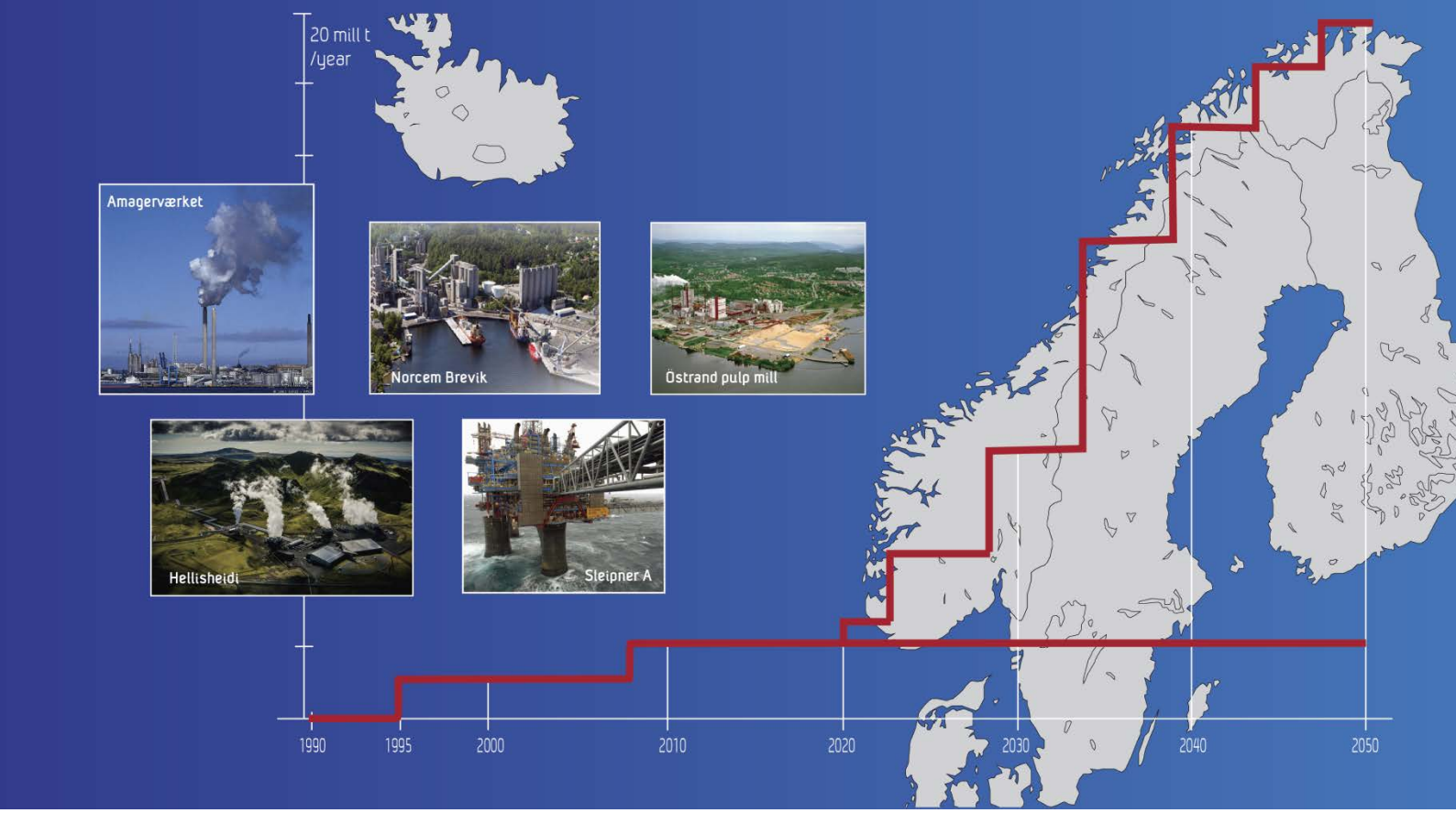

NORDICCS Consortium Day Summary

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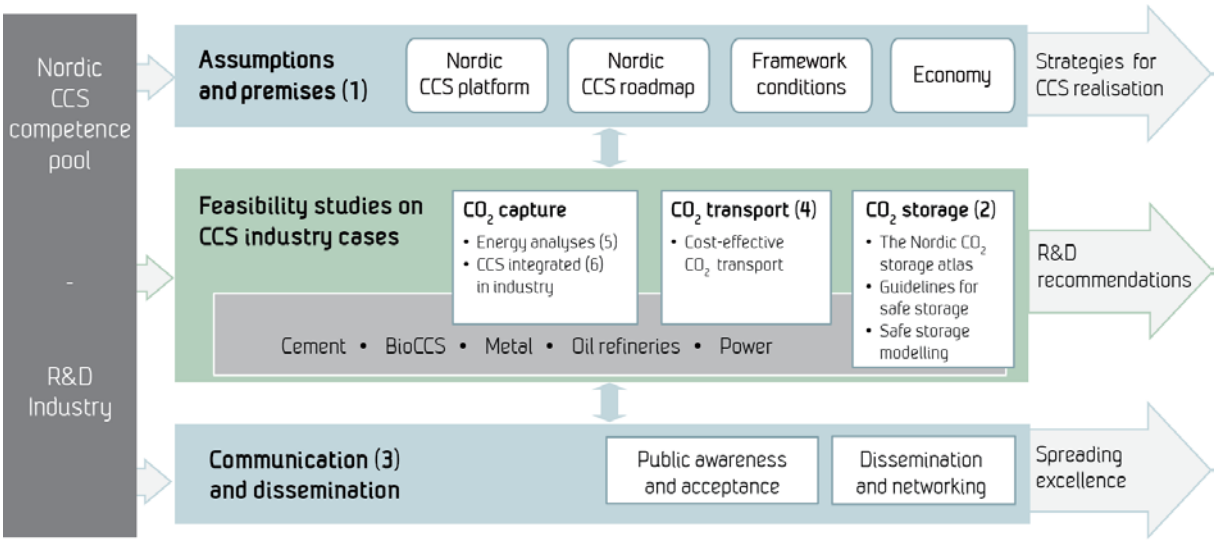
NORDICCS Technical Report D2, D1.1.1301

December 2013

norden
Top-level Research Initiative
nordiccs
Nordic CCS Competence Centre
CO2

NORDICCS concept:



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Summary

In order to predict the behaviour of CO2 mixtures during pipeline transport, proper mathematical models and simulation tools are needed. This report gives an overview over existing models and tools, and their applicability to CO2 pipeline transport. For each topic, a recommendation is given on what models and tools are best suited, or which further research is needed. A wide range of possible mathematical models for two-phase flow is presented, along with the relations necessary to close the model. This includes equations of state, and models for viscosity, friction, flow patterns, heat and mass transfer. Especially for equations of state, flow patterns and friction models, it is concluded that more experimental data for CO2 mixtures is needed. Full-scale tests of running fractures are also recommended. Available simulation tools for pipeline flow are also presented, and their applicability to CO2 pipeline flow is discussed. At the time of writing none of the commercially available tools seem fully capable of simulating flow of CO2 with impurities.

Keywords Nordic, CCS, Consortium Day, Summary

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About NORDICCS

Nordic CCS Competence Centre, NORDICCS, is a networking platform for increased CCS deployment in the Nordic countries. NORDICCS has 10 research partners and six industry partners, is led by SINTEF Energy Research, and is supported by Nordic Innovation through the Top-level Research Initiative.

For more information regarding NORDICCS and available reports, please visit http://www.sintef.no/NORDICCS.

The agenda for the Consortium Day 2013 was the following:

09:00 **Opening**
Nils A. Røkke, Vice President Climate Change Technologies, SINTEF

09:20 **Welcome**
Karen L. Anthonsen, Geological Engineer, GEUS

09:30 **Recommendations on CO_2 transport solutions**
Jan Kjärstad, Research Scientist, Chalmers

Simulation of transient flows of CO_2 in pipes
Alexandre Morin, Research Scientist, SINTEF Energy Research

10:30 **Mapping new storage sites in the Nordic – The Nordic CO_2 storage atlas**
Karen L. Anthonsen, Geological Engineer, GEUS

11:00 **Status update on industrial case studies**
Kristin Onarheim, Research Scientist, VTT Technical Research Centre of Finland

12:30 **NORDICCS WP 3 - CCS cases**
Ragnhild Skagestad, Project Manager, Tel-Tek

13:00 **Communication and acceptance of CCS in a NORDICCS context**
Peter Stigson, Associate Professor, IVL Swedish Environmental Research Institute

13:45 **Nordic CCS Roadmap**
Marit J. Mazzetti, Research Scientist, SINTEF Energy Research

14:30 ***Discussion***

15:00 ***Closure***

Technical Presentations:

The agenda (above) provide hyperlinks to the actual presentations found on the NORDICCS eRoom.

Summary by Nils Røkke

The NORDICCS Center has been successful so far and is recognized far beyond the Center.
It is a strong center that has generated interesting work and results over the two first years.

- An amazing amount of work is done and we are building a common identity.
- Very interesting figures from Iceland. Presentation today shows that there is potential for CCS on Iceland through basalt storage.
- It is hard to establish cases, but some of them show great potential. Some are definitely possible Issues come up again that were previously not seen as possible.
- The Transport WP is putting up a very useful framework. View on shipping has changed, and shipping will be an opportunity. Why not ask ship-builders/owners to join.
- Roadmap is the culmination of all the work. This must be a dynamic document, and it will be updated towards the end of the project. The Roadmap shows big differences among countries, and should be used for dissemination of results.

After two years of operation and half way through, how do we want to proceed? Do we have the correct work program? What should we ditch and what should we boost? How can we continue to have a continuous Nordic Center on CCS after the next two years and beyond? In terms of communication, how can we increase the CCS knowledge? We should get a more hands-on situation.

Discussion part – some issues and questions

- NORDICCS is making a difference looking at actual projects.
- Injectivity parameters will be important it will affect transport and the whole system
- The final version of the Roadmap will have a link to the storage atlas
- We must show how CCS can be part of an overall climate change strategy – not only promoting parts of the overall picture. There could be a call for this next year from Nordic Energy.
- This is the first project where we can see some real progress.
- We must display the huge potential for storage in the Roadmap. One case calculation should show how we could help the rest of Europe by importing CO_2. Do calculations of scenarios – one scenario could be transport to Iceland.
- ETS has to be at € 100.
- Policy makers: How do we relate CCS to policy?
- Risk mitigation is to do action rather than wait.
- There must be some incentive for the industry to do CCS. Certificates would create incentives. The cost per ton must be discussed.
- More realism should be brought into the storage figures.
- We want to direct the communication towards the politicians. We need a policy message.
- Should focus on what is the increased value of CCS. Cost alone is not enough.
- Bio-CCS: Somewhat disappointed on the work in NORDICCS. Bio-CCS is not progressing in NORDICCS because there is no external push. Not relevant for bio emission. Where is CCS in

landscape industry and energy? How will CO_2 for EOR perform? What are net emissions? Do we want to do studies showing overall results?
- How does CCS relate to energy efficiency and renewables? What are the net CO_2 emissions if used in EOR in 50 years, 100 years, etc.
- Should not only target public acceptance in communication. Should also focus on industrial acceptance and their stakeholders.
- What are the added values of CCS?
- Survivability for industry is important and should be clearly communicated.
- Updated roadmap should relate to other costs that we are accepting.
- EOR is an important step – added value.
- Cement and lime case: Cement accounts for 6.6 Mt CO_2 in the Nordic countries, 60 % from calcination, rest from fuel. 31% of emissions from biomass. Norcem performs a case study on MEA. 2 other Cement projects, Skyonic in US and 1 in Taiwan

Wrap-up by Chairman of the Steering Group, Gunnar Sand

The Chairman complemented the presenters for good and interesting presentations, and said that this has been a good event. Specifically, he mentioned the following:
- We are progressing nicely – important work is being done.
- Do we need to make some adjustments?
- What are the most critical topics related to our objectives?
- CCS should be put in relation to other climate strategies.
- How do we get form analysis to actions in communication?
- Public acceptance is obtainable if we do the right things.
- We need to reflect on the future!