

# What's on 2013-5

# BIGCCS

International CCS  
Research Centre

[www.bigccs.no](http://www.bigccs.no)

## BIGCCS – Next Steps

The exiting Norwegian government has decided that the full-scale carbon capture project at Mongstad will be stopped. At the same time the government promises to ramp up the research efforts towards supporting the development of alternative full-scale CO<sub>2</sub> capture in Norway by 2020. Also, from the negotiations for the new government there are signals indicating that the Climate Agreement will be strengthened. Further, Horizon2020, the new EU research program (follower of Framework program 7), is under development and we work hard together with the CCS community for maintaining a strong focus on CCS as well as forming the work program description. The final call will be published in December. So far it seem like CO<sub>2</sub> storage and CO<sub>2</sub> capture from industry sources are the main issues covered.

In BIGCCS we are now planning for the next phase taking advises from the Mid-way evaluation and partner dialogue into account. BIGCCS will be more focused and pay special attention towards innovation, IP strategy, and novel high risk-high gain activities.

*Mona J. MølInvik, BIGCCS Director*

## VISTA Board Visits BIGCCS



*VISTA board visiting the laboratory at SINTEF Energy Research. From left: Richard Kvile (VISTA), Bård Krokan (Statoil), Sigurd Størset (SINTEF), Elisabeth Alve (UiO), Tor Grande (NTNU), Leif Lømo (Statoil).*

VISTA ([www.vista.no](http://www.vista.no)) is a basic research program funded by Statoil and conducted in close collaboration with The Norwegian Academy of Science and Letters. VISTA was established in 1985 to promote the co-operation between Statoil and academia in Norway and to strengthen the capacity and quality of science in areas of particular interest in the oil and gas industry. The VISTA board held its last meeting at NTNU in Trondheim on September 11-12, and in that connection they wanted to visit relevant research groups.

The VISTA board met with BIGCCS representatives on September 12. BIGCCS Chairman of the board, Mr. Nils Røkke, gave a background to the establishment of BIGCCS and an overview of the international status of CCS. BIGCCS Centre director, Ms. Mona MølInvik provided an overview of the Centre, its activities and results. Finally, Mr. Alexandre Morin gave a presentation on activities related to transport of CO<sub>2</sub>. The visit was completed with a tour of the laboratory, where the VISTA board members were shown the CO<sub>2</sub>Mix test rig, for characterization of CO<sub>2</sub> mixtures.

The visitors found the meeting very rewarding, and their only regret was that they had not allocated more time to the visit.

- Bård Krokan, Vice President Exploration, Statoil
- Leif Lømo, Special adviser, Statoil
- Anders Elverhøi, Professor of Geology, University of Oslo
- Elisabeth Alve, Professor in Micropaleontology, University of Oslo
- Nils Christian Stenseth, Professor of Biology, University of Oslo
- Tor Grande, Professor of Materials Chemistry/Materials Science, NTNU
- Helge Holden, Professor of Mathematics, NTNU
- Odd Stokke Gabrielsen, Professor of Biochemistry and molecular biology, University of Oslo

## Assessing Svalbard CCS Chain

A promising CCS chain in Norway is on Svalbard, where researchers at the UNIS CO<sub>2</sub> lab (<http://co2-ccs.unis.no/>) have recently characterized an onshore storage site and are ready for CO<sub>2</sub> injection tests. Norway's only coal-fired power plant, the proposed onshore storage site, and the coal mine are all located within 15 km of each other. The combination of the chain's compactness, the availability of onshore storage, and the low-volume CO<sub>2</sub> source could potentially result in the Svalbard CCS chain being a cost-efficient chain and therefore an interesting possibility for early implementation of CCS and a high-profile showcase for CCS in Norway.

Researchers from BIGCCS SP4 and Task 1.6 traveled to Longyearbyen June 24-25, 2013 to meet with the managing director of Longyearbyen Bydrift KF, Ms. Marianne Aasen, and the director of UNIS CO<sub>2</sub> Lab, Ms. Ragnhild Rønneberg, to discuss how collaboration between BIGCCS and "Svalbard CCS" can assist in making CCS at Svalbard a reality.

The CCS value chain methodology developed in BIGCCS links technical, economic, and environmental assessments of CCS chains to improve our understanding of the most important dependencies and trends of the key factors surrounding CCS. The methodology has been applied to a variety of case studies by designing CCS chains using a modular approach, where each part of the chain (capture, transport, and storage) is treated as its own module and can be connected to create CCS chains to assess. This flexible approach allows us to design smart case studies in order to answer important questions surrounding CCS. The methodology will now be applied to the chain on Svalbard with the intention of evaluating the technical and economic performance of the Svalbard CCS project under a variety of system designs to identify potential ways of decreasing the Svalbard CCS costs. These case studies will be performed so that the results and potential benefit will be communicated effectively to researchers, industry, decision makers, and the public.



*(From left) Simon Roussanally, Amy Brunsvold, and Rahul Anantharaman (SINTEF) and Marianne Aasen (Longyearbyen Bydrift) visiting the coal-fired power plant in Longyearbyen.*



*SINTEF ER researchers visit the UNIS CO<sub>2</sub> Lab's well park*



*The UNIS CO<sub>2</sub> Lab well park*

## Presentations of selected PhD candidates

### Camilla Vigen:

Affiliation: University of Oslo  
Title of thesis: Novel mixed proton electron conductors for hydrogen gas separation membranes  
Related to: BIGCCS Task 1.2  
Supervisor: Prof. Reidar Haugsrud  
Duration: 2009-2013



Camilla Vigen is finishing her doctoral research at the University of Oslo, and is planning to submit the thesis within 2013. The thesis is titled "Novel mixed protonic electronic conducting materials for hydrogen gas separation membranes", and is part of SP1 – CO<sub>2</sub> Capture, Task 1.2 – High Temperature Membranes. The aim of the thesis is to identify new candidate materials for dense hydrogen gas separation membranes, and to improve the fundamental understanding of the processes at play.

In this work, compounds of different crystal structures have been characterized with respect to protonic and electronic conductivity. Parameters regarding proton uptake and mobility are discussed and compared with state-of-the-art ceramic materials. A joint publication together with SINTEF Materials & Chemistry and Statoil reported the details of the hydrogen flux in Sr-doped LaCrO<sub>3</sub>, which is among the best candidate materials for hydrogen separation today. Further work has been performed on this material, focusing on the effect that surface kinetics has on the hydrogen flux and a detailed analysis of the hydrogen flux characteristics.

### Georg Baumgartner:

Affiliation: Technische Universität München  
Title of thesis: Experimental investigation of hydrogen flashback behaviour in turbulent boundary layers  
Related to: BIGCCS Task 1.3  
Supervisor: Prof. Thomas Sattelmayer  
Duration: 2010-2013

Georg Baumgartner is finishing his doctoral research at the Technical University of Munich (TUM) and is planning on completing his degree by January 2014. He has been involved in the BIGCCS program since February 2010 in research relating to pre-combustion CCS.



The project aims to improve understanding on how hydrogen can be used as a gas turbine fuel for pre-combustion CCS realization. The focus of Mr. Baumgartner's research is investigating

potential flame flashback phenomena associated with lean premixed combustion of H<sub>2</sub> without any diluents, such as N<sub>2</sub>. His experimental studies involve a variety of different geometrical and operating conditions, such as burner geometry, flow pattern, mixture composition, flame confinement, and temperature influences. Mr. Baumgartner uses state-of-the-art laser diagnostic techniques (PIV, LIF) to study the occurring flashback phenomena with very high temporal and spatial resolution in order to identify the underlying flashback mechanisms. Based on the outcome of these studies, he has identified measures to broaden the safe operating range of future gas turbine burners by tailoring the distribution of the mixture composition in the burner. Furthermore, the detailed insight into the flashback process enables development of a theoretical model, which reflects the physical reality during initiation of a flashback more closely. All this will be helpful in designing safe and reliable burners using hydrogen-rich fuels.

### Rafael Sanchez

Affiliation: The Norwegian University of Science and Technology (NTNU)  
Title of thesis: Modeling and simulation of sorption-enhanced steam methane reforming (SE-SMR) operated in circulating fluidized bed reactors  
Related to: BIGCCS Task 1.6  
Supervisor: Prof. Hugo A. Jacobsen  
Duration: 2010-2013

Rafael Sanchez has focused his research on numerical model development and validation of reactive flows in circulating fluidized bed reactors. Conventional models for these reactors assume fixed profiles for the solid phase, however this assumption is not valid when the solid particles are changing their properties due to CO<sub>2</sub> sorption and desorption. In order to account for the coupling of the reactor units, the model developed includes particular source terms in the momentum, heat and mass balances accounting for the effects of the solid flux carrying these quantities between the reactor units.



Sorption-enhanced steam methane reforming is one of the processes that have been investigated. This process features H<sub>2</sub>-rich syngas production with inherent CO<sub>2</sub> separation by cycling sorbent particles between the two reactor units. In the same manner, CO<sub>2</sub> capture from flue gases has been studied using Ca-based sorbent particles. Solid fluxes and heat integration proved to be of importance for performance optimization. A third process under study is chemical looping reforming, that produces syngas while avoiding the formation of NO<sub>x</sub> oxides."

## Einar Vøllestad

Affiliation: University of Oslo  
Title of thesis: Characteristics of mixed proton cond. materials  
Related to: BIGCCS Task 1.2  
Supervisor: Prof. Reidar Haugsrud  
Duration: 2010-2014

Einar Vøllestad is finishing his doctoral research at University of Oslo towards the end of 2013 within the field of high temperature hydrogen transport membranes for pre-combustion CO<sub>2</sub> capture. He has been working in the BIGCCS program since September 2010.



The project has focused on novel proton conducting hydrogen transport membranes and their long term stability and applicability under realistic operating conditions, such as multispecies transport and cation diffusion related degradation in membranes exposed to large electrochemical gradients and high temperatures.

In his research, cation diffusion properties – which govern the long term stability and degradation phenomenon in proton conducting membranes – were studied on the novel lanthanum tungstate series in order to obtain valuable information regarding the durability and lifetime of such membranes in a pre-combustion CO<sub>2</sub> sequestration module. These experiments are experimental in nature and aims at providing diffusion data that can be implemented in numerical and statistical lifetime evaluation models, currently under development in related projects. In combination with these studies, Einar has also focused on the hydrogen permeation characteristics in the same material, to evaluate its potential as a competitive hydrogen transport membrane with superior stability towards high temperature and acidic gases, which may allow for thermal integration in the pre-combustion process. These experiments were conducted in parallel to the development of a numerical model that can predict concentration and electrostatic field profiles within the membrane under operating conditions, which allows for more accurate modeling of multispecies transport and integration of gas phase chemistry on the membrane surfaces.

## Upcoming Events

### Consortium Day 2014 – October 16

The Consortium Day 2014 is held at Lerkendal Arena in Trondheim.

**For more information and registration.** (For BIGCCS project participants only)

### General Assembly – October 17

The General Assembly is held at Lerkendal Arena in Trondheim, between 0900 and 1200.

### Joint PhD Seminar with CLIMIT – October 17-18

This year's BIGCCS PhD seminar is organized together with the traditional CLIMIT PhD seminar. It is held at Lerkendal Arena, from lunch on October 17 to lunch October 18.

### BIGCCS Capture Day 2014 – October 29

The BIGCCS Capture day is a yearly event organized by SP1 in BIGCCS in autumn. This year the event is on Oct. 29, 2013 at SAS Radisson Hotel, Trondheim Airport Værnes. The technical program is from 0930 to 1430. A section on planning of SP1 activities will take place for rest of day. All partners in BIGCCS and leader group of SP1 will participate in the planning section.

### Board Meeting – November 28

The meeting takes place in Trondheim between 0900 and 1500.

### The 3rd Trondheim Gas Technology Conference - June 4-5, 2014

The 3rd Trondheim Gas Technology Conference will be staged in Trondheim on June 4-5, 2014.

For more information [www.sintef.no/TGTC2014](http://www.sintef.no/TGTC2014).

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