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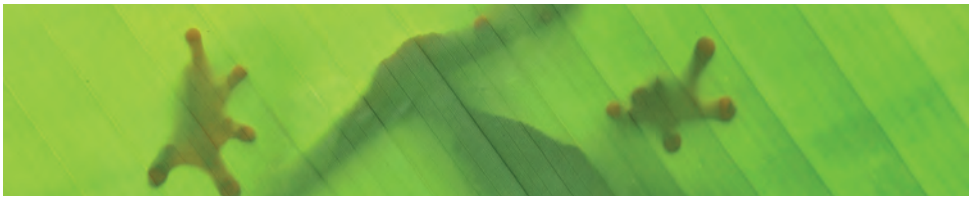


second 2011 sharing event

european ccs demonstration project network report

compostilla

spain

8-9 june 2011

contents

Introduction

The 2011 second CCS Network sharing event of the European CCS Demonstration Project Network was held in Ponferrada, Spain 8-9 June and hosted by CIUDEN (Fundación Ciudad de la Energía), a research organisation responsible for developing CCS technologies in Spain. CIUDEN is partnered with Endesa and Foster Wheeler in the Compostilla CCS project.

More than 50 Network member representatives and invited guests gathered to share their experiences and to visit the CIUDEN Technology Development Centre for CO_2 capture. The centre has a plant, recently started up, with a 20 MW pulverised coal (PC) boiler and a 30 MW circulating fluidised bed (CFB) boiler, both designed for operation from conventional (air) combustion to oxy-combustion.

The meeting clearly demonstrated that the Network members have established a good environment for open sharing of information and experiences and that the Network is an arena for discussing and dealing with common challenges.

Programme

The Network meeting followed, what is now a well established format of knowledge sharing on a theme in break-out groups: the public engagement, permitting and geological storage group. During the first 2011 meeting in Brindisi, opportunities for collaborative work on storage and permitting were identified. During a joint session, these opportunities were explored further.

During a plenary session in the morning of day 2, several presenters shared their views on progress of CCS in several areas.

Joint session Permitting and Storage

The Network member projects are currently preparing for the storage permit application process that will take place in 2012 and 2013 with expected approval in due time to project start-up by the end of 2015. The storage permit application process is the responsibility of the members attending the permitting thematic group. Likewise the members of the geological storage group represent the competence area that will undertake studies and provide the technical basis for the permitting process. These two competence areas will work closely in this process and following suggestions at the last sharing event in Brindisi, the two themes held a joint session at the beginning of the sharing day. The aim of the joint session was to identify potential areas of co-operation.

Todd Flach of DNV opened the session by identifying key lines of discussion that are expected to take place between a project developer and the competent authorities. Central to the debate on successful storage permitting is the issue surrounding the CCS Directive Article 4 that states that there should be “no significant risk of leakage” from the storage complex. Targets associated with the notion of ‘significance’ have yet to be defined and there is room for interpretation. The target will be interpreted and is expected to be more clearly defined as the project developers and competent authorities gain experience from the permitting process for the first storage sites.

The introductory presentation ended with the following questions for discussion:

1. What is your project doing to agree with the competent authority an acceptable risk level for storage site leakage?
2. What does your project do to establish a credible estimate of storage site leakage risk?
   a. What are the minimum and ideal levels of site data coverage?
   b. What are the minimum and ideal levels of site modelling?
   c. What are the minimum and ideal levels for documentation?
3. How is your project working to promote an efficient storage permit application process (e.g. success criteria)?

The participants worked in four groups sharing their thoughts and experiences on the dialogue with regulators and on the geological studies and assessments that need to be carried out as part of the permit application. Both the storage and the permitting specialists worked in distinct groups according to whether their projects proposed onshore or offshore storage. Porte Tolle, ROAD and Don Valley focused on offshore storage permitting and Jänschwalde, Bełchatów and Compostilla on onshore issues.

Onshore storage permitting issues

The Compostilla Project is currently developing both a pilot storage as well as a industrial/commercial storage location. The R&D activities on the pilot storage site (Hontomin) are undertaken by CIUDEN, while the activities for the industrial/commercial storage are lead by ENDESA. Baseline site characterisation is well underway, including gas emissions from the soil and monitoring of earth deformations. For the pilot site at Hontomin the storage permit has already been secured. The pilot site is developed under the auspices of research rather than industry. Interestingly, this seems to have enhanced local community support. For the demonstration (large-scale) project for storage two options remain: "Duero Site" and "Andorra Site". The main risks of these sites have been thoroughly assessed. The results have been presented in a risk matrix to the authorities. Government positions and requirements across regional and national level are not yet fully aligned.

The Belchatow CCS Project has identified three possible storage sites, which have been currently appraised. These are: **Budziszewice, Lutomiersk-Tuszyn (Belchatow) and Wojszyce,** located in the central Poland, Łódź Voivodeship. The geological research has been completed and currently the data interpretation and modelling are being progressively undertaken. The PGI (Polish Geological Institute) acts as an independent third party in verification of the storage plans.

Regarding storage legislation, the Ministry of Council has accepted assumption for ***„Draft Act of Amended Act - Geological and Mining Law and other Act"*** and now is waiting for the storage law to pass through the Parliament.

The Jänschwalde project has organised a risk management workshop together with representatives of the authority. Saline water movement has been identified as the main risk. A Monitoring Working Group has been established with representatives of the project, the authority and geological services. This approach is delivering good progress and results. It helps to inform and engage the government.

The German authorities have limited experience with risk assessments and are struggling to deal with "risk". Discussions on storage are public in Germany. This creates the need for an independent trusted third party to evaluate and verify plans.

The session made some generic observations and conclusions:

- A Risk matrix seems an effective tool to communicate the results of a risk assessment;
- There is a need for independent trusted third parties to evaluate and verify storage plans. The collaboration of Bełchatów with PGI is a good example;
- Governments seem to struggle to deal with risk. The joint workshop in Germany is a good practice for engaging government;
- The projects are concerned about the level of competence on storage in regional and national government. Limited understanding may result in slowing down decision making;
- Lack of alignment between regional and national government complicates the process of providing convincing evidence on storage safety;
- The project developer should take the responsibility for extensive communication with the competent authorities through working groups (and stakeholders);
- It is important to improve the internal communication in the project.

Offshore storage permitting issues

There was a specific example of one project that presented the classic well tested strategy for natural gas production wells, which is commonly referred to as a shut-in pressure build-up test. Some regulatory regimes prescribe that such tests be performed at regular intervals. The data can be used to estimate the amount of gas remaining in the reservoir and some other dynamic parameters. The analogue for the CO_2 storage case is straightforward. A CO_2 injection well can be shut-in and the resulting pressure decline observed at the well bore can be used to estimate the average reservoir pressure and thereby the amount of CO_2 stored in the reservoir (many other input parameters are required for this). The operational challenge is that the injection well cannot inject while this test is proceeding. If there are other injection wells, these should also be shut-in to avoid pressure effects from them interfering with the pressure response in the well under study. Thus for this test injection operations must stop, and this usually means that capture operations must also stop. This can result in significant disturbance in the CCS chain. The dialogue with the regulator is focused on how to either replace this testing method altogether with a method that does not disturb injection operations or to minimise the period of shut-in to minimize the disturbance. This issue can be extended to other types of monitoring and data collection that require "quiescent" conditions or otherwise disturb injection operations.

The group discussions confirmed the need for close cooperation between the two competence areas and that the member projects have organised the projects to ensure such co-operation, i.e. there are no organisational barriers. The member projects are preparing for a challenging storage permit application process that may be more resource and time demanding than expected. The critical issue still remains how to demonstrate "no significant risk of leakage" and that the storage site has an acceptable level of risk.

To address this issue and to further elaborate on the potential role of knowledge sharing between the member projects and competent authorities the last part of the joint session explored potential areas or means of sharing experiences from the storage permitting. The participants brainstormed the type of knowledge that could be shared between the member projects and also on what could be shared with the competent authorities.

Suggestions from the groups were:

- The projects should share information and evidence base with each other and in particular decisions/permits should be shared with the other Network members. The decisions/permits will be evidence of "what is acceptable risk" and important lessons learned for project developers and competent authorities. The EC has a role to play in this as it will assess all storage permits. There should be a system for disseminating this information to competent authorities and projects developers in order to further build knowledge on storage risk acceptance;
- The role of independent parties who might be commissioned to assess the storage permit application and state their opinion on the storage site (storage permit application);
- Methodologies used to qualify storage sites and define an acceptable risk level should be shared between projects (not numerical data). This will contribute to accelerating the development of industry knowledge on methodologies;
- The risk registers for leakages that will be developed by each project may be shared between the Network members. Sharing these registers will inform the project teams on potential risks and mitigating measures that may be implemented. This may again support the projects in the storage permit application process and in defining an acceptable risk level for the storage site;
- Time and schedule implications of multiple permits and multiple interfaces with regulatory bodies. There is a need for a great deal of coordination in the permitting process. This should be accounted for in the planning process. For example, discussions in the UK took 18 months prior to permit negotiations and the ROAD project has so far spent 20,000+ hours on the permitting process. How Member projects plan resources and mitigate delays will be an important topic for sharing.

Participants agreed that it is important that the permitting and storage competence areas work closely together and that the organisation of the projects facilitates this collaboration.

The issues identified in the group discussions and brainstorming will be discussed further in the permitting and storage groups and potentially in joint sessions in future Network meetings.

After the joint permitting and storage session the two groups continued with separate agendas.

Knowledge sharing theme 1: Permitting

The main agenda items for the permitting group was sharing experiences on transposition of the CCS Directive, progress on permitting in the member projects and lessons learned.

The permitting processes for most projects are still in an early stage, but are moving rapidly forward for the power and capture part of the projects. Initial activities have been initiated for the pipeline permitting and the projects are preparing for the storage permit application process.

The CCS Directive in Spain

The Network invited Ismael Aznar Subdirector General, Climate Change Office in the Spanish Ministry of Environment to present the status for the CCS Directive in Spain. The Spanish authorities have been active in implementing a regulatory framework for CCS projects and were the first EC Member State to transpose the directive into national legislation. The presentation gave the group insights into the different considerations of a regulator when transposing the directive and an opportunity to exchange views on the Directive and in particular financial security.

Permitting status of the projects

ROAD CCS Project

The ROAD project has completed and submitted the Environmental Impact Assessment (EIA) for the full CCS project including capture, transport and storage. The project has decided to describe a transport and storage part of the project with a capacity five times the capacity needed for the Maasvlakte capture plant. This has been done to facilitate simplification for other potential capture projects that may use the same transport and storage infrastructure as ROAD. Other projects may base their permit applications on the same EIA. The project has received some advice from the Dutch EIA commission and is currently updating the document.

The draft permit application for the capture plant has been reviewed by the regulators and comments have been received on emissions to air and fire safety. The permit is being updated and will be submitted to the regulators 14 June. The ROAD project will arrange stakeholder meetings with the public and NGOs after the summer.

Porto Tolle

The main news from the Porto Tolle project was that the State Council's decision partially voided the Environmental Authorization for its conversion to coal-fired power plant . In the decision it is also affirmed that there is the possibility of "reassertion of the given power" so as to reaffirm Environmental Authorization validity. Therefore ENEL will appeal for revision of the permit application and will continue the discussions with the authorities on the process of a positive outcome for the permit. This will lead to delays in the permitting process for the project. The CCS project will continue as planned and expect to meet the project deadlines.

Jänschwalde

On the 13th of April the German Federal Government proposed a new draft CCS law to implement the CCS Directive into German legislation and the first consultations in the Bundestag and Bundesrat have taken place. The key elements of the law are:

- Only applicable for demonstration projects when an application for a storage site is submitted by the end of 2016;
- Annual storage volume is 3 million tonnes per site and 8 million tonnes in total for Germany;
- It is the competence of the Federal States to designate areas in their territory which may or may not be used for CO_2 storage in their law;
- There will be a review of the law in 2017.

The project is steadily progressing in permit proceedings. For the capture part the documentation for the applications for both permits - modification and water permit - are under development on the basis set by the Environmental Authority. Concerning the pipeline, the documentation for the planning assessment performed by the Planning Authority of Brandenburg is under preparation. Subject of the procedure is the compatibility of the project (pipeline route) with the requirements of regional spatial planning. The start of exploration activities concerning potential storage sites Birkholz and Neutrebbin requires further permits - special operating plans under German Mining Law. The special operating plan for seismic has already been submitted to the Mining Authority, the plans for drilling are under preparation. The exploration permit for the Birkholz site which is a basis for the operating plans, is subject to a legal claim filed by the town of Beeskow (the biggest town in the storage area) and a local water and wastewater association. Vattenfall successfully applied for the immediate execution of the exploration permit which allows approval of special operating plans by the Mining Authority.

Don Valley

The Don Valley project is currently in the pipeline consultation process on strategic options. So far the project has studied three alternative routes from the capture plant to the offshore storage site. The project has received positive responses from the parties consulted. On the 18th of May the first decision on pipeline routing was taken and the northern route was selected ("Preferred Strategic Option"). The next step is to define the pipeline routing in more detail for this route and undertake consultation meetings with the local communities potentially affected by the proposed pipeline route. During the next few months National Grid will arrange sixteen meetings in local communities with the aim of receiving feedback on the various routing options it now faces.

As part of the permitting process, the Don Valley project provides financial support to local governments in order to enable them to undertake the assessment of the permit applications. This supports the costs of hiring and the capacity needed to assess the applications.

The project is preparing for the permitting process for the offshore activities. Consents for the storage site could either be pursued under the 2008 Planning Act or as separate consents under the Petroleum Act, Energy Act and additional temporary and permanent licenses. The obligation to consult is less onerous if separate consents are pursued. National Grid intends to undertake consultations with offshore stakeholders to the same level of detail as onshore stakeholders.

Bełchatów

With regard to the capture component and based on currently binding law Belchatow CCS Project has obtained two of the following administration decisions: *Decision on Environmental Condition* dated 11th December 2009 and *Building Permit* dated 26th January 2010, validated on 22nd February 2010

Regarding the transport component, the project's proposal of the potential pipeline routes was included into the National Spatial Development Plan Concept by the Ministry of Regional Development. *The Act on Transport Corridors* is still in preparation and waiting for successful social and interministerial consultation.

Concerning the storage component, the project gave an update on transposition of the CCS Directive. The Council of Ministers approved the draft *"Amended Act to the Geological and Mining Law and other Act"* 15 March 2011. The general procedures for approval of the law are:

- The Governmental Legislative Centre consults with the Ministry of Environment and other relevant governmental offices;
- Consultation with other stakeholders;
- Three readings in the Parliament;
- The Senate has the right to amendments;
- Approval by the Parliament, Senate and then signing by the President.

Compostilla

The Project gave an update of the status of the permitting processes in the different sides of the CCS value Chain:

CAPTURE: The Project has submitted the 'Initial Document' of the Capture Plant to the Substantive Body (Ministry of Industry) on February 2011. With this action, the Administrative permitting process including the Environmental Impact Assessment procedure has started. The Substantive Body (Ministry of Industry) submitted the documentation received to the Environmental Body (Ministry of Environment) on March 22nd, 2011, and the Administration has three months to submit to the promoter the remarks/comments they consider that have to be included in the Environmental Impact Study. According to the environmental procedure, a bank guarantee (20 M€) was submitted by Endesa Generación on May 2011.

TRANSPORT: The 'Initial Document' for the EIA of the CO_2 pipeline was submitted to the Ministry of Industry on June 2011 in order to comply with the project schedule. However, there is no legislation covering the CO_2 pipeline permitting process, and the administration bodies in charge of the procedure are not defined yet. Recent contacts with the administration found that the Ministry of Industry will be the competent Body.

STORAGE: All permits granted under the Spanish Mining Law (exploration permits, etc) are being adapted to the new Law on CO_2 storage. Timeline: 18 months since the publication of the Law (December 30th, 2010).

Key permitting issues

Key issues facing member projects include:

The sharing event concluded with the identification of important issues facing the projects at this stage in their development:

1. The transposition of the CCS Directive including financial security, long-term liability and different regulatory models;
2. How to accelerate CCS permitting though the potential use of independent bodies; having clear timelines; adopting an early engagement with regulators and sharing good experiences;
3. Public Acceptance/Perception (better) issues and the permitting process;
4. Regulators' readiness for CCS, including policy, capacity and competence;
5. Experiences and approaches to Environmental Impact Analysis.

The projects identified items number 2 and 4 to contribute to the next event (hosted by the Bełchatów project).

Knowledge sharing theme 2: Public engagement

Updates on public engagement activities from the Network members

The meeting allowed some time for member projects to update each other on their public engagement activities since the last meeting in Brindisi, their reflections on the recent Eurobarometer CCS survey results and their forward plans.

Bełchatów

The project reported no significant changes since the last meeting and focused its contribution on planned activities, which include:

- Informative-consultative meeting with participation of the EC and the Ministry of Economy;
- Series of meetings at schools, in cooperation with The Environment Office of PGE Giek;
- Series of publications in national trade journals;
- FAQ preparations;
- Organisation of a trip for local authority representatives to the demonstration project site and storage locations in France or Germany;
- Explore the organisation of a national meeting with other investors carrying out CCS projects;
- Social characterisation, carried out by an external company. The project believes that this work is important, as the project is hardly known in Poland.

Bełchatów reflected that the Eurobarometer results confirm the suspected a lack of knowledge on CCS in Poland. However, it seems that when people are aware of benefits from CCS (environmental and economic), people want to participate, so public engagement activities remain a key area of attention for the project.

Porto Tolle

The project shared its recent difficulties with respect to permitting, but stressed that it continues to work on the project and public engagement activities. The team is encouraged by the local population and Enel employees making a case for the economic benefits of the project.

Porto Tolle is dealing with CCS communication as part of Enel's corporate communication and does not want to position CCS as something external or a stand-alone project. To date, five key objectives are targeted with the CCS strand in Enel's corporate communication strategy:

1. Inform and engage Enel's employees;
2. Create visibility of the CCS project;
3. Promote importance for the country;
4. Help build public opinion and monitoring of opinions regarding CCS;
5. Provide information on CO_2 and CCS, leveraging Enel's role as first mover.

A great variety of initiatives against these objectives have been undertaken to date, including:

Information dissemination initiatives

- Website and online communication;
- Publishing/videos;
- Special projects. Enel's sustainability report refers to the CCS project;
- Sponsorship of scientific workshops and seminars;
- Italian- Chinese cooperation programme.

Visibility of the CCS project

A significant amount of work has been undertaken to create more visibility for the project. This work focused particularly on profiling the CO_2 capture pilot plant in Brindisi with:

- an external guests and visits programme;
- the organisation of high level CCS events in Brindisi;
- the sharing of information within existing stakeholder committees;
- advertising and international communication of the project.

Promoting CCS for the country

Enel has been actively promoting the results of the Italian CCS observatory, which produces newsletters and maintains a website on CCS developments. This observatory was created with the support of the company and includes relevant scientific and industry related stakeholders as well as representatives from involved Ministries. Also, Enel has actively participated in existing CCS support groups and organisations.

Opinion building and monitoring

Enel maintains media relations consistently and issues regular press releases, providing the media with interview opportunities and organizing special events as well as media trips. With respect to monitoring, Enel is undertaking public opinion research, qualitative research and is looking to use the Eurobarometer CCS survey results to further identify research needs.

Inform employees

Enel acknowledges the relevance of its employees as active citizens in issues related with climate change and energy policy. The company understands the strategic importance of adequately informing employees and has set up an internal information centre dedicated to CCS. The internal magazine (in various languages), the intranet and the internal TV and Radio channels are also used to inform the workforce about CCS and Enel's role in fighting climate change. Enel's CCS R&D projects are promoted internally and the existing platforms allow dialogue and engagement by employees who demonstrate high interest in CCS.

Public acceptance, how far have we come?

The project was not dissatisfied by the Eurobarometer results. Italy is among the top countries in terms of awareness with 24% of the Italian population aware of CCS - albeit only 5% can explain what it is. 41% of the Italians recognise that CCS could be effective in fighting climate change. Of those informed about climate change that number percentage rises to 86%. Nine per cent of the total population know of the Porto Tolle

project and that rises to 51% when analysing those informed about climate change. These figures are higher than the project had expected. It should be noted that the Eurobarometer survey results were generated before the Porto Tolle project was confronted with the withdrawal of the environmental permit. As about 30% of the population do not see advantages from implementing CCS projects in their own region, it remains very important that the projects communicate the relevance of CCS as a climate change solution and economic stimulus.

The Porto Tolle situation?

The Porto Tolle local situation can be characterised as an economically deprived area, where the existing power plant needs to perform a technological update in order to operate adopting the best available techniques as requested by the Authority. During the process of authorisation Enel was confronted with coal opposition in Porto Tolle; it is fair to say for now, that feedbacks between the media and public opinion asserts that there is no currently strong community opposition especially for CCS project. Actually near Rome, Enel built and currently operates a similar power plant as in Porto Tolle and this, is a successful track record. The Porto Tolle project is consequently viewed optimistically and the project will be able to continue.

Jänschwalde

The Jänschwalde project is currently focussing on the regulatory process. With respect to public engagement, the project has decided to not raise its profile unnecessarily and to remain calm until the legislative process has come to an end. The activities undertaken are however covered in the presentation held during the meeting.

Jänschwalde's reflections on the German Eurobarometer results are that people don't seem to understand the national energy mix in their own country. People seem to think that Germany has ample renewable energy and therefore do not see the need for coal-based power plants with CCS. What seems to be required is education on a quite fundamental level. Project developers such as Vattenfall are probably not the best placed to deliver this. It would be better if public services would take up this role.

With respect to the stakeholder landscape and current political situation, Jänschwalde informed the participants that there is now a plan to have a final decision on the German CCS law and that energy topics are very much on the political agenda. A German CCS-Law will be enacted in autumn 2011 and the content of the law has been discussed already. The project sees a number of major critical points in the law: Firstly there is a prolonged responsibility phase (30 years instead of 20 as proposed by the European Commission); there is a planned revision of the law in 2017 providing no stable basis for long-term planning and investments and unclear regulations will make CCS projects nearly impossible to insure. Another issue on the political agenda is that Federal States in Germany may exclude the application of the law on their territory, The project developer has not detected a willingness on behalf of the German government to improve the regulations for the case of a CCS project. Therefore, there is a critical situation, creating an uncertainty within the (project) organisation.

Jänschwalde foresees a number of issues affecting the project in general and its public engagement activities in particular. Firstly, the image created in the media is one of `energy companies are in favour of CCS because they want to make money´. Secondly, the new legal framework will make it much harder to work on public acceptance than ever before. Thirdly, there is a notable rise in opposition, increasing over the last month.

There seems to be a zero risk appetite towards energy technologies. This holds particularly for storage. For example, a report was filed recently about how CO_2 from the potential storage sites in Brandenburg can pollute groundwater on a large area extending to Berlin and parts of Poland. Vattenfall believes that the claims made in this report are completely unfounded since no exploration whatsoever has taken place in the potential storage region.

Compostilla

The Compostilla project reported that it is implementing an integrated communication plan based on continuous, interactive and effective messages. The actions of the communication plan started on the local area on the surroundings of both the storage and capture sites and are now moving from the local to the regional/national level. Press media, notes and TV microdocumentaries have been released at regional/national level, and meetings with the main scientific journalist organisations have been held in order to reach an agreement to collaborate in disseminating and communicating CCS activities to the general public.

The Compostilla project identified key messages such as: the CO_2 capture, transport and storage technologies being part of the climate change solutions, the promotion of public-private cooperation and the generation of jobs and opportunities in the territory. At the same time, several “taboo” words that might be misunderstood by receivers of the project’s key messages (as supercritical phase, leakage, etc.) have been identified. Based on these identified messages, several outreach and educational material like brochures, videos, information packs etc, tailored to different audiences as general public, journalists, local authorities, stakeholders, children and experts, have been designed and are periodically updated.

Day-by-day monitoring of the public reaction by reading newspapers and other sources of information (radio, tv) has been implemented in order to check the effectiveness of the project communication plant in order to be flexible to adapt the strategy to the current requirements.

The recent period has been considerable active in the area of social (site) characterisation. A second social site characterisation strategy is on-going, based on interviews to the previously identified stakeholders that additionally will help to identify more stakeholders.

There are a number of communications activities underway in both capture and storage sites, some of them are indicating below:

Capture site:

- The project reports that more than 1000 people visited the plant on CIUDEN's fifth anniversary;
- The project, in cooperation with the National Museum of Energy, is working locally with around 80 primary schools in the El Bierzo region with educational outreach activities, addressing some 13000 children in total;
- A group of specialised spokespersons for the media and the local population has been identified and is now receiving communications training;
- The interpretation centre located on the capture pilot plant area is to be inaugurated in the next forthcoming weeks.

Storage site:

- The project is capturing every element of fieldwork by means of videos and still images as a record and narrative of the project;
- A new activity is the development of a CO_2 storage interpretation centre near the storage TDP. This centre will address climate change, CO_2 and the energy mix, CCS as a climate change mitigation solution and the Hontomin storage complex development;
- Summer courses at universities are planned (with a discounted fee for local residents);
- A webcam on installations is being arranged to allow the population to follow the works at the sites via web.

Up to date, the project has focussed its public engagement activities at the Leon regional level. This might explain the Eurobarometer finding that only 2% of the Spanish population have heard of the Compostilla project. On reflection on the Eurobarometer results in Spain, the project believes that contextual factors favouring the project include the perceived economic benefits of CCS for the region, the public confidence in authorities and the finding that the Spanish population has high sensitivity to climate change. One of the concerns that the project highlights from the Eurobarometer survey is that 86% of respondents have a negative perception of CO_2. It is expected that the educational activities of the project will contribute to a shift in opinions in this sense, although this cannot be expected in the short term.

Interestingly, and contrary to other members' contexts, the Compostilla project is in a position to contribute to educational curricula, through the involvement of CIUDEN, a publicly funded body, in the project partnership. Other projects commented that corporate influence on national curricula could be seen as unwanted intrusion and are therefore not in a position to directly contribute to education. In some cases curricula are quite fixed, it could be hard to address CCS in schools.

The Compostilla presentation finalised with the input from Frederic Ximeno from ERF, public engagement advisor to the Compostilla project, who outlined the criteria for public engagement used to build the Compostilla framework for social interaction.

Don Valley

It had only been four weeks since 2Co Energy acquired the Hatfield project after it had gone into administration. The suspension of the EEPR grant was lifted and 2Co Energy managed, in the weeks leading up to the acquisition, to include an amendment in the NER 300 application to include a new storage option which would involve Enhanced Oil Recovery and permanent storage in an oil field. 2Co Energy agreed to the principles for coal supply and the offshore pipeline routing with National Grid. It was concluded that the pipeline should be extended by 175 km.

In the four weeks leading up to the Network sharing event, the media coverage was more extensive than 2Co Energy would ever have imagined. It should be noted that in the region there is a strong local newspaper and it is highly supportive.

2Co's short term communications schedule is largely driven by the National Grid. There will be public meetings along the pipeline corridor in the summer. The second meeting is in the village where the power plant will be. The power plant is to be built alongside one of Britain's few coal mines. As an effect of the administration process, another company owns the mine and the surrounding. 2Co is very aware that the local community is not going to make fine distinctions between the mine and the power plant. So, effort is being made to align local communications with both the coal mine and National Grid. Meetings have been arranged with local government officials and local community leaders. 2Co want to understand existing concerns and the legacy it is inheriting. 2Co aims to quickly establish local awareness about the company.

As the power plant and CCS installation is in an economically deprived area with high unemployment, 2Co is seeking ways to provide support for economic development. It believes that rather than offering jobs (although some thought is being put in to that), support for skill development and education can be arranged. A local NGO involved in training could provide a platform for this.

The project reflected that there were not many surprises in the Eurobarometer results for the UK and believes that with recent wet summers, levels of awareness about climate change may have dropped. Although the survey results suggest that there is a relatively high score on perception of the benefits from CCS, direct benefits for the local community are not easily seen by 2Co. Although the project may employ 2000 people during the peak of construction and perhaps 200 or so later on, only a few of these are likely to come from the local community. The project believes that more importance should be given to local understanding at a national level.

Current concerns of the project focus on three areas:

- The European level
- National government
- Local issues

In particular, the lack of speed with which UK policies are being put in place is worrying the project. In particular respect to the funding, there is not as much sense of urgency as one would want.

The government will fund its programme for the UK's projects 2-4from general taxation. And 2Co believes that this will make financing of CCS projects in the UK difficult.

The previous owners may have overestimated the potential for additional economic development, so expectations need to be managed.

The project needs to establish a dialogue with a local the group called "Residents Against Inappropriate Development (RAID)", however overall it's central government in London that is worrying the project, more than the local site.

ROAD

The ROAD project has undertaken a number of activities in the area of public engagement since the last Network meeting in Brindisi.

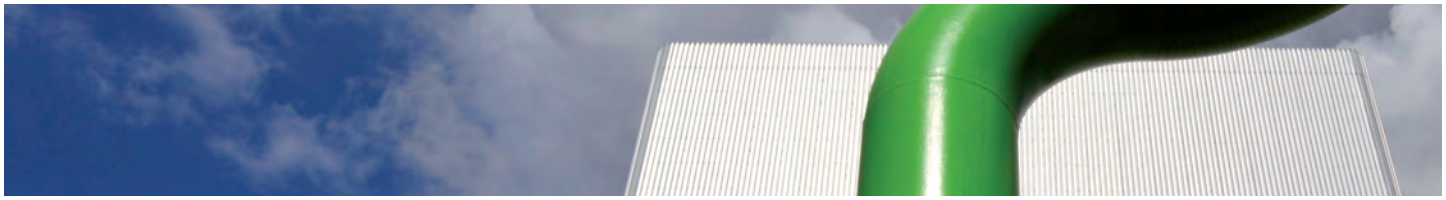
ROAD has continued to invest in a relationship with regional stakeholders, top down through a Regional Advisory Committee (RAC) and bottom up via a Community Advisory Panel (CAP). The RAC aims to:

1. Create regulatory, financial and political conditions for the development of a CCS hub in the Rotterdam region by joint representation of interests (Rotterdam sustainable economic development);
2. Share CCS knowledge and experiences amongst members of Regional Advisory Committee;
3. Inform regional, national and international stakeholders about the development of the Rotterdam CCS hub;
4. Manage contacts within regional, national and international stakeholder networks.

The RAC is a platform of high level representatives from regional organisations (including the Port of Rotterdam, the City of Rotterdam, the regional employers' organisation Deltalinqs and DCMR , the Environmental Protection Agency Rijnmond) that meets 4 times a year and consists of three supporting and advisory working groups (Regulatory & Public Affairs, Public Engagement & Acceptance and Permitting). Through the RAC, ROAD is able to link to regional, national and international stakeholders.

The CAP, by contrast, is a platform for open, constructive dialogue between ROAD and its (regional) stakeholders aimed at building mutual understanding and trust. It is composed of around 10 members from the local community (not representing special interest organisations), chaired independently. The CAP determines its own agenda and has its own financial and communication means and meets around twice a year with regular meetings with the ROAD project management, often combined with, for example, site visits. Agenda topics for the CAP are: external safety, environment, hazards and risks, nuisance, monitoring- & alarm systems, external communication and incident / complaint management.

The ROAD public engagement team is currently interested in the concept of 'framing', in particular how one can position the project from a more economic benefits point of view. As climate change seems to be off the agenda, the project believes it needs to look at the economic side of the technology and to position CCS as an important technology for energy-consuming industries that have high ambitions for emission reduction.



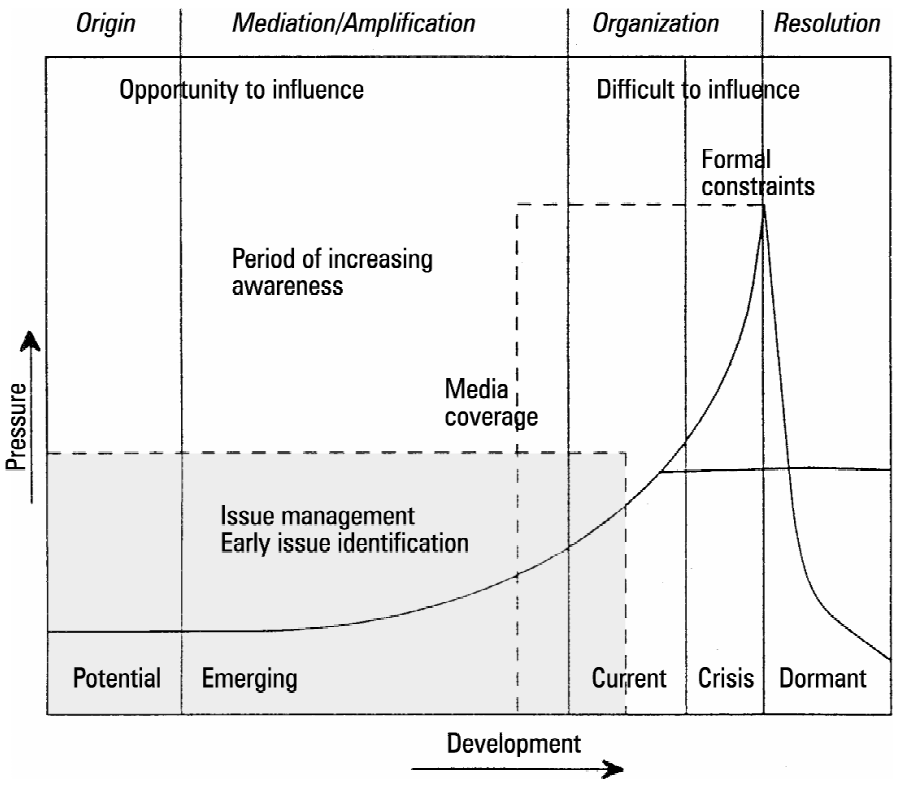
Rotterdam has the ambition to develop a local CCS industrial Network, in which producers of CO_2 are connected to users of CO_2. It is believed that this the economic benefits stemming from a CCS industrial Network are more tempting for stakeholders than only seeing the waste side of CO_2 (as experienced in the Barendrecht CCS project).

Issues management for CCS projects

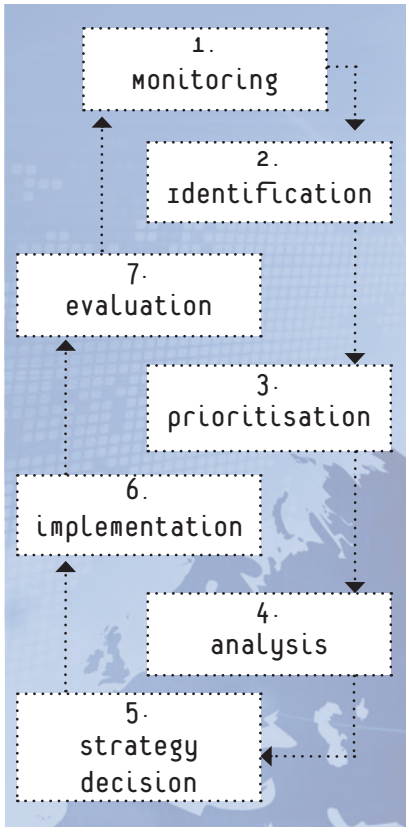
At the last meeting in Porto Tolle, the group had agreed to undertake work in the area of risk communication. After some discussion in the period leading up to the Compostilla meeting, it was agreed to use tools and techniques from the domain of issues management as a basis for a Network toolkit on dealing with emerging issues (rather than a toolkit for communication of risks).

After the round of updates, the participants were briefed by the ROAD project on the concept of issues management.

An issue is defined as: *an (emerging) issue is a condition or event (internal/external) that if it continues will have a significant effect on the functioning or performance of the project or on its future interest, or: a gap between corporate or project practice and stakeholder expectations. Issues management was defined as: the management process whose goal is to preserve markets, reduce risks, create opportunities and manage corporate or project reputation as an organisational asset for the benefit of both the organisation and its primary stakeholders,* or: bridging or closing the gap between corporate or project practice and stakeholder expectations.



Source: Hainsworth (1990) and Meng (1992)



The diagram on the previous page, makes it clear that issues need to be identified and acted upon at an early stage and that a clearly defined issues management process helps in addressing issues in a consistent and timely manner.
The proposal made for such a process is shown left/below:

Issues Management Toolkit

Step 1 > Monitoring
- Analyse the organisational or project environment (political, economic, social, technological)
- Scan/monitor public, media, politics, government, NGOs, science, influencers, opinion leaders
- Consider what may impact on the organisation or project

Step 2 > Identification
- Assess important elements in organisational or project environment
- Look for new pattern(s) emerging from public opinion
- Identify impactful issue(s) that gain widespread support
- Establish type of issue and phase in life cycle

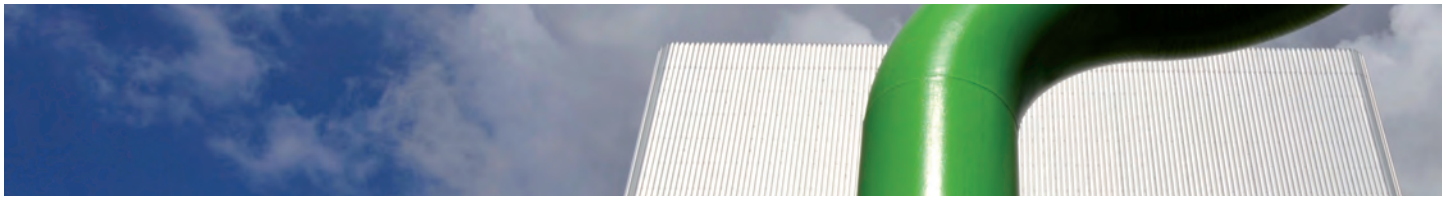
Step 3 > Prioritisation
- Analyse the extent of potential impact (project, company, industry)
- Identify interests (i.e. profit, reputation, regulation)
- Assess probability and urgency

Step 4 > Analysis
- Analyse key issues in more detail
- Determine probable impact (qualitative, quantitative)
- Establish issue team(s)
- Map relevant stakeholders

Step 5 > Strategy Decision
- Define objectives and expected outcomes (scenarios)
- Identify and analyse strategic options
- Determine strategic response and position/messages
- List key stakeholders / target audiences
- Identify resources, timing and planning
- Develop issues management action plan

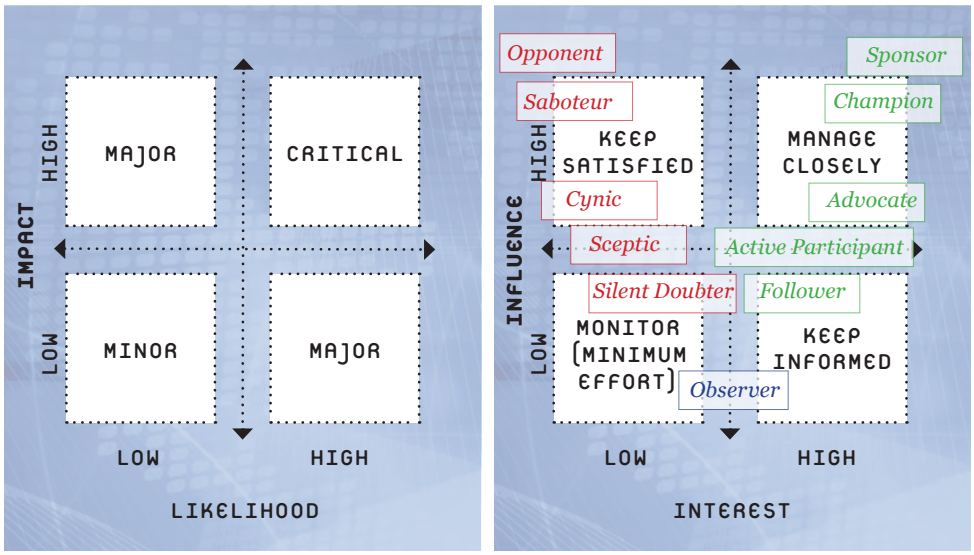
Step 6 > Implementation
- Implement issues management action plan
- Communicate position to key stakeholders

Step 7 > Evaluation
- Measure results
- Review strategic response and action plan
- Learn lessons from failures and successes



To illustrate what issues management could mean in practice, ROAD shared an idea of more proactively organizing the public debate on CCS. One approach could be to co-produce with a national daily a sequence of op-eds or opinion articles on CCS. This could offer a balanced forum for both experts (or stakeholders) supporting CCS and specialists opposing this technology. Instead of being overtaken by unilateral, negative media publications on CCS and reactively responding to this and countervailing media coverage ultimately being too little and too late.

Create the frame rather than have the frame created for you. For example, CO_2 is now framed negatively as a waste, toxic and harmful. On the contrary, CO_2 could also be positioned positively: as valuable, product, fertilizer and useful. For example, CO_2 is sold at 30 dollars/ton in the USA to facilitate Enhanced Oil Recovery. Not many journalists know this and therefore there is benefit in developing media relations.



Additionally, two tools were introduced to underpin the methodology above.

The first tool is for prioritising identified issues, whereas the second tool helps to map stakeholders.

It was agreed that the group would adopt some of the practices of the issues management methodology to coordinate issues tracking at the Network level, with a view to be able to respond to emerging issues as a collective. A brainstorm generated an initial list of issues that the participants would prioritise post-meeting, using the Network's intranet facilities.

The list consisted of the following items:

- Technology not proven at scale;
- Costs of CCS are perceived to be too high;
- The perception that CCS is not needed to abate climate change;
- Storage integrity (including timing);
- Pipeline safety;

- Lack of political support;
- Lack of public support/acceptance/awareness;
- CO_2 as a resource or a waste product (CCS versus CCU, carbon capture and use);
- Local benefits → what's in it for me/us?
- Level of awareness about CO_2;
- Increased connectedness of European NGO's;
- Financability of CCS projects/project risks/emission costs;
- CCS part of CDM.

It was agreed that, after prioritisation, the Network's intranet would serve as a platform to post any information around the prioritised issues, both from within projects as well in projects' environments. The group also valued a protocol through which factual information about local developments can be shared, so that each member project has awareness of first-hand information from colleague-members. The Network team proposed to draft such a mechanism.

CCS and social media

Over the last few months, the public engagement group showed great interest in the possibilities of social media to both check the pulse of the global, national and local debate around CCS as well as to serve as a platform to disseminate project news and information. By means of providing an overview of what social media could signify for the Network, Timo Kouwenhoven of DNV introduced the group to social media and its potential use for the Network.

What are social media?

Social media are media for social interaction, using web-accessible and scalable communication techniques. Familiar examples include Facebook, Twitter, YouTube, Foursquare and LinkedIn. It is clear that social media are used by people of all ages and the content created and shared grows at a staggering pace.

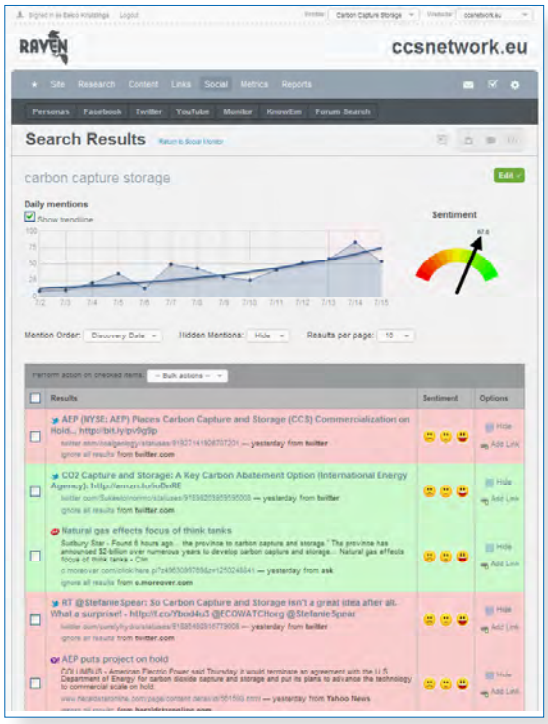
What opportunities are there to analyse social media?

Analysis of social media can provide insights into how the content that is published on member project websites and the Network site itself is appreciated on-line. With analysis tools, the following questions can be answered:

- if content was considered important;
- how much discussion on Twitter/Facebook is generated following publication;
- if the discussion was positive/neutral/negative;
- how our message is told by others;
- who could explain our message to others (online advocacy).

Currently available social media analysis tools offer:

- Discovery of blogs, discussion forums and web sites that frequently mention one's brand;
- Discovery of who is talking about your organisation, project, issues or topics;
- Sentiment tracking (know whether one's brand is being well-received);
- YouTube monitoring (number of views, comments and ratings);
- Twitter (microblogging) conversation tracking (including in-depth information about specific tweeters and tweet volumes);
- Follower tracking and importance analysis (followed by influential organisations/ people (likely to spread (retweet) messages));
- Buzz phrase discovery around a topic such as CCS, climate change or emissions
- Analysis of search engine statistics (e.g. what keywords generate better traffic on competing websites)?



The Network team is currently experimenting with the Raven platform *(for a sample screen, see figure)*, that allows tracking of 'sentiments' associated with certain keywords. Through providing the platform with feedback on what is both positive and negative, it can track various social media and websites and take the pulse of the debate (the above diagram provides a sample screen).

Can social media be used for the benefit of the Network?

The public engagement group drew the conclusion that social media and social media analytics could certainly be useful for the benefit of the Network. Ideas gathered to gain benefits were:

- Discover blogs/websites with (not) linked to the Network and discover buzz phrases associated with the Network;
- Understand which websites report on the Network and understand the sentiment on those websites;
- More sources for news about CCS (and about the Network);
- Track visitors to website;
- Where do they come from;
- Track language areas/regions/countries;
- New visitors versus returning visitors;
- Track subscribers to Network newsletters;
- Send news/flashes out via Twitter, follow influential people, get mentioned, get forwarded;
- Create a Facebook page.

In closing, the participants agreed to have the social media monitoring platform further developed by the Network team, to have the European CCS Projects Network webpages monitored in order to learn and to share member project social media usage with the Network team.

Knowledge sharing theme 3: Storage

Storage theme planning 2011

During the meeting in Brindisi the projects identified 3 lead questions to guide the collaborative work in the network in 2011:

- How to design a risk driven MVA plan for a demonstration project?;
- How to define quality requirements for modelling that will add confidence to the storage approach and will satisfy permitting requirements?;
- How to create an Integrated , Iterative Feed-back Learning Approach to Site Characterisation, Modelling and MVA.

These questions have been translated into an activity programme for 2011.

MVA plan

A significant amount of R&D and experience in pilot programmes on MVA already exists. The added value from the network effort should focus on actual experience. Differences between onshore and offshore storage will be acknowledged. The activities in the network should focus on providing an overview of MVA planning and challenges and identify any remaining gaps.

Model Quality

A limited number of modelling software packages as well as base models are in use for modelling CO_2 behaviour in a reservoir as a basis for site characterisation and operations.

The number of operating large scale CO_2 storage projects is small, resulting in limited opportunities to validate models. The geological variations of the surveyed storage locations decrease the possibilities of model validation Model outcomes and predictions will be used for key business decisions - like the FID - and permitting approval. A good understanding of required model quality is a requirement for good decision making.

This activity aims to develop an overview of models in use by the projects, to define model quality and to improve understanding of regulator requirements for model quality.

Integrated approach

Results from Site Characterisation, Modelling or MVA can inform further developments and improvements in any of the other activities. An integrated approach can be beneficial. This approach is new for the CCS projects but is common practice in the Oil & Gas industry. The solutions are available, although they might not be applicable to CCS projects. This activity aims to explore the current available solutions and its applicability to the CCS projects.

Planning

A plan was presented and updated based on the results of the meeting. See “agreed actions and planning”

MVA

Introduction to MVA and current guiding documents

- No shortage of public documents;
- NETL has provided overviews of MVA techniques related to MVA goals. Recent developments at Weyburn demonstrate the need for good MVA to support legal disputes;
- Experience shows that projects develop contrasting MVA strategies, driven by local conditions. The main drivers are site location offshore or onshore, and the inherent ability to collect seismic data with good resolution, which is a function of the depth and lithology of formations above the storage formation;
- Technology innovation is progressing further on monitoring solutions, and it can be expected that new options will become available for a variety of storage site situations. Today's best practice may be superseded by future innovative solutions;
- Different monitoring devices have different detection thresholds, and these will largely define what can constitute leakage from the storage complex.

Current status of MVA in the projects

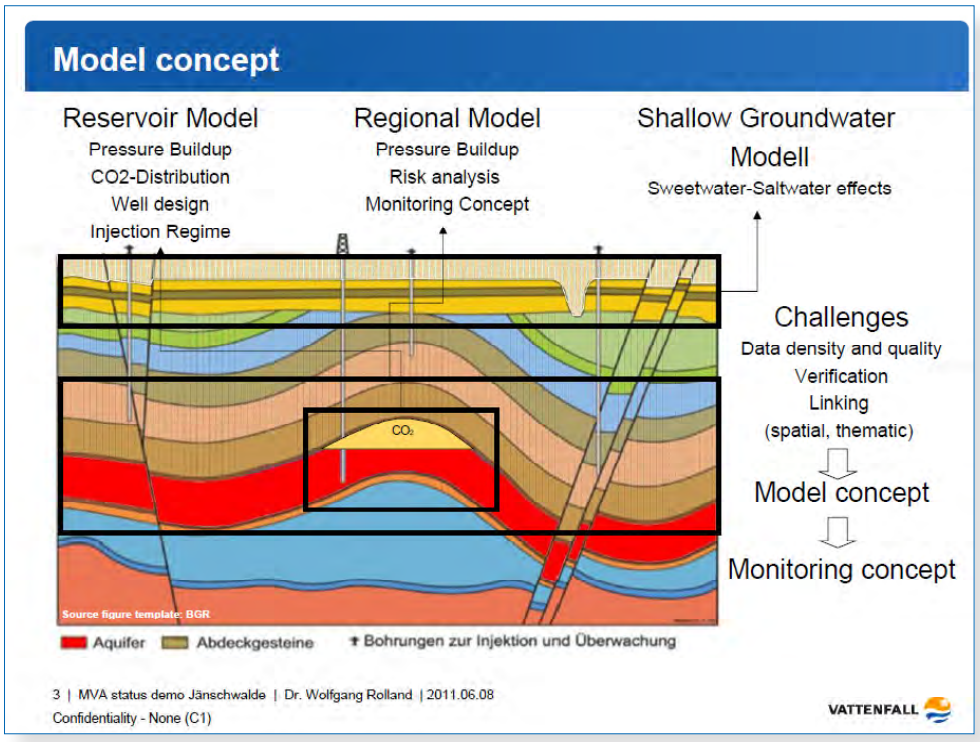
All projects presented the status of MVA in their project.

Jänschwalde

The MVA plan of Jänschwalde focuses on the main storage risks:

- Abandoned wells (10 old wells in the surrounding area, 2 in proposed stored structure);
- Storage integrity (uncertainty without exploration/ seismic campaign);
- Existing Faults;
- Dimensioning of the exploration and monitoring area.

To develop a monitoring concept Jänschwalde has developed a modelling concept consisting of a reservoir model (to predict pressure built up and CO_2 distribution among others), a regional model (to support development of the monitoring concept) and a shallow ground water model (to predict salt water/ sweet water effects) see figure 1. This requires data of sufficient density and quality and the ability to link the individual models.



↑ Model 1: The Jänschwalde model concept

Existing data on the area have been recovered and made reusable by the project. Installed groundwater gauges have been identified and baseline monitoring of groundwater has started based on regular measurements. Currently the soil CO_2 flux is being studied. Different types of sensors are being tested for stability and accuracy.

Current challenges are to obtain permission to explore the structure, to develop a dynamic model for plume spreading, to design MVA plan and start planning measurement network / assembly of different measuring stations to establish baseline conditions.

The Jänschwalde project is considering to apply several monitoring techniques *(see table 1 on the following page)* in line with the NETL MVA guideline.

Monitoring Techniques		demo Jänschwalde, sandstone injection
Atmospheric	Primary Technologies	CO_2-detectors
	Secondary Technologies	satellite leveling
	Potential Additional Technologies	Eddy Covariance
		Isotopes
Near-surface	Primary Technologies	Geochemical Analyses
	Secondary Technologies	Soil and Vadoze Zone Gas Monitoring
	Potential Additional Technologies	Remote Sensing (CIR,SAR, Hyperspectral)
		Aerial photography
Subsurface	Primary Technologies	Water Quality Analyses
		Wireline Logging
		Physical Testing
	Secondary Technologies	2D and 3D Seismic
	Potential Additional Technologies	Microseismic

↑ Table 1: Monitoring techniques being considered by Jänschwalde

The key challenge for developing a MVA plan is to find the optimal dimension (surface coverage) of the monitoring area and an optimal grid for each monitoring technique. The Jänschwalde project would like to learn from experiences with the evaluation of exploration and MVA plans by trusted third parties.

Bełchatów

Three potential storage locations (Wojszyce, Lutomiersk-Tuszyn (Belchatow), Budziszewice) have been identified and are currently being ranked. For the Budziszewice site, a preliminary MVA plan has been set up; a final MVA plan will be developed based for the selected storage location.

During the Site Characterisation Phase up to three new appraisal wells will be drilled. One well might be reconverted into a deep monitoring well and another well into an injection well during site construction. The detailed monitoring plan will include monitoring requirements for deep and shallow monitoring wells, continuous shallow aquifer, soil and atmospheric monitoring as well as all best practice time-lapse techniques. Following storage site characterisation, the decision on exact injector and monitoring facilities locations will be taken in cooperation with local authorities.

The preliminary monitoring plan for Budziszewice structure includes two deep and two shallow monitoring wells. One of the deep monitoring wells will be a converted appraisal well. None of the nearby existing wells are suitable to be used as monitoring wells due to their age and type of cement.

The monitoring plan includes the implementation of time-lapse 2D seismic, gravity, EM, micro-seismic, subsoil air and gas flux measurements and bio-monitoring.

Before the start-up of CO_2 injection, all of these technologies will be applied to establish baseline measurements. During and after injection measurements will be repeated periodically in order to track the CO_2 plume and detect any possible leakage from the storage complex.

Baseline surveys for environmental monitoring (subsoil air, gas flux and other bio monitoring) will be done over the period of one year.

The Bełchatów project is planning to apply a wide range of monitoring techniques:

- Gravimetric measurements are planned at regular intervals of several years. They enable the identification of the dynamic changes in weight distribution of rock formations around the CO_2 storage sites;
- The electro-resistivity method will identify the consequences of possible CO_2 migration in the Quaternary formations. After initial monitoring, measurements will continue throughout the operational phase. Measurements will be reviewed 2 years after starting the injection and then every 3 years. After completion of the injection, the same range of measurements will be performed every 5 years;
- The electromagnetic method will be applied to examine the geo-electrical properties of the potential reservoir, the diagnosis of tectonics, and thus an indication of the development of zones of tectonically disturbed, fractured and permeable geology. Measurements will be performed in the same scheme as in case of electro-resistivity method. Measurements will start before storage operations begin;
- Measurements of CO_2 concentration in the subsoil will be executed along designated profiles and provide geochemical surveys of CO_2 concentrations to a depth of 5 meters at selected locations. During operation and after, these measurements are aimed at finding gas leaks.

Sharing and learning

The Bełchatów would like to discuss within the network how innovative techniques implemented can be applied for MV; explore the options for better integrate of site characterization with modelling and MVA, increase the predictability of spreading of CO_2 plume and minimize the risks associated with leakage of CO_2.

Q&A

Don Valley was interested to learn more on the site ranking mechanism. It is developed by Schlumberger and PGI. The method take combines geological properties, the ability to obtain land licences and public acceptance into account.

It was also remarked that baseline monitoring of one year is rather short, as measurements will vary due to seasonal influences.

Porto Tolle

The Porto Tolle project has limited experience in developing MVA plans. Current activities focus on establishing the baseline for both onshore as offshore; this includes the use of an existing governmental monitoring network for seismicity. An extensive set of pre-injection monitoring is planned *(see table 2 on the following page).*

			Discontinuos	Continuos	Sampling points
On-shore baseline	soil gas & diffuse degassing survey	geogas fluxes (CO2 and CH4)	x		1000
		geogas concentrations (CO2, CH4, He, 222Rn, H2S, CO, H2, N2, O2, and light hydrocarbons)	x		200
	shallow aquifers & dissolved gases survey	On field: temperature, pH, Eh, electrical conductivity values, alkalinity, silica and NH4 concentrations Laboratory analysis on major anions and cations , on minor and trace elements and dissolved gases isotopic analysis of tritium, 14-carbon and δ13C-CH4	x		50
	pre-injection micro-seismicity	Temporary seismic stations		x	6
Off-shore baseline	Water column sampling (physical-chemical characterization)	CTD, pH and dissolved O2 measurements, Salinity and density Water samples will be analyzed for pH, DIC, DOC, alkalinity, dissolved O2, chl a, POC, PON, inorganic nutrients , major elements and selected trace elements, δ13C	4		20
	Water column sampling (dissolved gases analyses)	using head-space analyses or a vacuum extraction system on board ship followed by subsequent laboratory-based gas chromatograph analyses. dissolved gas (CO2, Ar, O2, N2, CH4, C2H6, He) and isotopic content	4		20
	Sediments and sediment-water interface sampling	at 50 cm deep sample analysis of sediment characteristics (grain size and water content), redox profiling during extrusion, and head-space analyses for dissolved gases (DIC, DOC and inorganic nutrients, Eh and TOC, chlor a, major elements, and selected trace elements) δ13C, DIC.	4		20
	Benthic communities	macrobenthos determinations, Grab samples will be collected and all organisms retained in 1 mm mesh sieves. Other benthic communities will be subsampled from cores.	2		20
	Measurements of current flow	ADCP (Acoustic Doppler Current Profiler), qualitative measurement of suspended particles.	4		20
	Dissolved gas sensor small stations	dissolved CO2 and CH4, P, T (once every 6 hours)		x	15
	Large monitoring stations	dissolved CO2 and CH4, ADCP, CTD, dissolved oxygen, pH (once every 6 hours)		x	2
	Sediment samples	grain-size composition (sand, silt and clay), the organic and inorganic elementary composition (C, H, N, S, O), porosity, bulk and dry density of the superficial undisturbed sediments (0-10 cm).	2		25
	Benthic chamber	Fluxes of dissolved CO2, total Dissolved Inorganic Carbon (DIC) and Total Alkalinity (TAlk) main sediment characteristic (grain-size distribution, elemental composition, porosity, bulk and dry density). pore water: CO2, DIC, TAlk, pH, Eh, O2, nutrients, Fe, Mn, δ13C. vertical profile of the main physico-chemical parameters (T, pH, dissolved oxygen, Eh, salinity) of the water column	2		25

↑ Table 2 Porto Tolle Pre-injection Monitoring

The following monitoring activities are foreseen over the storage lifecycle:

- fugitive emissions of CO_2 at the injection facility;
- CO_2 volumetric flow at injection wellheads;
- CO_2 pressure and temperature at injection wellheads (to determine mass flow);
- Chemical analysis of the injected material;
- Reservoir temperature and pressure (to determine CO_2 phase behaviour and state).

To support monitoring deployment the IEAGHG monitoring selection tool[1] is being tested. An appraisal well will be used for further testing activities.
The R&D monitoring aims at comparing different techniques to assess their respective potential for assessing site performance, leading to the eventual selection of the best value for money techniques in a commercial deployment.

Data from the R&D programme will be used to study well integrity and to predict geo-mechanical and geochemical reservoir behaviour through the updating of local models. Concerning seismic, gravity and CSEM data, the overall objective will be to achieve joint inversion of these dataset to optimize the post injection history matching.

1 See http://www.ieaghg.org/index.php?/20091223131/monitoring-selection-tool.html

Sharing and learning

The Porto Tolle project would like to discuss with the other project members approaches for establish the right monitoring area, criteria on monitoring tools selection and the minimum requirements for a monitoring plan.

Don Valley

The Don Valley project explores two different storage options on the UK continental shelf: saline formation in Southern North Sea and EOR and storage in Central North Sea.

The Don Valley Saline formation option

The project has not started developing MVA strategies, which is planned for 2011. The targeted storage area is a geological simple site with no faults and 2 abandoned wells. 2 potential migration paths have been identified.

A nearby wind farm may introduce new challenges and opportunities. Construction of the wind farm is planned in 2014 to 2017. Piling for the foundation of the turbines will preclude seismic monitoring. Once constructed the wind farm grid may provide the basis for monitoring. Seabed monitoring in the context of time-lapse seismic surveys might be sufficient to map CO_2 movement in the subsurface; this might be a more cost effective solution compared to 4D monitoring.

The Don Valley EOR Option

Don Valley is looking at potential CO_2 injection in one or two mature oil fields. Concurrent injection in both fields may optimise CO_2 injection availability and EOR performance. The combined potential injection capacity and storage capacity may exceed Don Valley CO_2 output.

The intended storage location has a rich reservoir characterisation dataset from existing operations:

- >100 wells in general area of storage sites;
- extensive well logs, cores and fluid analyses;
- decades of dynamic reservoir response to injection and production;
- multiple 3D seismic surveys.

The initial MVA plans will be developed in 2011, based on assessments of storage and well integrity and reservoir modelling. The plan will consider the use of mass balance to detect loss of reservoir fluid, high-resolution calibration of reservoir models with production and injection history, the use of extensive well coverage and plume monitoring using non-seismic methods, however the use of permanent seismic arrays for both passive and active observations will be considered as well.

The Project would seek to maintain average reservoir pressure below original (virgin) throughout the CO_2 injection period.

Sharing and learning

Don Valley is interested in understanding the state of MVA technology based on experiences of the projects in terms of accuracy, availability and cost.

Collaboration in R&D for development and application of innovative monitoring techniques may provide good opportunities for synergies across the network members.

ROAD

The ROAD project aims to store 1.1 Mton/year in a deep (3.5 km) depleted gas field in the North Sea near the port of Rotterdam. The concept MVA plans have been developed in the CATOII project and other studies. MVA planning is part of preparation for the final investment decision, which is expected in a few months. The main risks addressed in the MVA plan are cost risks, permitting risks and timely acceptance of the monitoring plan. The plan includes a contingency plan which describes required corrective measures to deal with uncertainties.

The MVA plan covers data, modelling and monitoring. Planned techniques include:

- **Data sources**: production history (e.g. P/Z vs. time), PVT data, well logging (petro-physical data by gamma-ray, density, sonic, neutron porosity), baseline 3D-seismic (velocity modelling);
- **Modelling**: Geological: Geological Static (property) models (Petrel); Reservoir: Dynamic Reservoir model (MoReS); History Matching; Geo-Chemical; Geo-Mechanical;
- **Monitoring**: 4D-seismic, passive (micro) seismic (for fractures), seabed sampling/acoustic (pockmarks), chemical/radio-active tracers, gravity surveys, shallow seismic echo-beam, bubbling detection at wellhead.

The MVA plan aims at achieving reproducibility of evidence on the state of the reservoir. A particular challenge is to understand how data collected at one well can be reused for nearby wells with less historical data.

Planned MVA activities include:

- Preparations of base and contingency monitoring plans, closure plan and post closure plan, corrective measures plan, storage permit application;
- Evaluation of Monitoring costs;
- Discussion with SodM (Dutch Mining Authority) and competent authorities;
- Development of a Risk Register: over CCS Chain and preferably including all network members.

Sharing and Learning

ROAD is interested sharing MVA plans with other projects, in particular with regard to precision, range and cost effectiveness of monitoring technologies as well as required sample grid and frequency. Exchange of identified risks and planned mitigating actions with regard to MVA is a second topic for sharing.

Compostilla

The Compostilla project is developing a pilot storage site (Hontomin site) and is selecting the storage site for the industrial scale demonstration project.

Hontomin site

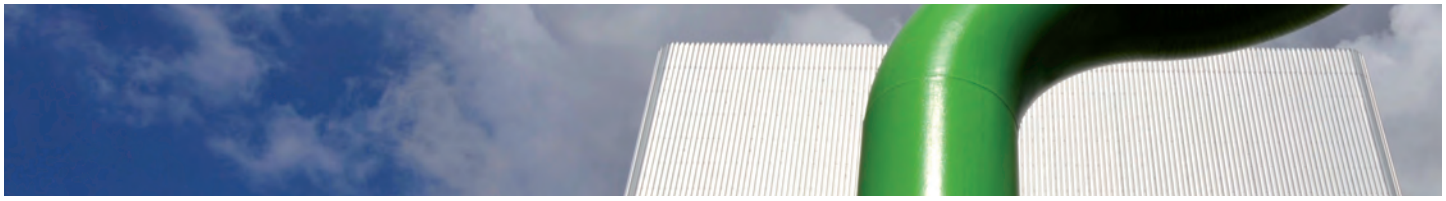
The pilot storage site at Hontomin is being developed to experiment and test with the various aspects of monitoring CO_2 storage (max 100 kT CO_2). The site contains 4 existing boreholes. Existing data supports geological understanding of the site. 3 new boreholes are planned.

The main risks for leakage are caused by faults and the old boreholes. The key focus of MVA is to test and demonstrate monitoring techniques for Subsurface, near surface and atmospheric monitoring. Activities to deploy a wide range of techniques are ongoing or planned. *Table 3 provides an overview of these activities.*

Hontomin PDT Monitoring Techniques	
Atmospheric	CO2 Detectors (Isotopic Analysis)
	Secondary Technology (to be defined)
Near Surface	Water Geochemical Analysis
	Hydrogeological Monitoring
	Bioindicators
	Gas Monitoring (Isotopic Analysis)
	DINSAR & Ground-Based SAR
Subsurface	**Passive Seismic Monitoring / Permanent Seismic Network**
	Micro-Seismicitiy Methodology
	Noise Interferometry (PII)
	3D Velocity Model
	Virtual ST
	Time Lapse Monitoring
	Seismovie Monitoring (4D)
	VSP (4D)
	Seismic Surface Profiling (4D)
	Gravity Survey (3D)
	CSEM/Electric (4D)
	ERT (4D)
	Geochemical Sampling for the Reservoir
	Temeperature (DTS) / Presure (fluids)
	Extensiometers in Boreholes
	* planned activities
	* on going activities

↑ Table 3: Hontomin monitoring Techniques

Several innovative techniques will be tested. The "Seismovie device" will measure seismic activity using a 2000 meter array of 80 measurement holes which will be equipped with several geophones each. New 4D multiseismic imaging techniques will be deployed. The 3 new boreholes will contain a rich set of instrumentation including ERT electrodes, geophones, extensometers and distributed temperature sensing and pressure measurements.



During the preinjection phase gas monitoring will establish a CO_2 soil flux baseline, identify potential leak paths and utilise isotope studies for dissolved and free CO_2. Gravimetry and Magnetotellurics are used for geological imaging and Ground based SAR (GBSAR) and Differential SAR interferometry (DInSAR) is used for surface displacement monitoring.

Key challenges for the Hontomin MVA plan

- Understand the resolution analysis of base line datasets; what are the margins of error in the baseline parameters?
- Resolution analysis of the datasets and parameters during and after injection;
- Specific challenges/topics in current development;
  - > Multiseismic 4D imaging;
    - >> High resolution noise interferometry;
    - >> Time reversal imaging;
    - >> Full wave-form inversion;
  - > Electrical/CSEM methods for monitoring the CO_2;
  - > INSAR Methodologies;
  - > Bio-indicators.

MVA Topics to explore further

Based on the presentations of the projects the following topics and issues were identified:

- **Monitoring for Accounting**

  Monitoring for accounting (Certificates), and their impact on CAPEX and OPEX. Monitoring for accounting is essential for any project as it will be the basis for the revenue stream. The responsible authorities for monitoring have no experience with CCS. Most likely experiences will be limited to the monitoring of emissions from power plants. It is to be expected that the responsible authorities for accounting will differ from the Authorities that will issue the storage permits. Capability building is likely to be an issue. Requirements for monitoring for Accounting may have impacts on Capex and Opex if requirements would introduce the need for additional instrumentation on top of measurements to ensure safety, to satisfy regulation and to optimize operations. In order to facilitate the authorities and to minimize risk of delays in this area the group has suggested combining ideas on implementing accounting methods in order to be able to be proactive towards the responsible authorities.

Action: Don Valley and Jänschwalde agreed to prepare a discussion paper with the facilitation of DNV.

- **Optimal size of area for monitoring**

  There are no clear criteria about the size of the area that should be monitored. Regulatory requirements will set boundaries. Requirement related to other MVA goals like establishment of a baseline may go beyond minimum regulatory requirements. Selection of monitoring area and techniques will focus on optimizing CAPEX and OPEX. There is a need to develop more specific criteria for monitoring area size.

The area size will depend on specific storage risks (like potential leak paths as cracks and bore holes or the risk of CO_2 migration to adjacent reservoirs), During the discussion the suggestion was raised that the monitoring area may grow as the plume expands during injection. This topic was not considered for further discussion.

- **Establishing an overview of monitoring techniques of the projects**
  All projects are trying to define the most optimal mix of monitoring techniques for their projects based on risk assessments, regulatory requirements and economics. A joint inventory of considered monitoring techniques and experiences would help the network members and other CCS projects in selecting the most appropriate instruments. In addition the inventory can help to share R&D results on innovative techniques as well as field tests of monitoring instruments to create synergies across the projects. The overview should consider planned, tested and deployed monitoring techniques based on experiences by the projects, including:
  > Applicability and selection criteria (e.g. on shore / off shore);
  > Detection levels, Area covered/required density;
  > Cost (Capex / Opex);
  > Practical experience: results, reliability, stability, economics.

Action: It was agreed to establish such an inventory. DNV will propose a structure and research available information on this topic; the projects agreed to provide information on their plans and experiences with monitoring techniques.

- **MVA for start-up/shutdown conditions**
  During start-up and shutdown operating conditions may differ significantly from normal operating conditions. The may trigger additional monitoring capabilities to detect anomalies that would not be detected by MVA for normal operating conditions. This issue was not considered for further discussion.

- **Risk scales**
  ROAD raised the need for common Risk scales for probability and Impact of risks on financial, SHE and Public acceptance objectives. DNV agreed to the scales that are current in recommended practices in the oil & Gas industry for financial and SHE objectives. An online discussion on the Network Intranet should sharpen its applicability for the CCS projects.

Action: projects to contribute to the online discussion.

Model Quality

All projects had prepared an overview of their models and input data based on the NETL template provided by DNV. Due to time constraints a full presentation and discussion of the models was not possible. The projects will share the information on the intranet; DNV will create an overview and a high level analysis. This analysis will be presented and discussed in the next meeting.

During a round table discussion the participants explored "model quality".

Model quality elements:

- *Regulator requirements:*
  - > The CCS directive requires the storage operator to develop and maintain a model or a set of models, which is calibrated with the storage history as it evolves;
- *Providing a robust understanding of the storage location*
  - > Different models serve different purposes. A portfolio of models will be required to understand all relevant aspects of the storage location;
  - > The critical questions to be answered by the model vary across the projects:
    - >> Jänschwalde: Predict pressure built up;
    - >> Porto Tolle: Plume evolution & brine displacement;
    - >> Don Valley: reservoir size, saturation pressure;
    - >> Bełchatów: Geo-mechanical Properties;
    - >> Compostilla: modelling the interaction between H_2O, Rock and CO_2; mineralization of CO_2;
- *Support of the development of operational guidelines:*
  - > Making operations robust against existing (geological) failures. The model should support the development of a safe operating envelop (e.g. pressure limits);
- *A planned approach*
  - > Road suggested that model development should be planned: The required combination of models, required reproducibility and reuse of data. During the CATO II project has provided an example of this;
  - > Sensitivity analysis should demonstrate model robustness and justify model simplification;
  - > Lack of data may require specific actions to validate the model;
  - > Planning of a portfolio of models also implies the planning of the interfaces between these models.

Agreed actions

- DNV will collect and analyse the information provided by the projects based on the NETL template;
- The projects agreed to share their portfolio of models;
- DNV will provide a template.

As part of the meeting, the participants visited CIUDEN's Technology Development Centre for CO_2 capture located in Cubilos del Sil.

Plenary meeting

The second day opened with a presentation from **Nick Otter,** *CCS Technical Advisor and former CEO of the Global CCS Institute*. Nick was part of the European Technical Advisory Group formed to examine the initiative of the Government of Spain for a Test Facility for Advanced Technologies for CO_2 Capture in 2005 which later evolve to CIUDEN`s Capture Centre. Nick gave his views on and status for CCS globally. Nick welcomed the high level of activity on developing CCS projects, but said that the majority of projects are still in the early feasibility stages and in his opinion there is a substantial need for governmental funding for the first full scale CCS demonstration projects. A key message was that governments have to start discussing potential financial incentives for the CCS projects following the demonstration projects.

Pedro Palencia from the *Cabinet of the Spanish Ministry of Industry* presented Spanish energy policies and status for CCS in Spain. The Spanish Government, he said, has identified CCS as part of the mix of measures to reduce CO_2 emissions nationally and is supportive of CCS projects.

John Scott, *Chief Risk Officer in Zurich Global Corporate* presented his views on the financial mechanism in the CCS Directive and one potential measure to cover long term liability for storing CO_2: the introduction of industry insurance pool.

At the end of the meeting, **Francisco García Peña**, *R&D Director of ELCOGAS* presented the pilot pre-combustion capture plant at the Puertollano IGCC power plant in the Castilla-La Mancha region. Francisco shared that the learning in the project phase included that there was quite some delay (over 12 months) in obtaining main equipment from suppliers. Also, in commissioning, the project experienced that is was hard to mobilise experienced personnel. During operation, the project found the CO_2 and H_2 design specifications could be easily achieved and that the integration of the operation into the existing IGCC was pretty smooth. The CO_2 capture rate is now at 91.7%.

Concluding remarks

In his concluding remarks Simon Bennett - on behalf of the European Commission - highlighted the progress made by CIUDEN in bringing their pilot plant to operation in an open access facility that will inform demonstration projects and the development of new technologies, including for heavy industrial emitters of CO_2, such as the cement and steel industries. He commented that the engagement of local journalists in the region appears to be a good example of communicating with the local community.

The new Network of CCS Regions, which currently includes Yorkshire, Scotland, Rotterdam, Brandenburg, Groningen, Le Havre and has been initiated independently from other EU initiatives, may provide good opportunities for collaboration with the CCS Project Network. Simon invited the projects to come forward with ideas for joint activities.

He commented on the good working atmosphere between the projects but reminded participants that knowledge sharing is about sharing experiences with each other and also providing stakeholders with the information that they can use to progress CCS in Europe. The projects face considerable challenges to become operational in the demanding timescale that has been set. The CCS Project Network is proving itself to be an asset to the timely demonstration of CCS in Europe and this will continue if the level of effort and commitment from participants is maintained. Simon referred to the Advisory Forum meeting on the 16 June as an important occasion for learning about the expectations for the Network for the next 12 months and the way in which issues such as international CCS knowledge sharing and interaction with Member States and the research community can be best addressed.

Finally he expressed his gratitude to for the great hospitality of the people of CIUDEN and the effort and contributions of the participants.