ENOS
Enabling Onshore CO_2 Storage

A CO_2GeoNet Initiative

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Results of the CO_2GeoNet Open Forum 2018 (ROF2018)

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Public

Contents

1 Introduction

CO_2GeoNet is the European scientific body on CO_2 geological storage. The Association currently comprises 29 research institutes from 21 European countries, and brings together over 300 researchers with the multidisciplinary expertise needed to address all aspects of CO_2 storage. With activities encompassing joint research, training, scientific advice, information and communication, CO_2GeoNet has a valuable and independent role to play in enabling the efficient and safe geological storage of CO_2. CO_2GeoNet was created in 2004 as a Network of Excellence supported by the EC FP6 programme for 5 years. In 2008, CO_2GeoNet became a non-profit association under French law, active on both the EU and global scene. From 2013, the membership of CO_2GeoNet expanded thanks to the support of the now completed FP7 CGS Europe project. New Members continue to join CO_2GeoNet to further enhance the pan-European coverage and expertise of the Association. CO_2GeoNet plays a valuable and independent role in enabling the efficient and safe geological storage of CO_2, and the annual Open Forum conference it organises, now in its 13th year, has become a “must-attend” event for stakeholders, including EU representatives, industry, regulators, public authorities, NGOs, and the research community.

The Open Forum gives a unique opportunity to meet and interact directly with Europe’s largest group of researchers on CO_2 geological storage. This year as ususal Open Forum was accompanied by a number of workshops, two dedicated to ENOS and one organised by Gassnova and ARI (Advanced Resources International Inc.). A further initiative organised by the ENOS team has involved scientific journalists and researcher to set up the basis for a long-term dialogue.

This document presents the Open Forum and the workshops. It also summarizes the event visibility and the key messages.

All the presentations held in the 13° CO_2GeoNet Open Forum and following workshops are available at: http://conference2018.co2geonet.com.

2 CO_2GeoNet Open Forum 2018

2.1 CO_2GeoNet Open Forum day 1

Growing CCS for a sustainable future. Linking local actions for a global solution
April 24, 2018

The Open Forum has been opened by Marcello Capra from the Italian Ministry of Economic Development, who has welcomed the participants and briefly summarised the Italian commitment towards the emissions reduction, in line with the Paris agreement. He has also emphasized the role of applied research for the large deployment of CCS techniques. After the introduction of Ton Wildenborg, president of CO_2GeoNet, on the objectives of this edition of the Open Forum, Jan Ros has held the conference keynote talk "What our energy future will look like and the role of CCS". To stay within the 2C° increment, we need to act now and reach "zero emissions" by 2070. A delay of 15 years, would imply not only a stronger reduction per year, but also to get "negative emissions" of about 250 Gt CO_2 in the last 3 decades of the century. According the scenarios studies, which have considered all the technical options in the Netherlands to reach the Paris targets, CCS in combinations with hydrocarbons and biomass cannot be excluded in the needed energy mix. In the Dutch 2017 governmental agreement, it has been stated that "CCS is one of the most important options to reach the ambitious emission target in 2030, especially in industry".
The first session ("*Meeting the Paris Agreement targets. Update on trends and achievements towards climate goals*") has given an update on trends and achievements towards climate goals, with presentations from European Commission (DG Climate Action), IEAGHG, and the TCCSUA from Taiwan, the latter with a summary of CCUS initiatives in Asia.
The role of CCS in energy intensive industries, in enabling a low-carbon economy via hydrogen, in moving towards negative emissions, has been illustrated in the second session ("*Transitioning to a net zero emission future. Zero/low CO_2 commodities using CCS*").
During the last session ("Accelerating CCS for large-scale deployment. What is needed to remove remaining barriers?"), speakers from Canada, Netherlands and Norway have proposed how to remove remaining barriers to the large deployment of CCS technology, by considering experiences developed in real projects like Boundary Dam in Canada, the Rotterdam cluster in the Netherlands, and the planned CCS network in the Smeaheia project in Norway.

2.2 CO_2GeoNet Open Forum day 2

Growing CCS for a sustainable future. Linking local actions for a global solution
April 25, 2018

During the welcome of the second day, Sergio Persoglia, Secretary General of the CO_2GeoNet Association has expressed a great satisfaction for the large number of registered persons (116 from 27 countries) and for the fact that the Open Forum has been enriched by 3 thematic workshops, two of which organised by the ENOS project, and by a special event to develop a long-lasting relation between ENOS researchers and scientific journalists. Moreover, he announced that during a CSLF Technical Group Meeting held at San Servolo the day before the Open Forum, the project ENOS has been proposed and accepted for CSLF recognition.
Large part of the second day of the Open Forum has been devoted to highlight new sectors and developments for CCS in Europe and elsewhere ("*Growing CCS sectors and emerging opportunities. New sectors and developments*"). The GCCSI has illustrated which are the actual and expected operation dates up to 2022 for large-scale CCS facilities. In Europe, the CCS ambition at start of the decade has not been realised. However, in October 2017, the UK Government released the UK's Clean Growth Strategy which confirmed the government interest and commitment to CCS and ongoing reform to the EU-ETS and

activities under the Strategic Energy Technology (SET) Plan process, which offer platforms for longer term CCS deployment.
New CO_2 storage pilot project opportunities are identified in Europe also by the ENOS project, while optimism for CCS in USA is related to legislative initiatives and DOE's storage plans.
In Europe, the project ALIGN-CCUS aims at expanding large-scale storage for industry, potentialities for EOR (Enhanced Oil Recovery) by CCS are studied in the region of Serbia, and the ACT initiatives pools 9 cooperating countries that have recently financed with 36 million Euro eight projects aimed at accelerating CCS technologies. ECCSEL, the European CCS Laboratory Infrastructure, can provide high-class laboratories and infrastructures to the international research community, to support improvements in the actual CCS technologies and speed up the development of their new generation.
In the last session ("*International knowledge sharing. Sharing practical experience and public engagement strategies*"), researchers from USA, Canada and Australia have reported their practical experience on knowledge sharing and engagement of general public. The discussion, which has closed the two-day Open Forum, has confirmed that, while sustained political support is the most important enabler, lack of public awareness is a key barrier. So, new ways of interacting with the public are needed and are under development in the ENOS project.

2.3 From pilot research to application in the field: a Norwegian-US knowledge-sharing workshop

Post-Open Forum workshop organised by Gassnova and Advanced Resources International (ARI)
April 26, 2018

This workshop has brought together Norwegian and American experts to discuss a number of topics underpinning large-scale on-shore and off-shore CCUS applications.
In the US, the Kemper CO_2 Storage Complex project aims to demonstrate that the subsurface can store commercial volumes of CO_2 safely and permanently within the saline reservoir system. There are no technical showstoppers and risks are mainly related to the regulatory and policy developments in the US, which can act as incentives or impediments. Regarding this matter, a panel of experts from industry and academia have discussed the main challenges in the US, which emerged from the past and running demonstration projects.
Presentations from Norwegian have been focused on the application of CCUS techniques in industries, which cannot rely on renewables energies to reduce emissions, because CO_2 is produced by the industrial processes and not by burning hydrocarbons. In Norway a project is under development, where the CO_2 will be collected in cement, ammonia and waste-to-energy plants, transported by ship to a harbour, and then by pipeline to a storage site in the Norwegian sector of the North Sea. The technology is well known, but putting all together is a big challenge. One important aspect is to apply the more advanced monitoring techniques in the offshore storage site, also for detecting microseismic events. The deployment of these real-time monitoring networks is important not only to quickly identify potential hazards, but also to help mapping the evolution of injected CO_2 in the reservoir. Of paramount importance is to start background monitoring as soon as possible, design appropriate monitoring network, based on all available background data and keep then open for later upgrades.

2.4 Advanced techniques for site characterisation

Pre-Open Forum workshop organised by ENOS Experience-sharing Focus groups
April 23, 2018

The main objective of this workshop was to share experience around the topic of advanced site characterisation, with speakers representing tested or envisaged techniques from various geographical settings. In the context of CO_2 storage, site characterisation activities include geological investigations, geophysical studies, collection of borehole data, etc. This workshop was focused on "advanced" techniques.

Vit Hladik from CGS, and leader of WP6 of ENOS introduced the workshop and explained the purpose of the Experience Sharing Focus Groups within ENOS international cooperation activities.
The first two presentations were on the topic of fibre optics and more specifically iDAS (intelligent Distributed Acoustic Sensors). The first presenter was Athena Chalari from Silixa, and showed the results of the deployment at the Otway site in Australia, and how they compare in terms of performance (often expressed as Signal to Noise ratio) to more traditional geophones. Flavio Poletto from OGS presented the results of a baseline 3D VSP (Vertical Seismic Profile) campaign at the Hontomin site in Spain, also shot with iDAS.
Then Anton Shchipanov from IRIS presented a technique called PTA (Pressure Transient Analysis) that allows to characterize faults and impermeable layers from analysis of injection and fall-off from a well using Permanent Downhole Gauges, typically measuring pressure and temperature in continuous. An application of the concept to the Snohvit site offshore Norway is then presented.
Also in relation to characterisation performed from boreholes, Mark Kelley from Battelle presented an overview of many techniques that are used to characterise important formation properties. A typical technique is flowmeter logging. Mark also introduced five types of discrete interval hydraulic tests (slug tests, DST tests, pulse tests, constant rate tests and constant pressure tests) and two types of discrete interval geomechanical tests (Hydraulic Fracture tests and Hydraulic Tests on Preexisting Fractures). He showed many examples form sites in the US including AEP Mountaineer (West Virginia) and FutureGen (Illinois).
The last talk of the workshop was given by Carlos de Dios from CIUDEN regarding their experience of drilling at the Hontomin site in Spain. They used a mining rig instead of a classical oil rig, which provided lighter operations and thus cost efficiency. Carlos presented their main achievements and existing gaps regarding the drilling phase. The equipment of the well, including sensors for site characterisation, was also presented.
Overall the workshop allowed a broad overview of novel techniques for site characterisation: from geophysical tools such as distributed acoustic sensors, to borehole-based solutions such as pressure transient analysis. The examples provided were also very diverse with experience from Australia, Spain, Norway and the USA.

2.5 ENOS Journalists' Workshop

April 23, 2018

The Journalists´ Workshop was organized as part of the WP8 and with the goal of continuing the actions started by CGS Europe project on developing interaction with media as key channel for the project results' dissemination. It was planned as a space for the mutual exchange of information and expertise between science communicators and CO_2 storage scientists. Seven journalists from different media of Italy, Netherlands, Spain and UK and similar number of ENOS technicians and scientists were the participants.

Roberto Martínez (IGME) and Ton Wildenborg (TNO) welcomed them on behalf ENOS project and CO_2GeoNet. They both underlined the importance for the CO_2 researchers community, and ENOS in particular, of establishing a direct line of communication media and scientists. It was also expressed our objective of following with a future relationship along the project.

The discussion was initiated by Mónica G. Salomone, scientific communicator, presenting the difficulties for the journalists to cover Science such as mistrust from the researchers, popular misconceptions and the need of a fast response. From ENOS, Ceri Vincent (BGS) and Gillian Pickup (HWU) pointed that researchers want to communicate openly and honestly but ensuring that Science is not misunderstood/misrepresented so it is needed time to build a consensual answer, data and details to provide scientific evidences and to review the articles previous to be published. The final conclusion was that we need each other and all these stoppers can be avoided, at individual level, building a relationship researcher-journalist based on mutual trust and, at project level, with a good communication

strategy where the main topics are identify and an answer is ready, and the communication contacts are clearly defined (by country and by topic).

All of them were invited to attend to the Open Forum sessions where they stayed in a very active way with questions and interviews to the speakers. The feedbacks from journalists were very positive and they showed a real interest to maintain and grow this initial network.

2.6 Storage site solutions: monitoring and verification

Post-Open Forum workshop organised by ENOS
April 26, 2018

Around 60 researchers, storage site operators and other stakeholders attended this ENOS workshop on 26th April in Venice. The workshop was designed to share research needs identified by storage operators and to present tools and techniques being advanced by researchers in ENOS WP3 to identify areas of common interest. The event focused on monitoring measurement and verification (MMV) technologies used to monitor the zone above the reservoir to demonstrate containment.
During the first session, storage operators and storage site monitoring teams presented recent activities and identified what improvements they would like to see in the currently available suite of monitoring tools (including ideas for new tools and technologies). Presentations were given by Shell, Battelle, University of Illinois, GeoScience Australia, CIUDEN and CMC Research Institutes. During the second session, researchers presented tools being advanced through ENOS including groundwater and soil gas monitoring probes, microbiological and geochemical techniques, UAV-mounted and mobile CO_2 detection tools, CO_2 quantification technologies and efficient data interpretation and modelling techniques.
All presentations were short and lively, sharing a great deal of information about the state of play for monitoring, measurement and verification technologies for CO_2 storage sites. Areas of common interest were identified and the tools being developed through ENOS the goals of storage operators for efficient, cost effective monitoring, but of course, there is always something new and exciting round the corner so hopefully new research partnerships will also develop following the post-workshop discussions.
All presentations will be posted on the dedicated CO_2GeoNet Open Forum 2018 webpage. Ceri Vincent prepared a short workshop report with input from all speakers, which will be circulated to all workshop attendees.

2.7 Internal ENOS WP7 Knowledge Integration workshop

April 27, 2018

The objective of this internal workshop was to focus the discussion around the Guideline documents (onshore CCUS quick start guide) to be prepared by the ENOS project.
It was suggested that the documents should improve EU competitive level and markets for CO_2 storage, they must focus on whole storage site lifetime from different perspectives (e.g. business, regulators, publics, scientists); they need to be highly practical and build mostly on ENOS results with inclusion of relevant other experience when and where possible (ISO, CCS Directive, US DOE NETL best practices).
The workshops seen a lively discussion involving both internal ENOS participants and external members of the End User Committee (first hour only). The main suggestions to the document structure and essence where:

The documents should be:
- Short
- Follow “TABLIOD” approach (catchy title, short basic information, details come later and on-demand only (“read more” button);
- “3 CLICKS APPROACH” (the average reader should get the desired information in 3 clicks max);
- GRAPHICS is essential (preferred use of graphics designed & developed within ENOS);

- LANGUAGE simple, yet professional language. From simple and more universal in high level introduction to more (but not heavily) professional in more details;
- STYLE: not to be prescriptive – rather “Recommendations”;
- CONSISTANT AND OPEN: We present four versions not to hide something, but to make information more accessible for different groups. All stakeholders (e.g. business, regulators, publics, scientists) are welcome and encourage to explore all four specific documents, possibly starting from the one specifically designed for them;
- PROGRESSIVE LEVEL OF INFO:
    - basic catchy, simple, essential;
    - expanded more food for thought, details and facts;
    - detailed presenting the essence (summary) of ENOS technical reports.

3 Event visibility

3.1 Announcements and on-line news

The CO_2GeoNet Open Forum 2018 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.

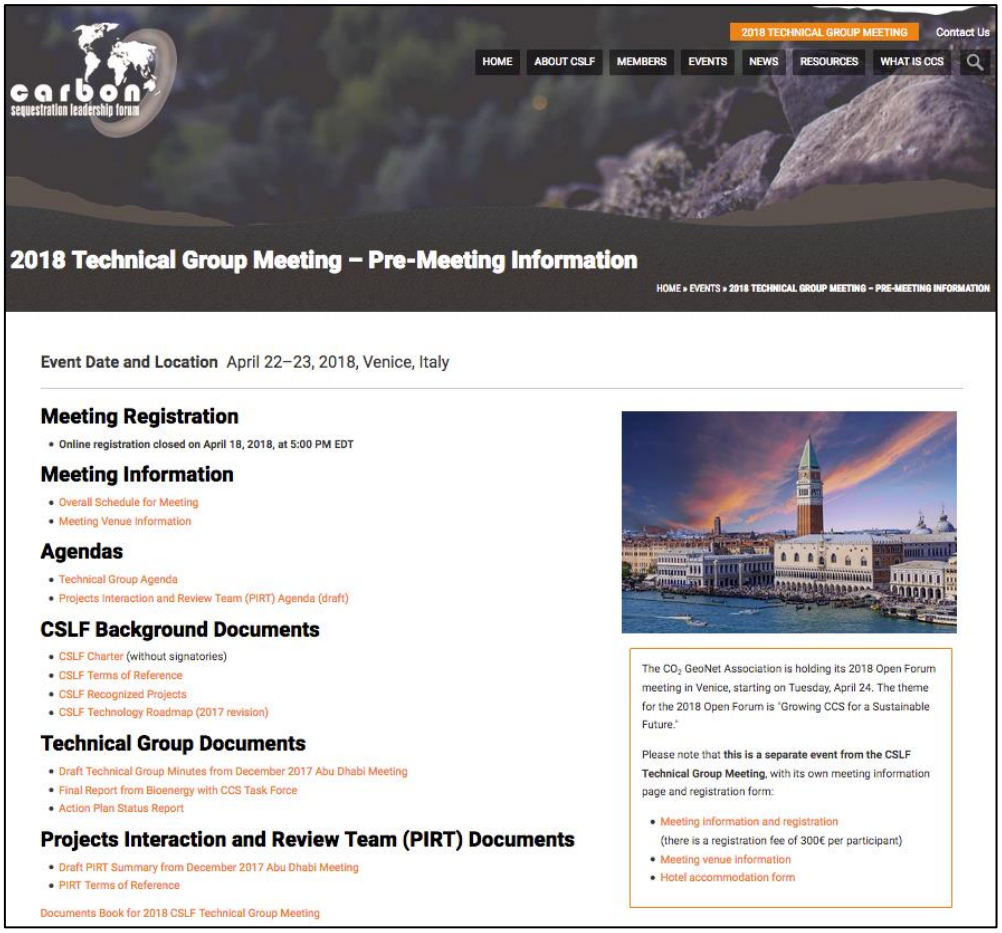

Figure 1 The Open Forum advertised by the Carbon Sequestration Leadership Forum (April, 2018)

3.2 Open Forum website

As for the past editions of the Open Forum, a dedicated website has been developed for the conference (http://conference2018.co2geonet.com), see Figure 2.

Figure 2 The CO_2GeoNet Open Forum homepage announcing the Pre- & Post-Open Forum workshops

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

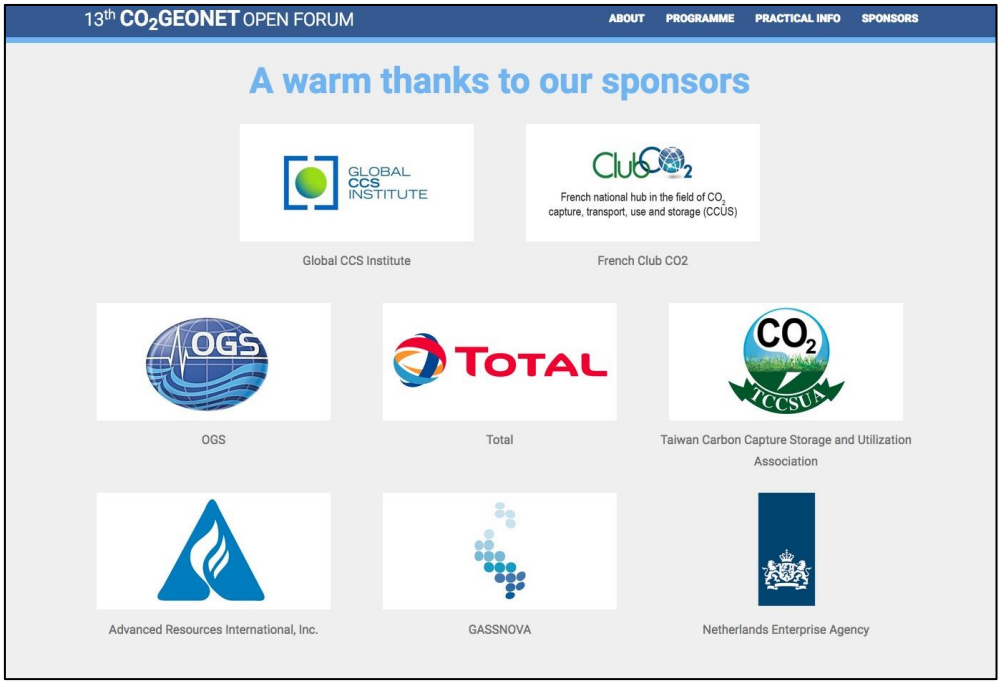

Figure 3 CO_2GeoNet Open Forum sponsors

After the conference, all the presentations held during the Open Forum and the workshops have been uploaded on the website, together with short interviews to the session chairs, as shown in Figure 4.

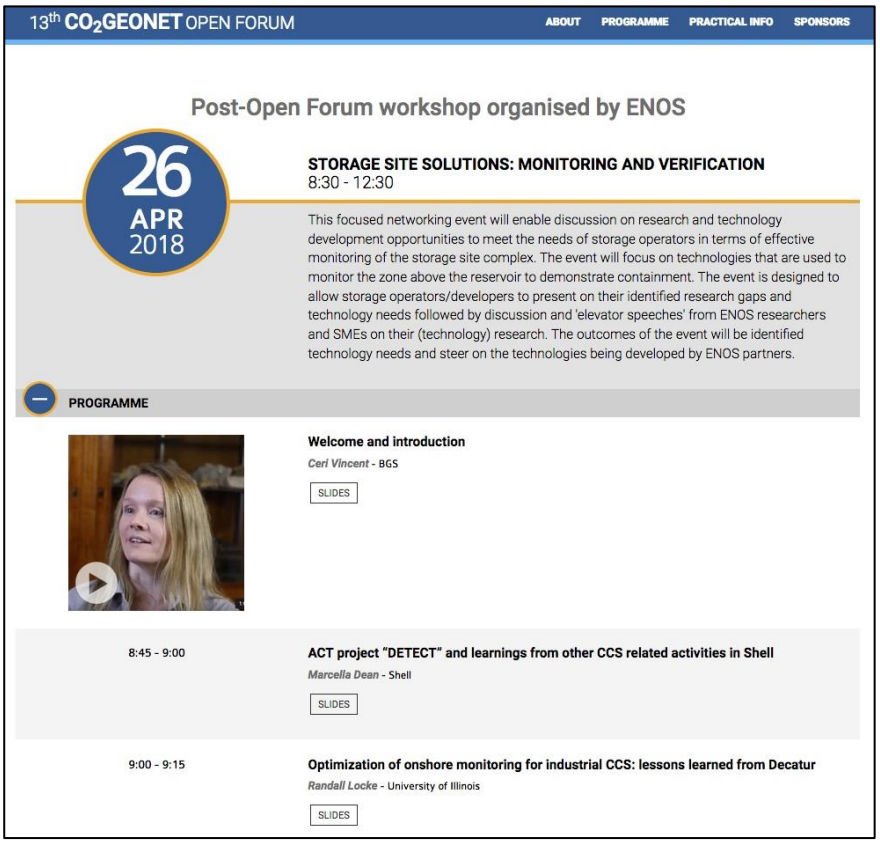

Figure 4 By clicking on the interactive programme, it's possible to download the presentations and watch the interview to the chair session.

3.3 Press release

The following press release, published just after the 2018 Open Forum, was posted on the CO2GeoNet website (http://www.co2geonet.com/news-and-events/news/open-forum-2018/) and circulated to the CO2GeoNet members, asking them to disseminate it among their contacts and scientific journalists in their countries, and to translate it into their languages for posting on their websites.

The 13thCO_2GeoNet Open Forum – Climate change and the science of geological CO_2 storage

To help address the pressing need to reduce CO_2 emissions, from 24 to 26 April, an international conference was held on the Island of San Servolo in Venice (Italy) to share the latest findings on CO_2 Capture, Utilisation and Storage (CCUS).

Scenarios from the IPCC and IEA show that CO_2 capture and storage (CCS) is key to achieving our climate goals in time. The technology is proven and there are 17 large-scale projects worldwide. The cost per tonne CO2avoided is comparable with other climate mitigation technologies. It is now time to rollout the technology, as the theme of this year's Open Forum 'Growing CCS for a sustainable future' indicates, in order to realise the contribution that CCS can make to meeting the Paris Agreement targets.

During the conference, many speakers highlighted the importance of local actions, and one of the aims of the event was to enable dialogue between people working on CCUS across the world, to help build the global solution for climate change. Early implementation of CCUS projects and networks will happen in urbanized, industrial regions. Applied research should therefore assist local and regional stakeholders in accelerating large scale CCS and getting CCUS projects off the ground, including offering civil society the opportunity engage more fully, so that the added value of CCS for society can be realised.

The president of the CO_2GeoNet Association, Ton Wildenborg of TNO, declared: “As the presentations and discussions have made clear, the science behind CO2storage is at an advanced stage and of high quality. Now all the elements that are necessary for large scale deployment have to be linked together and be made comprehensible to all stakeholders, including civil society, NGOs and the media”.

The CO_2GeoNet Association, a network of 29 research organisations from 21 European countries, organized the Open Forum. In addition to scientists working on CCUS, the Open Forum was attended by representatives from the European Commission, national governments, industry, NGOs and the media. Around 120 experts convened from 27 countries inside and outside Europe.

4 Results and key messages from the open forum

The following key messages emerged at the CO_2GeoNet Open Forum 2018, during the presentations, the interesting discussions and the works of the various break-out groups. They are put together as CO2GeoNet report (2018) Growing CCS for a sustainable future – Linking local actions for a global solution. Key messages of the 13th CO2GeoNet Open Forum, San Servolo Island, Venice, Italy, 24−25 April 2018, 6 pp.. The key messages are put together and prepared by CO_2GeoNet and were distributed to all Open Forum participants as well as via CO_2GeoNet website. The full text is presented in the Appendix 2. Full details of the 13th CO_2GeoNet Open Forum are available at http://conference2018.co2geonet.com/

Appendix 1 - The Programme

13th CO_2GeoNet Open Forum

April 24-25, 2018

Growing CCS for a sustainable future

Linking local actions for a global solution

April 23, 2018

Pre-Open Forum workshop organised by ***ENOS***

Experience-sharing focus groups: advanced techniques for site characterisation

April 26, 2018

Post-Open Forum workshop organised by ***ENOS***

Storage site solutions: monitoring and verification

Post-Open Forum workshop organised by ***Gassnova*** and ***Advanced Resources International (ARI)***

From pilot research to application in the field: a Norwegian-US knowledge-sharing workshop

CO_2GeoNet - a resource for Europe providing scientific support for the geological storage of CO_2

CO_2GeoNet - an Association of 29 members over 21 countries

The Forum - to make scientific research and researchers available to stakeholders

Venice, San Servolo Island, Italy

Organized by CO_2GeoNet in collaboration with:

GASSNOVA

ENOS

Advanced Resources International, Inc.

Endorsed by:

Through the EU funded Horizon 2020 project ENOS, a CO_2GeoNet initiative

ieaghg

carbon sequestration leadership forum

Zep Zero emissions platform

European Technology Platform for Zero Emission Fossil Fuel Power Plants

EERA European Energy Research Alliance

EERA-CCS

AGENDA

Tuesday April 24 - Day 1

8:30 **Registration**

9:00 **Welcome**
Marcello Capra, Ministry of Economic Development, Italy

9:05 **Objectives of the 13th CO_2GeoNet Open Forum**
Ton Wildenborg, CO_2GeoNet-TNO, CO_2GeoNet President

Keynote Talk – Setting the scene

09:15 **What our energy future will look like and the role of CCS**
Jan Ros, PBL Netherlands Environmental Assessment Agency

10:00 **Discussion**

10:15 *Coffee break*

Session 1: Meeting the Paris Agreement targets
Update on trends and achievements towards climate goals
Chair: Ton Wildenborg, CO_2GeoNet-TNO & Aage Stangeland, Research Council of Norway

10:45 **Update on EU developments post-COP23**
Maria Velkova, DG Climate Action, European Commission

11:05 **Progress towards the Paris Agreement targets – the IEAGHG's view**
James Craig, IEAGHG, UK

11:25 **CSLF recommendations to ministers following on from stakeholder feedback at the 2017 CSLF meeting**
Ceri Vincent, CO_2GeoNet-BGS, UK

11:45 **CCUS in Asia with focus on Taiwan**
Chung-Sung Tan, TCCSUA, Taiwan

12:05 **Panel discussion**

12:30 *Lunch break*

Session 2: Transitioning to a net zero emission future
Zero/low CO_2 commodities using CCS
Chair: Isabelle Czernichowski-Lauriol, CO_2GeoNet-BRGM & Mark Driessen, Port of Rotterdam

13:45 **CCS and energy intensive industries**
Dominique Copin, TOTAL, France

14:05 **The ERA-NET ACT project ELEGANCY: enabling a low-carbon economy via hydrogen and CCS**
Daniel Sutter, CO_2GeoNet-ETH Zurich, Switzerland

14:25 **BECCS - moving towards negative emissions (outcome from the recent BECCS report)**
Mark Ackiewicz, CCS R&D DoE, USA

14:45 **Panel discussion**

15:15 ***Coffee break***

Session 3: Accelerating CCS for large-scale deployment
What is needed to remove remaining barriers?
Chair: Ceri Vincent, CO_2GeoNet-BGS & John Scowcroft, GCCSI

15:45 **The Boundary Dam learnings with focus on technical-economical level**
Mike Monea, International CCS Knowledge Centre, Canada

16:05 **Building national CO_2 transport and storage infrastructure for public good: Rotterdam cluster experience**
Mark Driessen, Port of Rotterdam, The Netherlands

16:25 **Overview and status of the Norwegian full-scale storage project (Smeaheia) - moving towards a CCS network:**
Kari-Lise Rørvik, Gassnova, Norway

16:45 **Panel discussion**

17:05 **Closing remarks Day 1**
Ceri Vincent, CO_2GeoNet -BGS, CO_2GeoNet Chair

17:55 Departure by boat to the Gala Dinner

Wednesday April 25 - Day 2

8:30 **Welcome and introduction**
Sergio Persoglia, CO_2GeoNet Secretary General

Session 4: Growing CCS sectors and emerging opportunities
New sectors and developments
Chair: Roman Berenblyum, CO_2GeoNet-IRIS & Didier Bonijoly, Club CO_2 France

08:35 **The project pipeline and how do we fill it?**
John Scowcroft, GCCSI, Belgium

08:55 **New CO2 storage pilot project opportunities in Europe - outcomes of the ENOS project**
Jonathan Pearce, CO_2GeoNet-BGS, UK

09:00 **CCS optimism in the USA: legislative initiatives, Southern Company R&D, and DOE's storage initiatives**
Richard Esposito, Southern Company, USA

09:20 **ACT-ALIGN expanding large-scale storage for industry (considering new Dutch policy)**
Filip Neele, CO_2GeoNet-TNO, The Netherlands

09:40 **Full scale carbon capture at Norcem Brevik**
Liv Bjerge, Norcem, Norway

10:00 **Panel discussion**

10:20 *Coffee break*

Session 4: Continued
Chair: Niels Poulsen, CO_2GeoNet-GEUS & Filip Neele, CO_2GeoNet-TNO

10:45 **US-Norway – CCUS bilateral agreement; actions so far**
Aage Stangeland,The Research Council of Norway

11:05 **Potential oilfield pilot and growing CCS in the region of Serbia (southern part of the Pannonian Basin/Balkan region)**
Dušan Karas, Petroleum Industry of Serbia

11:25 **ACT – the impact on CCS in Europe**
Ragnhild Rønneberg,The Research Council of Norway

11:45 **ECCSEL – phase II and phase III: research platforms to support CCS roll-out in Europe**
Helen Taylor, CO2GeoNet-BGS, UK

12:05 **Panel discussion**

12:45 *Lunch break*

Session 5: International knowledge sharing
Sharing practical experience and public engagement strategies
Chair: Samuela Vercelli, CO_2GeoNet-La Sapienza & Kyle Worth, Worthy Environmental Engineering

13:45 **Decatur project - sharing practical lessons learned about moving from pilot to large scale**
Sallie Greenberg, Illinois State Geological Survey, USA

14:05 **CaMI Field Research Station FRS - lessons learned from first injection and monitoring**
Amin Saeedfar, CMC Research Institutes, Canada

14:25 **Otway shallow fault experiment**
Andrew Feitz , Geoscience Australia

14:45 **Panel discussion**

15:15 *Coffee break*

Session 5: Continued
Chair: Chair: Conny Schmidt-Hattenberger, CO_2GeoNet-GFZ & Sallie Greenberg, Illinois State Geological Survey

15:45 **Progress of the Tomakomai CCS Demonstration Project**
Daiji Tanase, Japan CCS, Japan

16:05 **The TRUST project and its progress at the Heletz test site**
Auli Niemi, CO2GeoNet-UU, Sweden

16:25 **ENOS project - working with the local communities to tackle onshore storage challenges**
Samuela Vercelli, CO2GeoNet-La Sapienza, Italy

16:45 **Panel discussion**

17:15 **Closing remarks Day 2**
Ton Wildenborg, CO_2GeoNet-TNO, CO_2GeoNet President

Monday April 23

WORKSHOP I - Pre-Open Forum workshop organised by *ENOS*
Experience-sharing focus groups: advanced techniques for site characterisation

14:00 **Welcome and introduction - overview of site characterisation activities**
Thomas Le Guenan, BRGM

14:15 **High-resolution offset VSP using fiber optic acoustic sensor – CO_2CRC Otway Site, Australia**
Athena Chalari, Silixa

14:40 **Borehole geophysical characterisation in the framework of the ENOS project, monitoring feasibility and initial results**
Flavio Poletto, OGS

15:05 **The value of well testing and pressure monitoring in injection site characterisation**
Anton Shchipanov, IRIS

15:30 ***Coffee break***

15:50 **Open borehole hydraulic and geomechanical well-test approaches**
Mark Kelley, Battelle

16:15 **Main achievements using light drilling applied to Hontomín site characterisation, technological gaps detected and future works**
Carlos de Dios, CIUDEN

16:45 **Discussion and wrap-up**
Thomas Le Guenan, BRGM

Thursday April 26

WORKSHOP II - Post-Open Forum workshop organised by *ENOS*
Storage site solutions: monitoring and verification

08:30 **Welcome and introduction**
Ceri Vincent, BGS

08:45 **ACT project "DETECT" and learnings from other CCS related activities in Shell**
Marcella Dean, Shell

09:00 **Optimization of onshore monitoring for industrial CCS: lessons learned from Decatur**
Randall Locke, University of Illinois

09:15 **Identified research gaps and technology needs for monitoring CO_2 leakage at faults**
Andrew Feitz, Geoscience Australia

09:30 **Battelle's monitoring experience from CO_2 geological storage field projects**
Mark Kelley, Battelle

09:45 **Gaps in current monitoring strategies based on experience at Hontomin**
Carlos de Dios, CIUDEN

10:00 **Monitoring technologies for identification of CO_2 migration pathways at shallow to intermediate depth**
Amin Saeedfar, CMC Research Institutes

10:15 **ENOS downhole groundwater monitoring**
Keith Bateman, BGS & Salvatore Lombardi, Sapienza Uni.Rome

10:30 **Advanced ENOS sampling & analysis techniques**
Tanya Goldberg, TNO

10:40 **ENOS effective wide-areal CO_2 detection techniques**
Michela Vellico, OGS

10:55 Coffee break

11:20 **ENOS CO_2 emission quantification tools**
Helen Taylor, BGS & Salvatore Lombardi, Sapienza Uni.Rome

11:30 **Innovative ENOS soil gas techniques**
Salvatore Lombardi, Sapienza Uni.Rome

11:40 **Advancing engineered constellation fibre plus integrated borehole survey design for detection of migrating CO_2 on fault planes at Sulcis Fault Lab**
Athena Chalari, Silixa & Flavio Poletto, OGS

11:50 **Efficient analysis of real world data**
Anton Shchipanov, IRIS

12:00 Panel discussion

Thursday April 26

WORKSHOP III – Post-Open Forum workshop organised by *Gassnova* and *Advanced Resources International (ARI)*
From pilot research to application in the field: a Norwegian-US knowledge-sharing workshop

US session

13:30 Welcome & introduction
Niels Peter Christensen, Gassnova

13:40 Integration of CO_2 storage with Enhanced Oil Recovery: a global perspective
Vello Kuuskraa, ARI

13:55 Regulatory and policy developments in the US: incentives and/or impediments?
Michael Godec, ARI

14:10 Establishing a commercial scale storage site in Kemper County, MS
David Riestenberg, ARI

14:25 Panel discussion: What could possibly go wrong? Challenges from US CCS demonstration projects
Moderator: Sallie Greenberg/Randy Locke - University of Illinois, ISGSI
Panel: Randy Locke, University of Illinois; David Riestenberg, ARI; Richard Esposito, Southern Company

14:40 Coffee break

Norwegian session

15:05 Norwegian full-scale project
Kari-Lise Rørvik, Gassnova

15:20 Integration across the CCS value chain
Audun Røsjorde, Gassnova

15:35 The Northern Lights project: towards the implementation of full-scale CCS in the North Sea
Renata Meneguolo, Statoil ASA

15:50 Monitoring offshore storage sites
Volker Oye, NORSAR

16:05 Discussion and wrap-up
Niels Peter Christensen, Gassnova

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CO_2GeoNet -The European Network of Excellence on the Geological Storage of CO_2

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CO_2GeoNet
The European Network of Excellence on the Geological Storage of CO_2

About CO_2GeoNet

CO_2GeoNet is the European scientific body on CO_2 geological storage. The Association currently comprises 29 research institutes from 21 European countries, and brings together over 300 researchers with the multidisciplinary expertise needed to address all aspects of CO_2 storage. With activities encompassing joint research, training, scientific advice, information and communication, CO_2GeoNet has a valuable and independent role to play in enabling the efficient and safe geological storage of CO_2. CO_2GeoNet was created in 2004 as a Network of Excellence supported by the EC FP6 programme for 5 years. In 2008, CO_2GeoNet became a non-profit association under French law. From 2013, the membership of CO_2GeoNet expanded thanks to the support of the now completed FP7 CGS Europe project. New Members continue to join CO_2GeoNet to further enhance the pan-European coverage and expertise of the Association.

More about CO_2GeoNet at www.co2geonet.com

San Servolo Island

Appendix 2 – Key messages from the Open Forum

Growing CCS for a sustainable future – Linking local actions for a global solution

Key messages of the 13th CO_2GeoNet Open Forum

San Servolo Island, Venice, Italy, 24 – 25 April 2018

CO_2GeoNet
The European Network of Excellence
on the Geological Storage of CO_2

DELIVERING GLOBAL CCS DEPLOYMENT

Key messages of the 13th CO_2GeoNet Open Forum

San Servolo Island, Venice, Italy, 24 – 25 April 2018

The theme of the 13th CO_2GeoNet Open Forum was "Growing CCS for a sustainable future – Linking local actions for a global solution". The title underlines the urgency to implement full-scale CO_2 Capture, Use 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 CO_2GeoNet 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.

CCS is back on the agenda

Increasingly, national governments are committing themselves to challenging emission reduction targets and decarbonisation strategies. More governments now accept CCS as one of the most important mitigation options to achieve the Paris Agreement Two Degrees Scenario (2DS) than ever before. Impartial stakeholders looking for the optimal decarbonisation solution are now beginning to turn to CCS.

CCS is not just a bridging technology associated with fossil fuel phase-out. Climate models show that CCS will be even more important after 2030, when new emerging technologies (such as hydrogen production, alternative hydrocarbons, etc.) are fully deployed.

Dialogue is key to integrating the necessary climate-change mitigation technologies (CCS, renewables, hydrogen, etc.) and achieving a low emission future.

Industry says: "We need CCS!"

The industrial stakeholders clearly stated "We need CCS"! Leading industrial entities now recognise that industry needs to be sustainable. Industrial initiatives planned around emission clusters and storage hubs are already on the table.

CCS is the only large-scale option currently available for process emissions (e.g. from steel, cement, fertilizers, refineries, natural gas treatment, heavy oil, waste-to-energy, hydrogen production, other

chemical industries). If the hydrogen industry grows as expected (multiplying by a factor of at least 5 by 2050), CCS is needed to ensure this is a low-carbon fuel.

Commercial stakeholders require consistent policies and political support that offers predictability (not necessarily certainty), effective and cost-efficient laws and regulations, reduced costs and increased efficiency through research and development.

No 1.5DS without CCS

Many NGOs have expressed frustration that Europe still behaves as in the pre-Paris Agreement state. The message from the Open Forum was clear: either do CCS or forget about any below 2° scenario!

CCS offers a flexible and adaptable opportunity to meet climate targets through its deployment in different regions in different modes (power, industry process emissions, supporting a hydrogen economy, etc.). Models indicate that, in order to achieve 2DS, 52 Gt of CO_2 must be stored from the power sector plus a further 29 Gt of CO_2 needs to be avoided by 2050 from industries with high process emissions (ETP 2017, IEA). The scale of this action is equivalent to the current oil and gas industry.

In the very short term, it is possible to reach the climate reduction targets without CCS, but from 2025 onwards, CCS is essential. Therefore, actions need to start now in order to ensure that CCS is deployed in time. Excluding CCS from the models results in an exceptionally high cost for achieving 2DS. The longer we delay, the more drastic the actions that will be required. The more ambitious we are in our climate targets, the more we need CCS.

To achieve the Below 2° Scenario (B2DS), net negative emissions of CO_2 are not optional, but mandatory. A clear advantage of CCS is that it is capable of delivering negative emissions at large scale. Biomass currently accounts for 10% of global energy supply. An increasing number of BECCS projects would need to emerge globally in order to achieve net negative emissions, some of which could include adapting existing plants to use biomass plus CCS. However, the supply chain needs to be developed, consistent policies ratified and the resource limitations fully defined.

Regional actions for a global solution

Given the global variations in economic development, available natural resources and social and cultural environments, the optimal emission mitigation solution will not be the same for all regions.

The use of domestic energy resources is essential for non-OECD countries to ensure better social and economic wellbeing. A strong belief exists that energy independence is achievable on a low carbon platform. CCS as a recognised climate-change mitigation technology is suitable for all regions in the world. Regional development is strategic for the EU (and all regions of the world) – therefore a tailored local approach is in line with strategies to achieve global solutions.

Sharing facilities and research efforts through international cooperation is already underway and further encouraged. Alignment and integration of these regional developments wherever possible

will result in greater efficiency. Mechanisms such as Mission Innovation, CSLF and national initiatives can play their role here. In addition, support (in the form of dissemination, technological, financial) for non-OECD countries is essential to facilitate deployment of CCS projects globally.

Large-scale installations already in operation prove that CCS works and that the economics can be positive and manageable. More strategic projects are needed in Europe to roll out CCS and to realise commercial opportunities. Every new installation has the potential to reduce costs. Further pilot and demonstration projects are crucial and an apparent dilemma is should we go small and safe or large and challenging? The consensual answer is start simple – stay flexible – upgrade.

So how do we get there?

Sustained political support is the most important enabler. CCS should form an integral component in national climate-change mitigation strategies. EU legislation is CCS ready.

We now request a level playing field with other climate-friendly technologies – all other low carbon options that are well advanced have all been supported in some way (policy and/or financial) to get them up-and-running. Subsidies and/or incentives and tailored financial mechanisms (Green Climate Fund, International Bank, etc.) should help governments and industry to establish their national CCS plans and to boost commercial uptake of CCS. Political and economic stability is essential as it can take around 10 years to advance from concept to a working CCS project.

Design of (international) hubs and clusters will make CCS even more technologically and economically efficient (particularly for industries with high process emissions). Cost reduction is also expected through optimisation of operations, economy of scale, and international cooperation.

Lack of public awareness is also a key barrier. What climate targets mean for people and the role for CCS need to be more clearly expressed in a relatable manner. New ways of interacting with the public are being developed (e.g. ENOS project at http://www.enos-project.eu/).

Recent studies show that the major concerns of the local population on CCS focus around mismanagement and non-appropriate operating of storage facilities in their neighbourhood. The public demand clear regulations and independent verification.

Climate impacts are global, not local. Everyone (regulators, scientists, engineers, the public, journalists, etc.) has a role to play in preventing negative climate impacts, using their expertise to move towards a sustainable way of life. Fuller dialogue between different sectors will optimise the impact of regional actions for a global solution to climate change.

Full details of the 13th CO_2GeoNet Open Forum are available at
http://conference2018.co2geonet.com/

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