with information on hands-on experience and challenges when establishing industrial scale commercial CCS projects. The workshops had two sessions, the first, led by ARI, presented the experience from the USA. The second session, comprised Northern Lights project presentations by Equinor, Total and Shell, as well as, Gassnova and OD. The focus of the workshop was to discuss deployment and challenges of industrial scale CCS projects in Norway and the USA.

The workshop brought together an interest group comprised of different stakeholders in order to share knowledge on establishment of the industrial scale CCS worldwide. Approximately 40 people participated.

The presentations were followed by QA/QC sessions with the audience, followed by plenary discussion in the end.

The first speaker **in session one** was David Reisenberg, ARI who have talked about “Financial aspects of saline aquifer storage”. David talked about stacked storage options and highlighted capacity in the Illinois Basin. He emphasised the importance of learnings from the earlier Decatur & IBDP projects. He presented estimated storage costs (in the range of 2 to 4\$ per ton), and noted the importance of the 45Q tax scheme for realisation of new projects.

George Koperna, ARI talked about EOR and business cases. George demonstrated that there is vast experience of working with CO₂EOR and gas storage in the USA. He talked about business models for large natural CO₂ sources vs industry capture, as well as the importance of government subsidies and the complexities of infrastructure development. George showed that today in the US >75% CO₂ for EOR comes from natural sources. He highlighted that hydrogen, ammonia and fertiliser production are the purest anthropogenic CO₂ sources, able to compete cost-wise with natural CO₂. George talked about business cases and observed that infrastructure development for large projects requires a lot of creative fund-raising including government subsidies, with highly volatile CO₂, oil and gas prices providing a considerable challenge. George commented that centralised processing of recycled CO₂ for clusters of EOR/storage could help the business case by sharing costs. He commented that CO₂ capture from high purity, low volume sources could look at directing efforts to link these clusters to oil fields for EOR. Finally, George mentioned stacked storage where EOR already happening as a relatively cheap pathway to make a bigger impact on emissions.

Finally, Mike Godec, ARI presented financial aspects of 45Q. Mike talked about the size of the USA CO₂-EOR prize with 414 bn barrels of oil in the ground after primary & secondary recovery. He presented, that since natural CO₂ can't meet demand for CO₂-EOR as industry grows an obvious low hanging fruit is availability of high purity anthropogenic sources. Mike highlighted the main efforts in US to incentivise CCS: FUTURE ACT (the enhancement to 45Q), California low carbon tax, regional and state incentives. He discussed the new terms; highlighting the importance of when the tax credit can be sold by the entity that disposes of/uses the CO₂ (eg. if you're not paying tax, 45Q is no good for you!). Mike explained that details of legislation and

information from IRS are still pending for the new legislation, and further actions may be needed to clarify the situation for project developers. He also presented state initiatives such as the California low carbon tax (LCFC) designed to reduce carbon intensity of transport fuels. In mid-April 2019, the LCFC was \$190/ton CO₂. Mike noted that overall there are still some issues to be ironed out, for example, obtaining a storage permit for a Class VI (storage) well can take more than several years at moment, which is a huge disincentive, and that 50-years post injection monitoring requirement is a big concern for operators.

The second session shared experience from the Northern Lights project, where talks were often shared between government and industry representatives.

Mike Carpenter, Gassnova, was first to present on “Storage evaluation from concept to reality” focused on experience gained from the past two decades in Norway, from 1990 (CO₂ tax) to the 2014 White paper to CCS, being identified as one of government priorities in 2016. Mike showed that in Norway, for full scale CCS projects, the government gives subsidies, industry operates and Gassnova acts as the interface. Mike said that CO₂ storage for Northern Lights is expected by 2023/24 (if successful FID) and that projects do not necessarily follow a linear development pathway when many aspects of the CCUS value chain affect one another.

Mike’s talk was paired with a presentation from Diego Alejandro Vazquez Anzola, Shell. Diego talked about the industrial perspective mentioning the high cost of offshore wells. Diego highlighted three main questions for storage: 1) How much can we store safely? 2) What is the risk profile? and 3) What are the risk mitigation measures, OPEX and injectivity concerns. The Aurora project (storage site for Northern lights) was presented with a current estimated storage capacity of 480 Mt. Diego talked about the risk profile, OPEX risks (with limited legacy wells) and the need for data (the latter of which should be satisfied by the drilling of a well planned for Q4 of 2019). The aspect of the risk of damaging the public view on CCS if something does not go according to plan was discussed.

The second talk was shared between Eva Halland (NPD), speaking about the exploitation licence, and Szczepan Polack (Equinor) presenting the business case for Sleipner and Snøhvit. Eva talked about the licence granted for the Northern Lights project so the area can be developed and prepared for injection. She also talked about development of the regulatory framework. Eva noted that Norwegian regulations for CO₂ storage are based on and related to petroleum law. She shared aspects considered by authorities in the process of awarding the first storage licence in Norway. She mentioned that permission was granted with conditions; a plan to develop the site will be presented, well locations confirmed and a plan to monitor pressure and leakage will be in place. Aspects of capacity, safety, monitoring and handing the site back to the government were presented.

Szczepan Polack talked about learnings and highlighted a few differences between the Sleipner and Snøhvit projects and the current Northern Lights project. He noted that Sleipner and Snøhvit operate under petroleum regulations while a storage license has been granted for Northern Lights. Sleipner and Snøhvit store in the same licence block as the CO₂ is produced from together with hydrocarbon gas, while Northern lights will inject CO₂ from industrial sources onshore. He talked about CCS being stimulated by Norwegian government policy and tax incentives and indicated that all the projects had received state financial support. He talked about the offshore CO₂ tax in Norway of 50 euro/ton with 5% increase every year from 2020 to 2024. Szczepan highlighted Northern lights as an important step to reduce risk for others to start with CCS. He also observed that it should allow stepwise development of CCS from more regional hubs and have the ability to serve as basis for emerging value chains like gas to hydrogen plus CO₂-EOR.

Renata Meneguolo (Equinor) presented Aurora project risks and focused on the aspects of choosing the Johansen formation with only near-by wells, but no wells drilled within the project area. Reduction of the risk caused by the lack of well information from within the new area was

discussed. Renata explained that the area was selected because of its anticipated good reservoir properties. She highlighted that the well, presented earlier by Szczepan, is expected to reduce risk by providing new information and allowing testing of geological formations (flow test, injection test).

The presentations concluded with Laurent Fritz (TOTAL) speaking on streamlining industrial CCS and anticipated future upsides. Laurent talked about Northern Lights being scalable for EU clients with storage of more than 100 kt/y readily available. Laurent presented the main project development risks: subsurface uncertainty and schedule complexities. He also spoke about potential additional capacity available outside EL001 licence that could be reached from onshore, and an extension possibility in the future to currently operating fields like Sleipner, Heimdal and Troll.

After the presentation, there was an open discussion with the panel of the speakers. The key points of the discussion were:

- In the USA, the Department of Energy funded regional partnerships that started accessing storage. The partnerships identified 13 possible sites and drilled 6 wells in these areas. More than 50 Mt/year capacity for storage was identified. Whilst everybody agreed that this was a successful approach, for Northern Lights the circumstances were different, and assessment really started from the capture part of the CCS chain.
- Across Europe, the situation may be very different and will depend on socio-economic conditions. The ECO-BASE project partners talked about their two case studies: They briefly introduced the Bati-Raman field in Turkey, where the operator of a CO₂-EOR project is looking for anthropogenic CO₂ to replace diminishing reserves of natural CO₂. The Romanian case is starting from a very different perspective where there is interest on the capture side and no available infrastructure.
- Pilots should be steppingstones; they should be located where scale up is possible. Pilot projects in Europe need to be able to step out from pure R&D questions. That being said, learnings from different sites important and public engagement with onshore pilot sites can be very positive and there are some research questions that can only be answered at test facilities.
- Is CO₂-EOR gaining ground in Europe and should it? Are there any companies investing in EOR? CO₂-EOR brings economic incentives that may help to pay for large scale infrastructure construction, however, it could also potentially bring a public acceptance issue, for example Sweden want to store CO₂ but not use it for EOR. Carbon credits in Europe are not applicable during CO₂-EOR, only if CO₂ storage continues following oil recovery. ISO, however, says once CO₂ delivered to storage facility it's in a closed loop and fluids are recognised as stored, so there is some scope for changing this to follow the USA tax credit model if so desired.
- USA 45Q equivalent and storage site monitoring were discussed extensively. How should reporting and accounting be carried out? What happens in the unlikely event leakage of hydrocarbons and CO₂ from site were to occur? An active monitoring and reporting programme at wellheads, valves and surface is important.
- The CCS industry need to learn from experience, requirements and techniques of natural gas storage.

3. Event visibility

3.1. Announcements and on-line news

The CO₂GeoNet Open Forum 2019 and parallel workshops have been advertised through a series of announcements, sent by e-mail to about 1,800 recipients.

Information about the incoming event have been posted in the websites of co-organisers and endorsers and circulated through on-line weekly news, as shown, for example, in Figure 1.

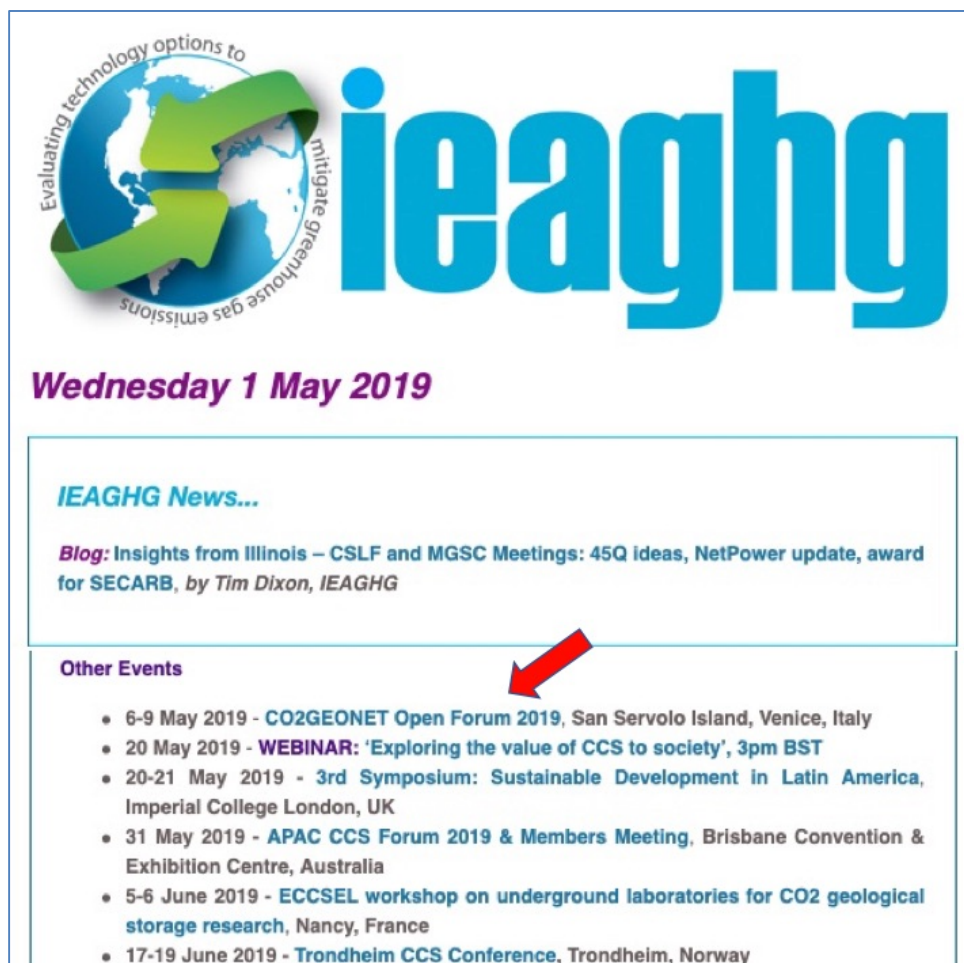


Figure 1 The Open Forum advertised by the IEAGHG Newsletter (May, 2019)

3.2. Open Forum website

As for the previous editions of the Open Forum, a dedicated conference website was built (<http://conference2019.co2geonet.com>), see Figure 2.



Figure 2 The CO₂GeoNet Open Forum homepage announcing also the Pre- & Post-Open Forum workshops

The event was supported by many organisations (see Figure 3).

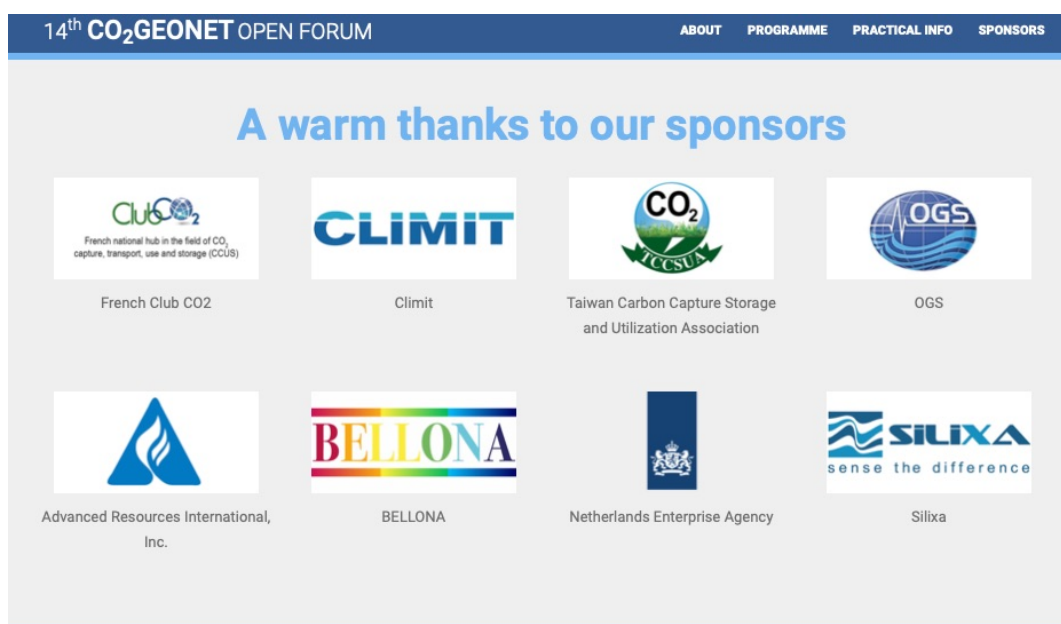


Figure 3 CO₂GeoNet Open Forum sponsors

After the conference, all the presentations from the Open Forum and the pre- and post-workshops were uploaded on to the website, together with a short CV of the speakers and some interviews, as shown in Figure 4.

14th CO₂GEONET OPEN FORUM
ABOUT PROGRAMME PRACTICAL INFO SPONSORS

Post-Open Forum workshop organised by CO₂GeoNet and ENOS project

9
MAY
2019

NATIONAL NETWORKING: DRIVING CCS FORWARD
9:00 - 12:30

CO₂GeoNet and ENOS are organising a workshop dedicated to national CCS Clubs and Associations adjacent to the Open Forum. This event offers an opportunity for national CCS clubs/associations to join together to drive CCUS forward more effectively by sharing lessons learned and communication strategies.

The aims of this workshop are as follows:

- Establish an informal network of national CCS clubs and associations that will enable sharing of experience and future joint actions
- Produce a joint press release from CO₂GeoNet and the national clubs/associations highlighting key issues (topics to be agreed at the workshop)
- Discuss possibilities for organising joint events or cooperative actions to promote the uptake of CCS (eg talking with policy makers with support from CO₂GeoNet or other national clubs)

The event is broken into two sections, the first half will comprise short presentations from the CCS clubs/associations (firstly European and then international). This will be followed by a discussion session to consider how and if the aims of the workshop can be met.

PROGRAMME

Chair:
Ceri Vincent, BGS & Vit Hladik, Czech Geological Survey

9:00 - 9:15



Aims of workshop
Ceri Vincent - BGS, UK

SLIDES

SPEAKER PROFILE



Ceri J Vincent graduated with an MSci in geophysics from the University of Leeds in 2000. She has worked at the British Geological Survey (BGS) on CO₂storage projects for over 18 years. Her CO₂storage related research includes interpretation of geological and geophysical data for assessment and characterisation of potential storage sites at a range of scales (basin to reservoir).

Ceri is science lead for the UK Energy Research Accelerator GeoEnergy Test Bed, a field laboratory designed to advance understanding of processes and impacts in the shallow subsurface in order to refine monitoring techniques and technologies for CO₂storage sites. Ceri is leading the workpackage on 'managing leakage risks for protection of the environment and groundwater' for the CO₂GeoNet H2020 ENOS (ENabling Onshore Storage) project.

Ceri is President of CO₂GeoNet (2019 – 2021), the European Network of Excellence on the geological storage of CO₂. She is also an Honorary Assistant Professor at the Faculty of Engineering at the University of Nottingham (2014 onwards).

Figure 4 By clicking on SLIDES, it's possible to download the full presentation and, by clicking on SPEAKER PROFILE, a short CV appears. Moreover, when an image with an "play" sign appears on the left, a short movie with the interview can be played

4. Results and key messages from the open forum

Interesting key messages emerged from presentations, discussions and breakout groups at the 2019 CO₂GeoNet Open Forum 2019. The key messages were summarised in the following CO₂GeoNet report (2019):

Act now for zero emissions: the role of CCUS

**Key messages of the
14th CO₂GeoNet Open Forum**

*San Servolo Island, Venice, Italy
7–9 May 2019*

This report has been distributed to all the Open Forum participants as well made available on the CO₂GeoNet website. The full text is presented in the Appendix 2. Full details of the 14th CO₂GeoNet Open Forum are available at <http://conference2019.co2geonet.com/>

Appendix 1 - The Programme



14th CO₂GeoNet Open Forum

May 7-8, 2019

Act now for zero emissions *The role for CCUS*

May 6, 2019

Pre-Open Forum workshop

CO₂ storage stories: learning by doing
organised by CSLF - CO₂GeoNet

May 9, 2019

Post-Open Forum workshops

National networking: driving CCS forward
organised by CO₂GeoNet - ENOS project

Towards commercialization: insights from US and Norway
organised by CLIMIT - ARI

CO₂GeoNet - a resource for Europe, providing scientific support for the geological storage of CO₂

CO₂GeoNet - an Association of 30 members over 21 countries

The Forum - to enable knowledge exchange between researches and other stakeholders

Venice, San Servolo Island, Italy



Organized by CO₂GeoNet in collaboration with:



CLIMIT

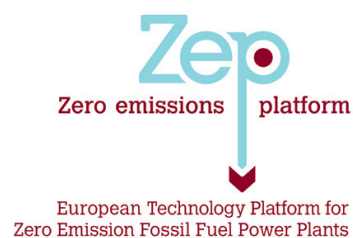


**Advanced Resources
International, Inc.**

Endorsed by:



Through the EU funded Horizon 2020
project ENOS, a CO₂GeoNet initiative



EERA-CCS

Monday May 6 - Icebreaker welcome

Ton Wildenborg, Former President of CO₂GeoNet

Tuesday May 7 - Open Forum - Day 1

8:30 **Registration**

9:15 **Welcome**

Sergio Persoglia, CO₂GeoNet Secretary General

9:20 **Objectives of the 14th CO₂GeoNet Open Forum**

Ceri Vincent, CO₂GeoNet President

Keynote Talk – Setting the scene

09:30 **CO₂ Storage - time to shift gear**

Chris Davies, former European Parliament CCS rapporteur

10:00 **Discussion**

10:15 *Coffee break*

Session 1: Four years after the Paris agreement

Update on trends and achievements towards climate goals

Chair: Ceri Vincent, CO₂GeoNet-BGS & Chris Davies, former European Parliament CCS rapporteur

10:45 **CCUS in the Clean Energy Transition - EU perspective**

Vassilios Kougionas, European Commission - DG Research and Innovation, Belgium

11:05 **Tackling industrial emissions in The Netherlands: the role of CCS**

Joëlle Rekers, Ministry of Economic Affairs and Climate, The Netherlands

11:25 **Carbon utilization challenges and opportunities**

Mark Ackiewicz, Department of Energy, US

11:45 **The status and challenges of CCS in South Korea**

Seong-Taek Yun, Korea CO₂ storage environmental management - KCOSEM, Korea

12:05 **Discussion**

12:30 *Lunch break*

Session 2: Leading edge trends in CCUS

Utilisation & storage for long-term emission reduction and removal of CO₂

Chair: Roman Berenblyum, CO₂GeoNet-NORCE & Jonas Helseth, Bellona

13:45 Green hydrogen – transitioning our gas supplies

Lars Ingolf Eide, Research Council of Norway

14:05 CCUS in the cement industry: CLEANKER technology, progress and project perspectives

Martina Fantini, Laboratory of Energy and Environment Piacenza, Italy

14:25 CCU value chains in Norway

Catherine Boccadoro, CO₂GeoNet-NORCE, Norway

14:45 Discussion

Session 3: Plug & Play Storage – how close are we?

Providing a transport and storage service

Chair: Isabelle Czernichowski-Lauriol, CO₂GeoNet-BREM & John Scowcroft, GCCSI

15:00 The public good case for European CO₂ transport & storage networks

Jonas Helseth, Bellona, Norway

15:20 Building a European CO₂ transport network - Porthos project

Bram Herfkens, EBN - Port of Rotterdam, The Netherlands

15:40 *Coffee break*

16:10 CO₂: an emerging business line

Laurent Fritz, Total E&P Norge as, Norway

16:30 The road ahead: building on successful CCS project experience

Diego Alejandro Vasquez Anzola, Norske Shell AS, Norway

16:50 Advancements in establishing business case scenarios for fully integrated projects

Charles Gorecki, Energy & Environmental Research Center, US

17:10 Discussion

17:25 Closing remarks Day 1

Roman Berenblyum, CO₂GeoNet ExCo Chair

18:15 Departure by boat to the Gala Dinner

Wednesday May 8 - Open Forum - Day 2

8:50 Welcome and introduction
Sergio Persoglia, CO₂GeoNet Secretary General

Session 4: Communication – putting people at the centre

Engaging with, and creating benefits for the community

Chair: Sabina Bigi, CO₂GeoNet-Sapienza University & Susan Hovorka, Gulf Coast Carbon Center

08:55 Communicating CCS
John Scowcroft, GCCSI, Belgium

09:15 Onshore storage: the solution on your doorstep - ENOS project
Marie Gastine, CO₂GeoNet-BRGM, France

09:35 Engaging with the local community - ENOS case studies and materials
Samuela Vercelli, CO₂GeoNet-Sapienza University, Italy & Mathew Humphrey, University of Nottingham, UK

09:55 New business models and new employment opportunities
Anne-Beth Skrede, Norwegian Confederation of Trade Unions, Norway

10:15 Discussion

10:35 Coffee break

Session 4: Continued

The role of CCS in the energy transition (breakout sessions)

Building on the knowledge shared during previous sessions, participants will work together to prepare key messages we can share with the public and other stakeholders, to illustrate how CO₂ storage can contribute to the energy transition and to achieving the climate targets (topics to include contexts for application of CO₂ storage, possible synergies with renewables and other technologies, relationship with energy storage, etc.).

Chair: Samuela Vercelli, CO₂GeoNet-Sapienza University

11:00 Introduction
Samuela Vercelli, CO₂GeoNet-Sapienza University, Italy

11:15 Breakout sessions

12:15 Feedback from breakout sessions & discussion

12:45 Lunch break

Session 5: Integrating CCS

Fitting CCS into our low carbon society

Chair: Ton Wildenborg, CO₂GeoNet-TNO & Kyle Worth, Worthy Environmental Engineering

14:00 Legal and regulatory issues: technical ISO standards as an important piece to commercialize CCUS
Ingvild Ombudstvedt, IOM Law, Norway

14:20 **How much storage is really needed and when? Preliminary results from UK CO₂ storage projects**
Jonathan Pearce, CO₂GeoNet-BGS, UK

14:40 **Geological CO₂ buffering for re-use - ENOS project**
Mariëlle Koenen, CO₂GeoNet-TNO, The Netherlands

15:00 **Discussion**

15:20 *Coffee break*

Session 5: Continued

Chair: Niels Poulsen, CO₂GeoNet-GEUS & Didier Bonijoly, Club CO₂ France

15:50 **CCS demonstration projects of Japan - Tomakomai and other projects**
Yoshihiro Sawada, JCCS, Japan

16:10 **Challenges to injection start-up in a gas field due to thermal issues**
Filip Neele, CO₂GeoNet-TNO, The Netherlands

16:30 **Scaling up CCS testing and deployment in the Illinois Basin**
Randall Locke, Illinois State Geological Survey, US

16:50 **Discussion**

17:10 **Closing remarks Day 2**
Ton Wildenborg, Former President of CO₂GeoNet

Monday May 6 - Pre-Open Forum workshop

CO₂ storage stories: learning by doing organized by CSLF and CO₂GeoNet

11:00 Welcome and aims of workshop

Mark Ackiewicz, CSLF and US Department of Energy, US

Session 1: Seismicity

Chair: Kyle Worth, Worthy Environmental Engineering

11:10 Decatur lessons learned

Randall Locke, Illinois State Geological Survey, US

11:30 Recent results of Tomakomai CCS demonstration project

Yoshihiro Sawada, JCCS, Japan

11:50 Discussion

12:20 Lunch break

Session 2: Injectivity

Chair: John Scowcroft, GCCSI

13:30 ENOS project: injectivity changes produced by the alternate injection of CO₂ and brine

Carlos de Dios, CIUDEN, Spain

13:50 Industrial scale CO₂ injection: geology vs. business

John Midgley, British Geological Survey, UK

14:10 Carbon storage and the living subsurface: how CO₂ and CO₂/H₂S injections can prompt microbial communities to evolve and bloom

Rachael Moore, Institut de Physique du Globe de Paris, France

14:30 Discussion

15:00 Coffee break

Session 3: Monitoring

Chair: Didier Bonijoly, BRGM

15:30 Injection, measurement, monitoring and verification at Aquistore: lessons learned by doing

Erik Nickel, Petroleum Technology Research Center, Canada

15:50 Optimizing monitoring to document storage permanence: lessons learned at SECARB "early" test at Cranfield

Susan Hovorka, Gulf Coast Carbon Center, University of Texas, US

16:10 The convergence of modelling and monitoring: reviewing conformance at Sleipner using geophysical data

Jim White, British Geological Survey, UK

16:30 Discussion

17:00 Workshop close

Thursday May 9 - Post-Open Forum workshop

National networking: driving CCS forward

organized by *CO₂GeoNet and ENOS project*

Chair: Ceri Vincent, BGS & Vit Hladik, Czech Geological Survey

09:00 Aims of workshop

Ceri Vincent, BGS, UK

09:15 Storage Forum

Eva Halland, Norwegian Petroleum Directorate, Norway

09:25 Club CO₂

Didier Bonijoly, Club CO₂ President and BRGM, France

09:35 CO₂ Club Romania

Andreea Burlacu, CO₂ Club and GeoEcoMar, Romania

09:45 Supporting CCS roll-out in the UK - Carbon Capture and Storage Association

Ceri Vincent, BGS, UK

09:55 CATO and CCS in the Netherlands

Jan Hopman, TNO, The Netherlands

10:05 PTECO: a vision on the present and the future of CCS in Spain

Paula Cantelli, IGME, Spain

10:15 CO₂ Club

Sergio Persoglia, OGS, Italy

10:25 Coffee break

10:55 Midwest Geological Sequestration Consortium - partnership experiences

Randall Locke, Illinois State Geological Survey, US

11:05 Public outreach activities of Tomakomai CCS demonstration project

Yoshihiro Sawada, JCCS, Japan

11:15 Carbon Capture and Storage promotion in Taiwan

Chung Huang, TCCSUA and Taiwan Power company, Taiwan

11:25 Large scale zero-to-negative industrial emissions now a reality

Michael Monea, International CCS Knowledge Center, Canada

11:35 Discussion - role for national actors in driving CCS forward

12:30 Lunch

Thursday May 9 - Post-Open Forum workshop

Towards commercialization: insights from US and Norway

organized by *CLIMIT (Norway) and ARI (US)*

Chair: Roman Berenblyum, NORCE & Kris Piessens, Geological Survey of Belgium

13:30 Aims of workshop and introduction

Roman Berenblyum, NORCE, Norway

13:40 Financial aspects of storage in saline aquifers

David Riestenberg, ARI, US

14:00 EOR clusters and business cases

George Koperna, ARI, US

14:20 Regulatory and financial aspects of 45Q

Michael Godec, ARI, US

14:40 *Coffee break*

15:00 Storage evaluation and risk assessment from idea to realization - from demo to field scale

Mark Carpenter, Gassnova, Norway & Diego Alejandro Vazquez Anzola, Shell, Northern Lights project, Norway

15:20 CO₂ storage license - Norwegian Petroleum Directorate perspective

Eva Halland, Norwegian Petroleum Directorate, Norway

Business case - from Sleipner and Snøhvit to Northern Lights

Szczepan Piotr Polak, Equinor, Northern Lights project, Norway

15:40 Streamlining industrial CCS - future upsides

Laurent Fritz, Total, Northern Lights project, Norway

Aurora project risk

Renata Meneguolo, Equinor, Northern Lights project, Norway

16:00 Joint debate and Q&A session

16:50 Summary: key messages from actual experience on what it takes to get industrial CCS going

Roman Berenblyum, NORCE, Norway

17:00 Workshop ends

Sponsors



French national hub in the field of CO₂ capture, transport, use and storage (CCUS)



Italian national institute of oceanography and experimental geophysics



Taiwan carbon capture, storage and utilization association



Netherlands Enterprise Agency



**Advanced Resources
International, Inc.**

CO₂GeoNet -The European Network of Excellence on the Geological Storage of CO₂



CO₂GeoNet members

Austria: GBA - Geologische Bundesanstalt; **Belgium:** RBINS-GSB - Royal Belgian Institute of Natural Sciences; **Croatia:** UNIZG-RGNF - University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering; **Czech Republic:** CGS - Czech Geological Survey; **Denmark:** GEUS - Geological Survey of Denmark and Greenland; **Estonia:** TALTECH - Institute of Geology at Tallinn University of Technology; **France:** BRGM - Bureau de Recherches Géologiques et Minières; **IFPEN** - IFP Energies nouvelles; **Germany:** BGR - Bundesanstalt für Geowissenschaften und Rohstoffe; **Germany:** GFZ - German Research Centre for Geosciences / Deutsches GeoForschungsZentrum; **Greece:** CERTH - Centre for Research & Technology Hellas; **Italy:** OGS - National Institute of Oceanography and Experimental Geophysics; **Italy:** SAPIENZA - Università di Roma "La Sapienza"; **The Netherlands:** TNO - Netherlands Organisation for Applied Scientific Research; **Norway:** NORCE - International Research Institute of Stavanger; **Norway:** NIVA - Norwegian Institute for Water Research; **Norway:** SINTEF; **Poland:** PGI-NRI - Polish Geological Institute - National Research Institute; **Poland:** GIG - Central Mining Institute; **Portugal:** ICT - Instituto de Ciências da Terra; **Romania:** GeoEcoMar - National Institute of Marine Geology and Geoecology; **Slovenia:** GEO-INZ - Geoinženiring d.o.o.; **Spain:** CIUDEN - Fundación Ciudad de la Energía; **Spain:** IGME - Instituto Geológico y Minero de España; **Sweden:** UU - Uppsala University; **Switzerland:** ETH - Swiss Federal Institute of Technology Zurich; **Turkey:** METU-PAL - Middle East Technical University Petroleum Research Center; **UK:** BGS - British Geological Survey; **UK:** HWU - Heriot-Watt University; **UK:** IMPERIAL - Dept. of Earth Science and Eng., Imperial College London.



CO₂GeoNet

The European Network of Excellence on the Geological Storage of CO₂

About CO₂GeoNet

CO₂GeoNet is the European scientific body on CO₂ geological storage. The Association currently comprises 30 research institutes from 21 European countries, and brings together over 300 researchers with the multidisciplinary expertise needed to address all aspects of CO₂ storage. With activities encompassing joint research, training, scientific advice, information and communication, CO₂GeoNet has a valuable and independent role to play in enabling the efficient and safe geological storage of CO₂. CO₂GeoNet was created in 2004 as a Network of Excellence supported by the EC FP6 programme for 5 years. In 2008, CO₂GeoNet became a non-profit association under French law. From 2013, the membership of CO₂GeoNet expanded thanks to the support of the now completed FP7 CGS Europe project. New Members continue to join CO₂GeoNet to further enhance the pan-European coverage and expertise of the Association.

More about CO₂GeoNet at www.co2geonet.com



San Servolo Island

Appendix 2 – Key messages

Act now for zero emissions: the role of CCUS

Key messages of the 14th CO₂GeoNet Open Forum

San Servolo Island, Venice, Italy
7–9 May 2019



CO₂GeoNet
The European Network of
Excellence
on the Geological Storage of CO₂

ACT NOW FOR ZERO EMISSIONS: the role of CCUS

The title of the 2019 Open Forum underlines the urgency to implement full-scale CO₂ Capture, Utilisation and Storage (CCUS) projects across the world, and emphasises the existing diverse CC(U)S opportunities that will enable tailored solutions for individual regions, local communities and industrial entities.

The following key messages extracted from the CO₂GeoNet Open Forum presentations and panel discussions, were voiced by the forum participants which included researchers, regulators and decision makers, industrial stakeholders and CCS project operators, journalists and researchers.

A just transition to a low-emission future

Society demands a just energy transition – a low emission future encompassing the creation of new jobs, economic growth and improved quality of life. This transition to a low carbon future needs careful planning upstream in order to make the right decisions: near-term actions are essential in achieving a long-term vision. **CCS is part of the transition and part of the solution.** The challenge ahead is enormous, but CO₂ Capture and Storage (CCS) technology is ready and working¹. IEA modelling indicates CCS is 'essential' to a low-emission future, alongside renewables, energy efficiency and other solutions. CCS is needed to decarbonise the cement and steel industries, at least in the short-to-medium term. CCS is not an excuse to continue using fossil fuels, it's an indispensable technology in decarbonising the manufacturing industry, and CO₂ storage is a vital component for emission reduction with Direct Air Capture (DAC) and Bioenergy.

Shared responsibility

Everyone –citizens, politicians, industry- has a **shared responsibility towards climate sustainability.**

Governments and politicians have a leading responsibility in the just transition. Many governments are in the process of defining their climate plans and ambitions. Plans should be challenged to include CCS so that the maths works.

Positive signals are coming from carbon intensive industries, interest is developing in the financial sector, there is increased investment in CCS research & development and companies are seeking decarbonisation solutions, including CCS.

Recently the younger generation has taken on an inspiring role, bringing renewed energy and a fresh outlook to encourage the public to demand changes and to press politicians to make large-scale CCS happen. NGOs also play an important role in advocating CCS; they can influence politicians, leaders and citizens.

Pay the bill or face the consequences

CO₂ that is emitted should be considered as 100% leakage; CO₂ that is captured and stored can dramatically reduce this. One of the main arguments for not deploying CCS is cost. However, the cost for mitigating climate change will be dramatically higher without CCS², and extreme if we do nothing or act too late (climate-induced disasters, loss of lives, climate-change refugees, shortage of drinking water supplies, etc.). Implementing large scale CCS is a challenge, but more dramatic changes to large-

¹ Global CCS Institute, 2018. [The Global Status of CCS: 2018](#). Australia.

² [IPPC AR5 Climate Change Synthesis Report 2014](#) (Table 3.2)

scale infrastructure have been made in the past. **CCS is ready now and costs will come down significantly with learning-by-doing**, as has happened in the past with other breakthrough technologies, for example personal computers and solar energy. Communicating benefits and costs in terms that can be easily understood helps build shared understanding, for example, comparing the cost of a CCS project with the cost of building kilometres of highway/train line or expressing captured CO₂ in terms of the equivalent number of cars taken off the road (the CO₂ captured at Boundary Dam is equivalent to taking 250,000 cars off the road annually³).

Creating a favourable context

CCS technology is ready, but favourable economic and regulatory conditions are still not mature. One of the current major challenges for the CCS community is to engage with politicians at various levels, to enable them to help create a favourable and sustainable framework for deployment (e.g. international agreements, national climate policy plans, initiatives, incentives, and regulations). Politicians will have to provide tools to help create a business case for industry. **Clear, consistent and long-term policy and regulatory measures are needed to provide a predictable business landscape that will attract investment**. There are multiple pathways to reduce costs; the approach should fit the local context. Sometimes positive incentives work more effectively than penalties (e.g. 45Q in USA has generated significant interest).

CCS vs. CO₂ utilisation vs. CCUS

CO₂ should be considered a commodity, not a waste. CO₂ has been utilised for goods for over a century. Although utilisation will not on its own tackle large-scale emissions, we should identify high-value utilisation opportunities in the market ('push' technologies) to help sway opinion, pay for early projects and get CCS going (market 'pull'). Utilisation can help develop a project business plan. However, CO₂ utilisation is a completely different concept to CCS and we need to consider how long the CO₂ is actually 'stored' (e.g. where will all "bio"plastics end-up?). Not all types of CO₂ utilisation are climate-friendly actions and we should not lose sight of the distinction between the technologies.

Urgency of upscaling and deployment: Act now

Our emissions are still accelerating: how do we change this? In order to deliver the expected emission reductions, massive storage capacities will be required before 2030, meaning that annual CO₂ storage rates need to increase 20 fold (IEA⁴ states that by 2060 we should store 6.8 Gt per year for 2DS). **Upscaling is needed now**. The CCUS community has to talk with local and national politicians to explain how CCS can fit into climate plans and what is needed to get CCS projects off the ground.

Large-scale CCS projects will draw on knowledge and experience from the oil & gas industry: not only in terms of investigation, but also for planning, implementation and operation. The development and operation of a research site is distinctly different from that of a large-scale industrial site.

Opportunities: seek low-hanging fruit, locally

CCS is an opportunity for economic growth and job creation. This is a key message to communicate to policy makers, NGOs and the public. CCS can create new jobs and preserve workers' rights to good quality jobs. CCS projects can be tuned to match local needs and opportunities. For example, buffer storage for utilisation can help the business case for storage. The combination of CCS with hydrogen can play a paramount role by producing CO₂-free hydrogen to decarbonise electricity, transport,

³ [Sask Power \(Boundary Dam\) website](#)

⁴ International Energy Agency ([IEA](#)) [ETP2017](#)

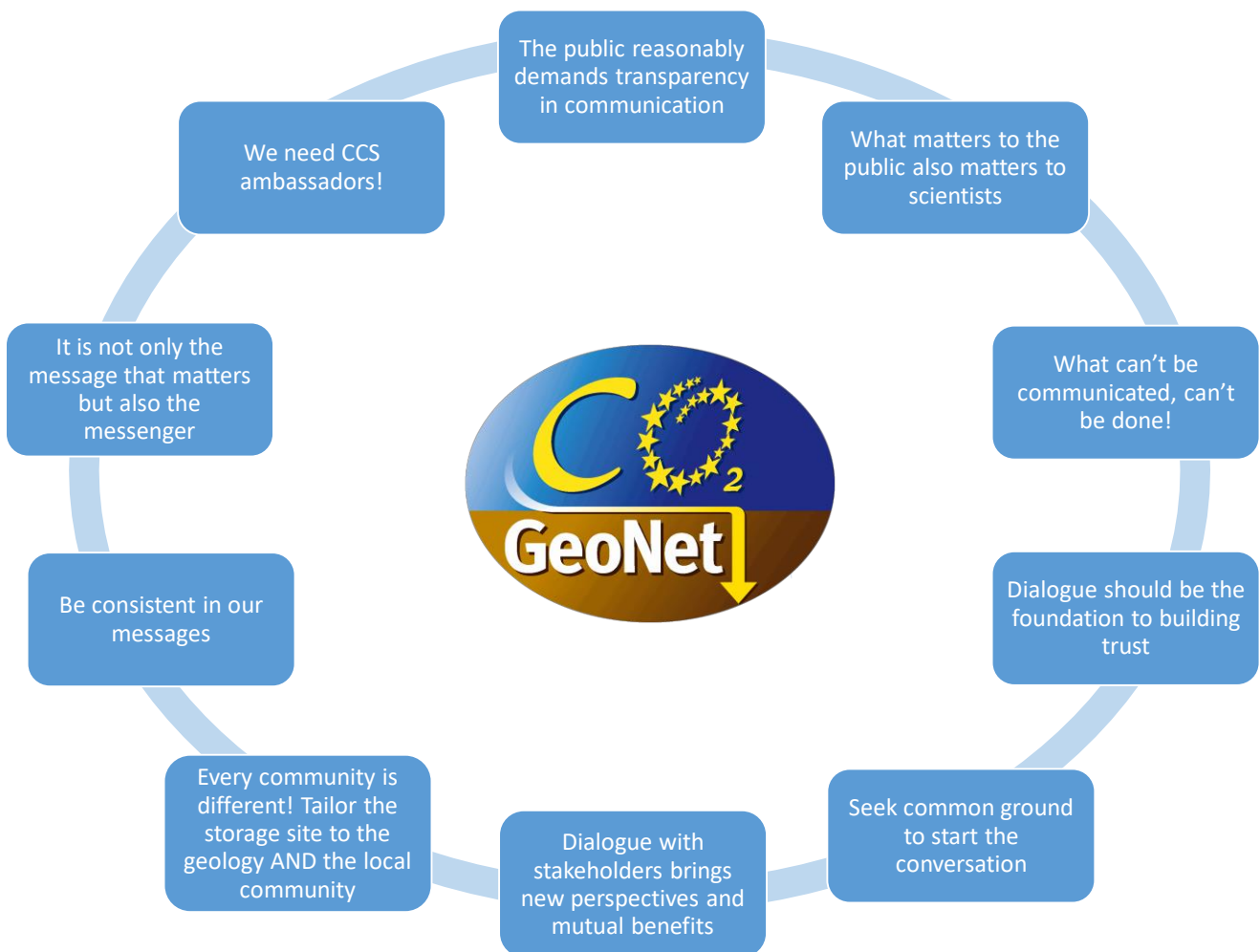
heating, etc. Hydrogen from natural gas reforming with CCS is competitive in terms of economy. In addition, CCS can enable renewables acting as a working fluid or helping to balance supply and demand in the electricity grid.

Onshore storage gives the opportunity to handle CO₂ storage locally, reducing costs and managing emissions. **Such smaller, onshore projects can contribute to building public trust in CCUS technology.**

Hubs and clusters: create a one-stop-shop for access to a CO₂ transport and storage network (e.g. Porthos, H21, etc.) linking different industries together. Plug-and-play storage solutions are attractive to industry.

Communication

Establishing and maintaining a dialogue on CCS is essential, both in terms of international actions to drive CCUS forward, but also on a local level, particularly in communities that are hosting CCUS projects:



Full details of the 14th CO₂GeoNet Open Forum are available at <http://conference2019.co2geonet.com/>

This report should be cited in literature as follows: CO₂GeoNet (2019) Act now for zero emissions: the role of CCUS. Key messages of the 14th CO₂GeoNet Open Forum, San Servolo Island, Venice, Italy, 7–9 May 2019.

About CO₂GeoNet

CO₂GeoNet is the European scientific body on CO₂ geological storage. The Association currently comprises 30 research institutes from 21 European countries, and brings together over 300 researchers with the multidisciplinary expertise needed to address all aspects of CO₂ storage. With activities encompassing joint research, training, scientific advice, information and communication, CO₂GeoNet has a valuable and independent role to play in enabling the efficient and safe geological storage of CO₂. CO₂GeoNet was created in 2004 as a Network of Excellence supported by the EC FP6 programme for 5 years. In 2008, CO₂GeoNet became a non-profit association under French law, active on both the EU and global scene. From 2013, the membership of CO₂GeoNet expanded thanks to the support of the now completed FP7 CGS Europe project. New Members continue to join CO₂GeoNet to further enhance the pan-European coverage and expertise of the Association.

More about CO₂GeoNet at www.co2geonet.com





CO₂GeoNet
The European Network of
Excellence
on the Geological Storage of CO₂

CO₂GeoNet Secretariat: info@co2geonet.com

Website: www.co2geonet.eu