IMPACTS

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IMPACTS

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The impact of the quality of CO_2 on transport and storage behavior

Collaborative large-scale integrating project

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PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential , only for members of the consortium (including the Commission Services)	

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Abstract

The EU FP7 IMPACTS project (2013 – 2015) has a broad objective to develop the knowledge base of CO_2 quality required for establishing norms and regulations to ensure safe and reliable design, construction and operation of CO_2 pipelines and injection equipment, and safe long-term geological storage of CO_2. The project performs technical research in diverse areas, such as fluid flow, corrosion and reactivity between CO_2 mixtures and storage reservoir rock to provide recommendations for optimized CO_2 quality, based on techno-economic analyses (amongst other considerations) of the capture, transport and storage infrastructure.

The purpose of this report, a results exploitation plan, is to enable an optimal dissemination and use of the results of the IMPACTS project. Publishing own results is a priority for all researchers. The purpose of this plan is to focus on joint activities for dissemination, knowledge sharing and utilisation of results.

The plan describes the elements of results exploitation, including roles, responsibilities and timing.

The main elements of the plan are:

1. The main dissemination effort is the IMPACTS Toolbox, which will contain all relevant results, conclusions, guidelines, rules of thumb, etc. from the various work packages in the project.
2. Utilisation and dissemination of results via scheduled update of DNV RP-J202 Recommended Practice for Design and operation of CO2 pipelines
3. Dissemination of results via databases and partner's participation in standardisation work
4. The IMPACTS CCS course in Romania for students at master level is planned for 26-30 October 2015.
5. A synthesis, implementation and dissemination workshop was be arranged on June 16th, in connection with the TCCS-8 conference in Trondheim June 17-18 2015.

Other elements that are part of the IMPACTS dissemination plan are the project website, the scientific blog on the website and the IMPACTS newsletter, as well as presentations at conferences and publications in scientific journals.

Public introduction (*)
The EU FP7 IMPACTS project (2013 – 2015) has a broad objective to develop the knowledge base of CO_2 quality required for establishing norms and regulations to ensure safe and reliable design, construction and operation of CO_2 pipelines and injection equipment, and safe long-term geological storage of CO_2. The project performs technical research in diverse areas, such as fluid flow, corrosion and reactivity between CO_2 mixtures and storage reservoir rock to provide recommendations for optimized CO_2 quality, based on techno-economic analyses (amongst other considerations) of the capture, transport and storage infrastructure. The purpose of this results exploitation plan is to enable an optimal dissemination and use of the results of the IMPACTS project. Publishing own results is a priority for all researchers. The purpose of this plan is to focus on joint activities for dissemination, knowledge sharing and utilisation of results. The plan describes the elements of results exploitation, including roles, responsibilities and timing.

(*) According to Deliverables list in Annex I, all restricted (RE) deliverables will contain an introduction that will be made public through the project website

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1 INTRODUCTION

The EU FP7 IMPACTS[1] project (2013 – 2015) has a broad objective to develop the knowledge base of CO_2 quality required for establishing norms and regulations to ensure safe and reliable design, construction and operation of CO_2 pipelines and injection equipment, and safe long-term geological storage of CO_2. The project performs technical research in diverse areas, such as fluid flow, corrosion and reactivity between CO_2 mixtures and storage reservoir rock to provide recommendations for optimized CO_2 quality, based on techno-economic analyses (amongst other considerations) of the capture, transport and storage infrastructure.

Dissemination and utilisation of results is a key success factor in any research project and has been a priority for IMPACTS all the way from the planning stage. Now, towards the end of the project dissemination and utilisation will be a top priority.

Publishing own results is a priority for all researchers. The purpose of this plan is to focus on joint activities for dissemination, knowledge sharing and utilisation of results.

The full utilisation of the benefits of IMPACTS being an international European cooperation project will be achieved by facilitating knowledge sharing, coordination of actions and time scales, and identifying synergies with other activities and projects. It also means drawing advantage from the comparative strengths of the various partners in the project that should lead to a coherent overall effort by industry, research institutes, academia, European Commission and Member States to apply the project knowledge base in practice in order to support and prove the existing CCS technology and demonstrate it on a large scale in integrated CCS projects.

Potential users of the results in addition to the project partners will be identified and a plan for exploitation of the results of the project will be developed within this WP. The main results from IMPACTS are:

- the IMPACTS toolbox comprising new experimental data,
- thermodynamic reference models for CO_2 mixtures relevant for CCS,
- and the framework for CCS risk assessment taking HSE aspects, the impact of the quality of the CO_2 and CCS chain integrity into account,
- and, finally, the IMPACTS recommendations report.

These results together form the technological knowledge base for the analysis of the relation between CO_2 quality (composition of the captured CO_2 stream) and the design and operation of the CCS chain.

[1] See, for more information on the project, http://www.sintef.no/projectweb/impacts/.

2 IMPACTS PARTNERS' UTILISATION OF RESULTS

2.1 Recommended Practice DNV-RP-J202

2.1.1 Update of DNV-RP-J202

DNV GL recommended practices are regularly updated, and the DNV-RP-J202 Design and operation of CO2 pipelines is due for update in 2015.

Key recommendations available at the time of update (second half of 2015) may be incorporated in the DNV-RP-J202. Relevant topics would encompass results from:

- Physical properties of CO_2 mixtures,
- Impact of impurities on fluid flow in pipelines, and
- Relation between impurities and corrosivity of the CO_2 mixture.

Design requirements, for both elements of the CCS chain, and for the entire chain, are also relevant for the update of the recommended practice.

IMPACTS partners will take part in the review process, that is led by DNV-GL.

It is recommended that each work package leader should review the current version of DNV-RP-J202 http://exchange.dnv.com/publishing/codes/docs/2010-04/rp-j202.pdf, identify the sections where their work may have an impact and advise DNV GL on what changes should be done to RP-J202.

The update of DNV-RP-J202 will be led by Jock Brown (Jock.Brown@dnvgl.com) and Sigbjørn Røneid (Sigbjorn.Roneid@dnvgl.com).

2.1.2 Use of DNV-RP-J202

Industrial partners will make use of the updated standard in their commercial projects.

The DNV-RP-J202 is presently the only standard available for CO2 pipelines, and is thus also used outside the IMPACTS consortium.

The standard can be downloaded and printed for free from DNV GL's website http://exchange.dnv.com/publishing/codes/docs/2010-04/rp-j202.pdf.

2.2 Dissemination via databases

The IMPACTS results will be shared with other standardization organisations and institutes, to maximise the value of the work done within the project.

1. NIST, the National Institute of Standards and Technology[2] in Gaithersburg MD (US), holds the reference database of properties of CO_2 and CO_2 mixtures. The results from measurements on the physical properties of CO_2 mixtures done in IMPACTS will be included in the reference database held by NIST.

[2] See http://www.nist.gov/srd/nist23.cfm.

2. The IMPACTS project has strong links with ISO, the International Standards Organisation, which is currently in the process of developing a standard on CCS[3]. A number of partners of the IMPACTS consortium take part in the working groups on CCS, ensuring information transfer between the project and new ISO standard on CCS. A meeting with the relevant ISO group is planned for December 2015, in Kjeller, Norway.
3. Contacts with the European Committee for Standardisation[4] (CEN) will be maintained to ensure the take-up of IMPACTS results in the CEN and CENELEC work programme[5].
4. The International Association for the Properties of Water and Steam[6] (IAWPS) will be presented with public data from IMPACTS, which can be incorporated in their databases and used for development of internationally accepted references and standards.

The implementation should be discussed with each body separately. This will be done but by IMPACTS partners participating in the committees as well as in specific meetings.

Table 2-1 Utilization of data in standards

Organisation	Standards	Data sharing activities
NIST	CO_2 properties	Publications, direct contribution
ISO	CO_2 pipelines	Partners: SINTEF ER
CEN	CO_2 handled by ISO	No relevant standards identified yet
IAPWS	Power production	Partners: Alstom, Vattenfall

2.3 The IMPACTS Toolbox

One of the key deliverables from IMPACTS will be a so-called Toolbox, which will contain all relevant results, conclusions, guidelines, rules of thumb, etc. from the various work packages in the project. Together with the recommendations from the overall project, which will be defined in WP3.1, this Toolbox aims to provide the data and results that can be used by CCS projects to establish the impact of impurities on their intended or ongoing project.

One element of the Toolbox is a new CO2 properties reference model, which will contain all results obtained by Ruhr Universität Bochum, on the physical properties of CO2 mixtures. IMPACTS Newsletter 2014-02 11

Another element is results from the techno-economic optimisation of CCS chain design and operation versus CO2 quality.

The work started in the second half of 2014, with a preliminary inventory of potential elements of the Toolbox. The IMPACTS Toolbox will incorporate results from both SP1and

[3] See http://www.iso.org/iso/iso_technical_committee?commid=648607 for information on the ISO working group on CCS.
[4] See www.cen.eu.
[5] See http://www.cencenelec.eu/News/Publications/Publications/CEN-CENELEC-WP2014_EN.pdf.
[6] See http://www.iapws.org.

SP2. The tool will encompass algorithms, results from analyses of various kinds, models, benchmark results, effects of impurities in various domains (e.g., corrosion, injectivity) and techno-economic issues (e.g., results from analyses on separate elements of CCS chain) The IMPACTS Toolbox will be made accessible on the web, possibly also on a DVD. It is scheduled to be ready in October 2015.

3 IMPACTS CCS COURSE IN ROMANIA

3.1 Background

Romania transposed the CCS Directive 2009/31/EC into the national legislation by Law no. 114/2013. In 2010 Romania launched the initiative to develop the Getica CCS Demo Project and finished its feasibility study in 2012. The project is currently being in stand-by with perspectives of renewing the effort of identifying the financing sources for further steps. Among many studies and research projects developed in the field, Romania rolled out the GCCSI regulatory test toolkit and prepared the CCS Roadmap for Romania "Our future is carbon negative".

Considering the major current challenge related to the decarbonisation of the European economy, deploying innovative technologies such as carbon capture, transport, storage and/or usage is of real interest for the energy market players in Romania – starting from the academic environment up to power & heat generation and oil & gas industries, and related equipment manufacturers.

Topics of interest are:

- *CO_2 capture and transport* - mixtures of CO_2 and impurities.
- *Integrated full chain CCS technology* - effect of CO_2 impurities on materials, equipment, processes, operation and safety procedures; Norms and regulations for safe and reliable design, construction and operation of CO_2 pipelines and injection equipment.
- *CO_2 geological storage* - CO_2 impurities impact on the process integrity; Norms and regulations for safe long-term geological storage of CO_2.

3.2 The CCS course in Romania

Considering the above, a CCS course will be organised in Romania, being open for participation from outside IMPACTS. The course will be adjusted to the level of Master students being open for universities, research institutes, regulatory authority and people from industry. IMPACTS researchers are invited to give lectures at the course. The training session will be organised in an interactive manner thus contributing to the exchange of viewpoints and knowledge from trainers/lecturers to trainees.

An opinion survey will be performed collecting answers from two questionnaires prepared for the participants in order to assess – firstly, their level of knowledge related to full chain CCS technology and – secondly, their appreciation related to the training session.

The Training Kit consisting of excerpts from the IMPACTS Toolbox and Recommendations Report will be provided to the participants. Simultaneous translation will be provided during the sessions, if necessary.

3.2.1 Targeted audience

The targeted audience for the course is mainly from within Romania:

- Universities from the cities of Bucharest, Ploiesti, Brasov, Petrosani and Craiova;
- Romgaz – the largest producer and main natural gas supplier in Romania, recently becoming also a natural gas power generator;
- Transgaz - National Gas Transmission Company;

- OMV Petrom - Largest oil and gas producer in SEE region, including also a power generation capacity of 860 MW on natural gas and a wind farm of 45 MW;
- CE Oltenia – the largest national energy holding generating 18 TWh annually, with a market share of more than 30% out of the National Power System – the Getica CCS carbon capture plant location;
- TenarisSilcoTUB Zalau - leading Romanian producer of small diameter seamless steel pipes;
- ZIMTUB Zimnicea - important Romanian steel pipes producer;
- UPET Targoviste - one of the biggest manufacturers of drilling rigs and equipment of Europe;
- GeoEcoMar – research and development institute of national interest, performing research in geology, geophysics and geo-ecology, promoter of CCS technology in Romania;
- National Agency for Mineral Resources – the regulatory authority responsible for CCS deployment in Romania.

3.2.2 **Proposed topics for agenda and proposed lecturers** (to be discussed with the IMPACTS consortium)**:**

Day 1 – typical CO_2 mixtures and operating conditions, transport and storage gap analysis, classification of CO_2 impurities (lecturer: representative of TNO); models on thermodynamic properties and equilibrium (lecturers: representatives of RUB and SINTEF);
Day 2 – the influence of CO_2 mixture composition (lecturer: representative from SINTEF), corrosion of pipeline steels caused by CO_2 mixtures (lecturer: representative from CSM);
Day 3 – chemical and physical effects of impurities on CO_2 storage (lecturer: representative from CIUDEN); operational and material effects of impurities in CO_2 streams (lecturer: representative from CIUDEN)
Day 4 – typical CCS chains (lecturer: representative from PEL); techno-economic analyses of impacts of CO_2 quality (lecturer: representative from PEL);
Day 5 – risk assessment of CO_2 transport and storage infrastructure (lecturer: representative from TNO), IMPACTS recommendations (lecturer: representative from SINTEF).

The proposed CCS course topics and structure are in line with our national RDI and CVET (Continuous Vocational Education Training) policies for the period 2014-2020, bringing together researchers, regulators and industry representatives.
Technical details will be submitted to all participants in the invitation letters, once the location and exact date will be established.

3.2.3 Scheduling

The proposed period for the course (to be discussed with the IMPACTS consortium) is 26-30 October 2015. The course has been scheduled for October 2015 in order to have more results available for presentation.

The organisations proposed to provide lecturers will be invited to nominate lecturers and present suggestions for specific presentations.

4 IMPACTS WORKSHOPS

4.1 Workshop during TCCS-8

A synthesis, implementation and dissemination workshop was arranged on in connection with the TCCS-8 conference in Trondheim, June 17-18 2015. This workshop focused on the main achievements from IMPACTS, the IMPACTS Toolbox and the IMPACTS Recommendations.

The workshops was held on the afternoon of June 16 and was open for participants outside of the IMPACTS consortium and also for those not participating in the conference. In addition, the IMPACTS consortium invited audience which includes other EU CCS projects, CCS demonstration projects, standardisation organisations, regulators and other relevant stakeholders.

The main objective of this arrangement was to engage into a dialogue on the results from the IMPACTS project, their shape and form and ways to optimise the impact of the results in the CCS community. This will help to make the results from IMPACTS available to the CCS community and secure short lead time from the generation to utilisation of results.

4.2 Workshop in December 2015

In March 2015, IMPACTS participated in a dissemination event organised by the EU FP7 CO2QUEST project, which also has CO_2 quality as topic. That event took place in Athens and was aimed at the same CCS audience.

The IMPACTS workshop during the TCCS-8 conference was organised when not all results in IMPACTS were available. Following the March event in Athens, the CO2QUEST project invited IMPACTS to join another dissemination event in December 2015, in the same location. At that time, close to the end of the project, IMPACTS results (as described in Sections 2 and 3) will be ready to be presented to the CCS community.

The IMPACTS team decided to take part in this dissemination event, to further link with CCS stakeholders.

5 OTHER DISSEMINATION ACTIVITIES

5.1 Presentations and publications

Members of the IMPACTS project team present their results at a range of national and international events and conferences. During the first half of 2015, presentations were given at the following events.

14th Annual Carbon Capture, Utilization and Storage Conference, Pittsburgh, Pennsylvania from Tuesday, April 28 – Friday, May 1, 2015.

- IMPACTS: the impact of the quality of CO_2 on transport and storage behaviour, Sigmund Ø. Størset, Marit J. Mazzetti, Morten Hammer, Charles Eickhoff, Filip Neele, Daniël Loeve.

TCCS-8, Trondheim Norway, June 17-19, 2015

- Impact of CO_2 quality on transport and storage- IMPACTS, Marit Jagtøyen Mazzetti, Sigmund Østtveit Størset, Morten Hammer, Charles Eickhoff, Filip Neele.
- Hydraulic characterization tests at Hontomín Technology Development Plant for CO_2 Storage. Experiences with brine, CO_2 and tracer injection; Daniel Fernandez-Poulussen, J. Carlos de Dios, Juan A. Marin.
- Effects of impurities in a CO_2 transport experimental installation. First results and experiences at CIUDEN, Ruth Diego, Abraham Fernández, Miguel Ángel Delgado, Rosana González.

The international Thermophysical Properties Symposium in Boulder, Colorado (June, 2015)

- Accurate vapor-liquid phase equilibrium measurements on the binary CO_2-O_2 system, Snorre F.Westman, H. G. Jacob Stang, Sigurd W. Løvseth.

Plans for further dissemination through presentations and publications include the event co-organised with CO2QUEST (see section 4.2) and, after the project has finished, the GHGT-13 event in Lausanne, Switzerland, in October 2016.

5.2 Website

All IMPACTS results and public reports are published on the project website, http://www.sintef.no/projectweb/impacts/. The website has been upgraded early 2015, to have a more complete representation of the activities in the project (Figure 1). As can be seen in the figure, the site contains links to relevant, CCS related events.

Figure 1: Home page of the IMPACTS website.

5.3 Scientific blog

The project website contains a blog, which is regularly updated by project scientists. This adds to the dynamic nature of the website and helps disseminate the project results.

5.4 IMPACTS newsletter

A newsletter is sent around to CCS stakeholders every 6 months. The newsletter summarises activities over the past period and lists publications and presentations. The aim of the newsletter is to keep stakeholders informed about the project.