

 NTNU SINTEF

Gas Technology Activities 2010 - 2011

**Report prepared by the
Gas Technology Centre
NTNU-SINTEF**

Table of contents:

Preface	1
News	2
Conferences	4
New R&D projects	4
Selection of national R&D projects	8
Selection of international R&D projects coordinated by NTNU/SINTEF.....	12
Other international projects with NTNU/SINTEF participation	13
Research groups and networks	15
National priorities	16
Internationalization	17
Education	18
Internal events	21

About the Gas Technology Centre NTNU-SINTEF

The Gas Technology Centre NTNU-SINTEF (GTS) was established in 2003 and is the largest centre for gas technology research and education in Norway. GTS provides new knowledge and technology which will contribute to efficient, environmentally friendly and profitable utilization of natural gas.

The GTS focuses on exploring and exploiting the synergism of multidisciplinary research based on NTNU and SINTEF's broad expertise that encompasses the entire value chain from the energy source to the end user.

Approximately 75 professors/associate professors, 10 adjunct professors, 150 PhD candidates, 25 postdoctoral fellows at NTNU and 200 research scientists at SINTEF are associated with GTS.

The mission of GTS is to act as a common interface in gas technology R&D between NTNU/SINTEF and the market.

More specifically, GTS will:

1. Increase the visibility of gas technology R&D at NTNU/SINTEF, both externally and internally.
2. Promote new R&D opportunities and initiatives
3. Influence Norwegian national priorities
4. Ensure top quality education and recruitment of students and researchers
5. Be active in networking and internationalization activities
6. Promote internal coordination and synergism in gas technology R&D at NTNU/SINTEF

CCS - Carbon dioxide Capture and Storage

CRI - Centre of Research-based Innovation

ECSEL - European Carbon dioxide Capture and Storage Laboratory Infrastructure

ESFRI - National Financing Initiative for Research Infrastructure

FCH JU - Fuel Cells and Hydrogen Joint Undertaking

FME - Norway's Centres for Environment-friendly Energy Research

GTS - Gas Technology Centre NTNU-SINTEF

IEA - International Energy Agency

IFE - Institute for Energy Technology

LNG - Liquefied Natural Gas

NGCB - Natural Gas Conversion Board

NFR - Research Council of Norway

NTNU - Norwegian University of Science and Technology

SFI - Centre of Research-based Innovation

UiB - University of Bergen

UiS - University of Stavanger

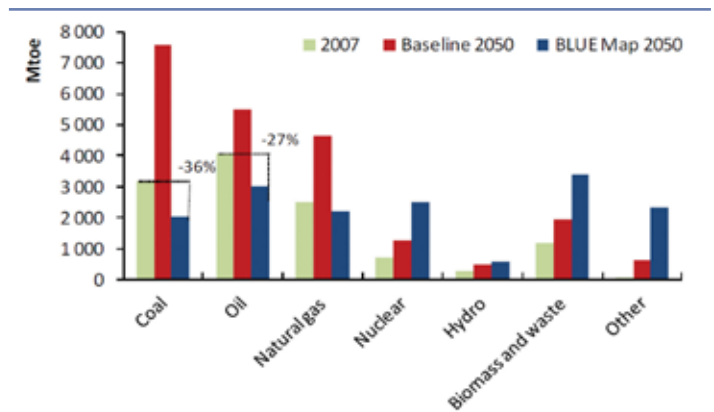
UiO - University of Oslo

Preface

This report provides an overview of the ongoing research and educational activities in gas technology at NTNU and SINTEF, with special focus on the main achievements in 2010-2011. Our gas technology portfolio includes 20 new projects, 25 national projects and 17 European R&D projects which are all described briefly. On the educational front, we are proud of the 37 PhD candidates that have been awarded their doctorates in this period in gas technology. In our context, the term gas technology refers to several gases: methane, carbon dioxide and hydrogen, and involves numerous scientific disciplines. It covers the entire gas value chain from the source to the end user.

The challenges of supplying clean and sufficient energy for the future is receiving increasing attention worldwide. At NTNU and SINTEF we focus strongly on environmentally friendly energy. Topics like renewable energy, energy efficiency, CO₂ capture and storage (CCS) and energy system analysis are on the agenda. However, the energy situation is a complex issue and most analysis show that the energy demand worldwide cannot be covered solely by renewable energy, not even in the most optimistic scenario (see figure). Fossil fuels will still play an important role in 2050, and how the natural gas resources are utilized will thus be extremely important.

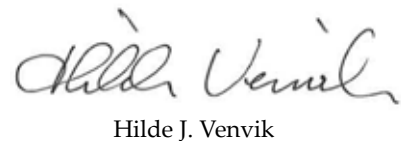
NTNU and SINTEF have been active in the development of sustainable oil and gas production in Norway for decades. In particular, subsea, gas processing, materials technology, information and communication technologies are areas where the R&D conducted at NTNU and SINTEF is internationally acknowledged for its high quality. A high level of competence is crucial for developing environmentally friendly and economical solutions for Norwegian natural gas resources in the future, in particular as the exploration of these resources becomes increasingly challenging in terms of climate, environment and distance to market. NTNU and SINTEF will therefore continue and strengthen even further our efforts within education and research along the natural gas value chain.



Source: Technology Perspectives 2010, International Energy Agency

Further development of natural gas technologies is crucial in the transition towards a sustainable energy system. The use of natural gas presents opportunities for reduced emissions of greenhouse gases and pollutants relative to other fossil fuels. Core competence in processing, conversion and the use of natural gas is also highly relevant in a renewable fuel perspective, such as hydrogen technology and bioenergy. Divided efforts within renewable and non-renewable gas research may limit knowledge building and potential synergisms, and we therefore say "Play along with natural gas".


Maria Barrio


Hilde J. Venvik

Co-directors of the Gas Technology Centre NTNU-SINTEF



News

Establishment of the Tri4CCS Alliance

The research institutes SINTEF in Norway, TNO in the Netherlands and IFP Energies nouvelles (IFPEN) in France established the "Tri4CCS Alliance" in June 2011. The alliance aims to make the capture, transport and storage of CO₂ safer and more cost-effective. In addition they offer R&D services to promote the use of CO₂. The Tri4CCS Alliance will spend 60M€/year on CCS research and 450 persons are devoted to CCS research annually.

Contact: Nils.A.Rokke@sintef.no
www.sintef.no/ccs-alliance



Professor May-Britt Hägg and the Minister of Research and Higher Education Tora Aasland. Photo: Sølvi W. Normannsen



Contacts:
Bjornar.Arstad@sintef.no
Magnus.Ronning@chemeng.ntnu.no

Opening of new laboratory facilities

The new Chemical Engineering laboratories, also to be used for ESFRI-ECCSEL, in Kjemiblokk 4 and parts of Kjemihallen, Gløshaugen, were officially opened by the Minister of Research and Higher Education Tora Aasland on 18 May 2010. The total rehabilitation includes new laboratories, offices and meeting rooms mainly for the CO₂ capture, membranes, crystallization, and process simulation groups at NTNU and SINTEF. Further renovation of Kjemihallen has been approved and the work will be conducted during 2011.

Successful evaluation of inGAP centre of research based innovation

Autumn 2010 the CRI inGAP, Innovative Natural Gas Processes and Products, hosted by the University of Oslo, Department of Chemistry, went successfully through a midway evaluation: "inGAP has very successfully developed research on natural gas processing in the international frontline and maintains excellent contacts and technology transfer with partner industries." inGAP's partners comprise UiO, NTNU, SINTEF, Borealis, Haldor-Topsoe, INEOS and Statoil.

Crown Prince Håkon opens new full scale research facility for CO₂ capture

On 29 April 2011 SINTEF's new research facility for CO₂ capture, located at Tiller right outside Trondheim, was opened by His Royal Highness Crown Prince Håkon of Norway. 42 MNOK was the price tag for one of the most advanced capture installation in the world, which size corresponds to industrial scale cleaning plants; a 30 meters high tower and a 25 meter high cleaning column. The height is necessary for verification of 90% removal of CO₂ from the flue gas. The test facility has been built as part of the SOLvit project and aiming at making the cleaning process cheaper and contribute to technology development that is being tested at the European CO₂ Technology Centre at Mongstad on the west coast of Norway.



Contact:
Aslak.Einbu@sintef.no
www.sintefloops.com

The Award For Excellence in Natural Gas Conversion

Professor Anders Holmen at NTNU received the NGCB's 2010 Award for Excellence in Natural Gas Conversion. Professor Holmen is being recognized for his achievements in advancing concepts and practical applications of direct and indirect routes for the efficient utilization of natural gas. The award consists of a plaque and a monetary prize, which were presented at the 9th Novel Gas Conversion Symposium in Lyon in May 2010.



From left: David Trimm, Enrique Iglesia, Lanny Schmidt, Jens Rostrup-Nielsen, Anders Holmen and Ad Punt, chairman in NGCB
www.ngcb.org

International CO₂ prize to SINTEF researcher Erik Lindeberg

Head researcher at SINTEF, Erik Lindeberg, received this prize in 2011, at the 6th Trondheim CCS Conference, on the basis of his pioneering research on CO₂ storage in geological pockets. This is the first time someone has been awarded with this prize which is meant for researchers who gain distinction within capture, transport or storage of CO₂.



Commercialization of small scale LNG production technology

The first full scale mini-LNG equipment based on technology from SINTEF Energy Research was successfully installed on one of I.M. Skagen SE's multi gas ships in the first half of 2010. The equipment can recondensate exhaust gases from ships during transport and make extra cooling of cargo possible. The capacity for the mini-LNG equipment is 20 tons of LNG per day. The technology could also be interesting for a number of other applications, for example liquefaction of methane from landfills or biogas.



Contact: Petter.Neksa@sintef.no

Integrated Operations 2010 Science and Practice

The 6th international conference on integrated operations in the petroleum industry took place in Trondheim 28-29 September 2010 with 280 participants. It was arranged by the Center for Integrated Operations at NTNU.

www.ioconf.no/2010/doku.php

The NTNU gas technology team has been strengthened

The high research activity within gas technology level has caused the number of NTNU professors to increase – along with the number of female faculty! Professor Terese Løvås joined the Department of Energy and Process Engineering in fall 2009, with a background in combustion from Lund University, Sweden, and Queen Mary University of London and University of Cambridge, UK. Hanna Knuutila became Associate Professor at the Department of Chemical Engineering in August 2011 to work with CO₂ absorption processes. Associate Professor Liyuan Deng joined the same department at the same time to work with membrane separation for CO₂ capture. They will also contribute to teaching and developing the MSc programmes in gas technology as well as process and chemical engineering.



Contacts:

Liyuan.Deng@chemeng.ntnu.no
Hanna.Knuutila@ntnu.no
Terese.Lovas@ntnu.no

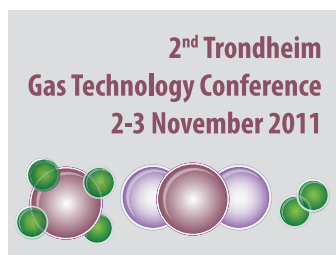
New "gas-to-metallurgy" project portfolio in 2011

The world market has seen increased prices of minerals despite the 2008 and current financial challenges. There is also renewed interest in the use of natural gas in metallurgical processes to improve the efficiency and reduce emissions. The IRONMAN project is a proposed LKAB/Höganäs plant for the direct reduction of iron alongside Statoil's methanol plant at Tjeldbergodden, and SIVA - The Industrial Development Corporation of Norway – is currently working to facilitate this investment. NTNU-SINTEF core competence within metallurgy as well as gas technology resulted in three new projects in this area from the Research Council of Norway GASSMAKS Programme in 2011, that involve the use of natural gas for production of iron and silicon.

Contacts:

Leiv.Kolbeinsen@material.ntnu.no
Jack.Odegard@sintef.no
www.klif.no/nyheter/dokumenter/Ironman_utredningsprogram_260809.pdf





www.sintef.no/tgtc2011

Conferences

2nd Trondheim Gas Technology Conference, TGTC2011

TGTC2011, arranged by GTS, takes place in Trondheim on 2-3 November. The 2nd Trondheim Gas Technology Conference focus on fundamental and applied gas technology research and development. The aim of this international and scientific conference is to bring forward, present and discuss the work being performed in this area at R&D institutions, universities and industries. Main sponsor are Gassco and Snøhvit Future Development.

NTNU and SINTEF contributions to GHGT10

The 10th International Conference on Greenhouse Gas Control Technologies (GHGT10) took place 19-23 September 2010 in Amsterdam, Netherlands. The conference had 1600 participants from 55 countries, with a total of 260 oral presentations and 650 poster presentations. SINTEF contributed with 7 oral presentations and 24 poster presentations, and NTNU contributed with 5 oral presentations and 21 poster presentations.

www.ghgt.info

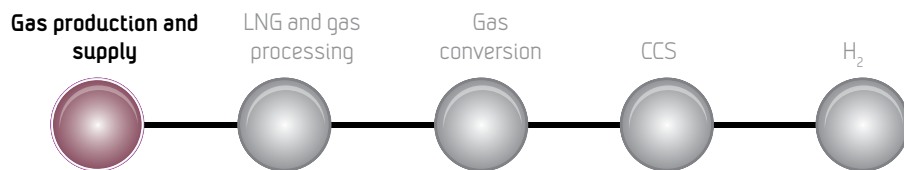


Contact:
An.Hilmo@sintef.no
www.sintef.no/Projectweb/TCCS-6

The 6th Trondheim CCS Conference (TCCS-6)

The Trondheim CCS Conference has grown to become a leading scientific CCS technology conference series. TCCS-6, held on 14-16 June 2011, recorded an all time high attendance of 425 participants from 22 countries, an increase by 40% from the TCCS-5 in 2009, and a 7-fold increase from the first TCCS held in 2003. Focus of the conference was research and development across the entire CO₂ value chain; capture, transport and storage.

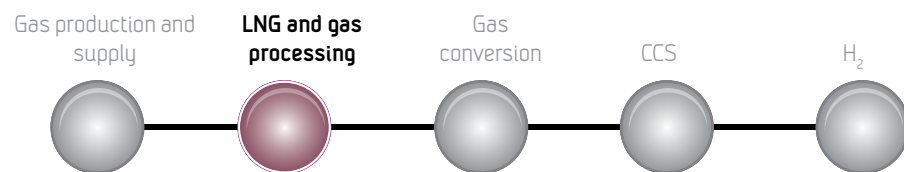
New R&D projects



HiPGLS - High Pressure Gas-Liquid Separation

The project will enhance our understanding of the chemical and physical processes associated with high pressure gas/liquid separation in systems containing hydrocarbons, water and chemicals. In 2010, the project entered a new 3-year phase. Partners are Statoil, Shell Technology Norway, ExxonMobil, VetcoGrey, FMC Kongsberg Subsea, Sulzer Chemtech, Natco Norway, Pall Europe, Peerless and the Research Council of Norway PETROMAKS Programme. Budget: 11.4 MNOK.

Contact:
Are.Lund@sintef.no



VISTA project on gas hydrate stability

Professor Signe Kjelstrup and Professor Thijs Vlugt from the Technical University in Delft in the Netherlands were awarded a VISTA project for studies of the stability of gas hydrates. VISTA is since 1985 a research cooperation between The Norwegian Academy of Science and Letters and Statoil. This is a 3 year project. Budget: 3 MNOK.

Contact:
Signe.Kjelstrup@chem.ntnu.no



Cryogenic distillation column

PhD student Leen van der Ham and Professor Signe Kjelstrup at the NTNU Department of Chemistry, in collaboration with SINTEF Energy Research, were awarded 5 MNOK, within the DECARBit project of the FP7 program, to build and test a cryogenic distillation column needed to reduce CO₂ emissions from power plants.

Contact:
Leen.vanderHam@chem.ntnu.no

A GREEN Sea

The objective of the project is to identify and evaluate new technologies and concepts for removal of CO₂ and H₂S from natural gas, thereby avoiding CO₂ emissions to air and avoiding the use of harmful chemicals. Project partners are the Research Council of Norway PETROMAKS Programme, Statoil, TOTAL, Gassco and Petrobras. This is a 5 year project. Budget: 32 MNOK.

Contact:
Maria.Barrio@sintef.no

SNOP - Snøhvit Optimization

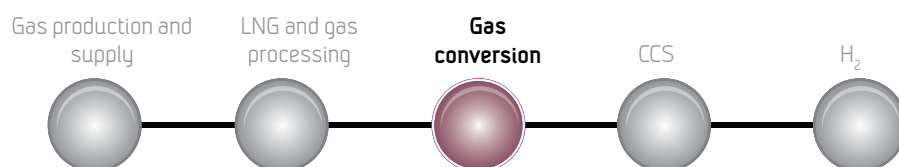
A software tool for process optimization is under development for the cryogenic part of the Hammerfest LNG plant, in cooperation with Statoil R&D. The liquefaction process is based on three integrated circuits with mixed refrigerants where operational parameters can be optimized. The software tool will assist plant operations in selecting optimal process parameters for maximal production and minimal power needs. Budget for 2011: 1.1 MNOK.

Contact:
Magne.Lysberg@sintef.no

Natural gas processing by the use of new membrane materials

The objective is to optimize and up-scale recently developed polymer membranes for natural gas sweetening (removal of CO₂ and/or H₂S). This is an innovation project under the Research Council of Norway GASSMAKS Programme. Partners are Statoil ASA, Petrobras and the Department of Chemical Engineering, NTNU. Budget for 2011-2014: 11 MNOK

Contact:
May-Britt.Hagg@chemeng.ntnu.no



NTNU-SINTEF-Statoil BTL project

The main goal of the project, Biomass to liquid fuels (BTL), is to develop the knowledge needed to select or design new catalysts and adsorbents in order to improve the technology for BTL based on gasification and Fischer-Tropsch synthesis. The project is focusing on the effect of gas-phase pollutants (e.g. tar, alkali and sulphur) on the catalytic steps used to produce liquid fuels. NTNU and SINTEF perform the work, which is funded by the Research Council of Norway RENERGI Programme, Statoil VISTA, and NTNU and SINTEF through the Gas Technology Centre. This is a 3 year project. Budget: 8.5 MNOK.

Contact:
Edd.Blekkam@chemeng.ntnu.no

Microstructured Reactors for Compact Conversion of Natural Gas to Liquid Fuels

The primary objective is increased knowledge on microstructured reactor technology for production of liquid fuels from natural gas. The targeted fuels include synthetic (Fischer-Tropsch) diesel and dimethyl ether (DME). This is a 3 year researcher project under the Research Council of Norway GASSMAKS Programme, in collaboration between Department of Chemical Engineering, NTNU, SINTEF Materials and Chemistry and Karlsruhe Institute of Technology, Germany. Budget: 7.4 MNOK.



Contacts:
Hilde.Venvik@chemeng.ntnu.no
Rune.Myrstad@sintef.no

GasBio

Building of knowledge in thermochemical biomass conversion for future production of second generation biofuels is the main objective of this project. It addresses key elements such as large scale production of synthetic diesel from wood and forest resources, as well as processes for smaller scale production of biofuels from forest, household and industrial waste fractions. The consortium consists of leading research groups and several industrial partners. The project duration is 4 years (2010-2014). Budget: 25 MNOK.

Contact:
Judit.Sandquist@sintef.no
www.sintef.no/Projectweb/GasBio

Use of Natural Gas in Ferroalloy and Si production and Ilmenite processing

The project will investigate different ways to use natural gas in the production of ferroalloys and related products in order to lower the energy consumption and/or greenhouse gas emissions. This is a knowledge-building project (KMB) under the Research Council of Norway GASSMAKS Programme. Project partners are the Department of Materials Technology, SINTEF Materials and Chemistry, Eramet Titanium, Iron AS and The Norwegian Ferroalloy Producers Research Association. This is a 7 year project. Budget: 40 MNOK.

Contact:
Leiv.Kolbeinsen@material.ntnu.no

Pure Silicon production using Natural gas

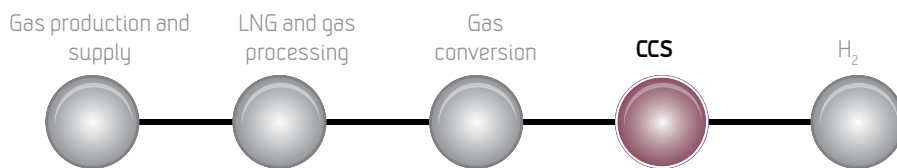
The project aims to develop a basis for production of FeSi and Si, with focus on solar cell Si, from natural gas and Norwegian quartz. This is a 3 year research project under the Research Council of Norway GASSMAKS Programme, in collaboration between Department of Materials Technology, NTNU, SINTEF Materials and Chemistry and the University of New South Wales, Australia. Budget 12.9 MNOK.

Contact:
Merete.Tangstad@material.ntnu.no

Development of Rana Gruber's iron ore for processing with natural gas

This project targets the development of new products from the Rana Gruber iron ore: direct reduced iron (DRI) pellets and ore mini-pellets produced by recently developed small-scale technology. This is a 3 year innovation project under the Research Council of Norway GASSMAKS Programme. Project partners are Rana Gruber AS, SINTEF Materials and Chemistry and Department of Materials Technology, NTNU. Budget: 9.2 MNOK.

Contact:
Eli.Ringdalen@sintef.no

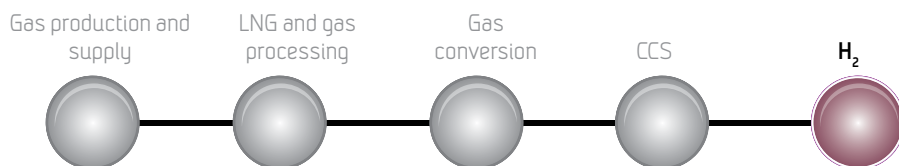


The Nordic CCS Competence Centre

Initiated under the Top-level Research Initiative (TRI) and funded by the Nordic Innovation, the Nordic CCS Competence Centre (NORDICCS) aims at being the Nordic CCS platform involving major CCS stakeholders in the five Nordic countries. The main objective of NORDICCS is to boost the deployment of CCS in the Nordic countries by creating a durable network of excellence, integrating R&D capacities and relevant industry. The Centre commences activities during the second half of 2011 and will operate for five years. Host institution is SINTEF Energy Research.

Contact:
Nils.A.Rokke@sintef.no





nextgenFCmat – Next Generation Fuel Cell Materials

nextgenFCmat seeks to facilitate development of high energy density solid oxide fuel cells (SOFCs) with low weight, compact design and low cost through materials development by “low” temperature thin film routes. Partners are Risø-DTU, Lund University and RWTH Aachen. The project is coordinated by SINTEF and financed through the Northern European Innovative Energy Research Programme N-INNER II (Nordic Energy Research). This is a 3 year project. Budget: 1 M€.



Contact:
Camilla.Haavik@sintef.no
www.sintef.no/
Projectweb/nextgenFCmat

NICE - Nanodesign to Improve the Catalytic layer of the Polymer Electrolyte Fuel Cell

The project exploits new ideas for design of functional layers in the polymer electrolyte fuel cells. This is a 3 year project funded under the Research Council of Norway NANOMAT Programme in a partnership between SINTEF and IFE. Budget: 5.5 MNOK.



Contact:
Signe.Kjelstrup@chem.ntnu.no

HyLIFT DEMO

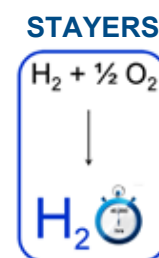
The objective is to conduct a large scale demonstration of H₂ powered fuel cell forklifts, to enable deployment and market introduction starting no later than 2013. Partners: Ludwig-Bölkow Systemtechnik (Coordinator), H2Logic, DanTruck, TÜV SÜD, Technical University of Denmark, Linde AG, JRC, SINTEF and ENEA. The project is supported by FCH JU, with national co-funding through the Research Council of Norway RENERGI Programme. This is a 3 year project. Budget: 48 MNOK.



Contact:
Steffen.Moller-Holst@sintef.no

STAYERS STATIONary PEM fuel cells with lifetimes beyond five YEaRS

The objective is materials research to produce PEM fuel cell stacks with a lifetime of 40000 hours for stationary applications where longevity and reliability are essential. Partners: Solexis, Solvi-Core, NedStack and Joint Research Centre of the EC. Funded by FCH JU with national co-funding through the Research Council of Norway RENERGI Programme. This is a 3 year project. Budget: 33.6 MNOK.



Contact:
Anders.Odegard@sintef.no

RAMSES Robust Advanced Materials for metal Supported SOFC

The objective is development of a SOFC cell with improved lifetime due to low operating temperature (600°C) while maintaining high performance by applying advanced low-temperature electrodes and electrolyte materials. The multidisciplinary consortium involves 9 organizations. Funded by FCH JU with national co-funding through the Research Council of Norway RENERGI Programme. This is a 3 year project. Budget: 38 MNOK.



Contact:
Camilla.Haavik@sintef.no



KEEPEMALIVE

Contact:
Steffen.Moller-Holst@sintef.no
www.keepealive.eu

KEEPEMALIVE

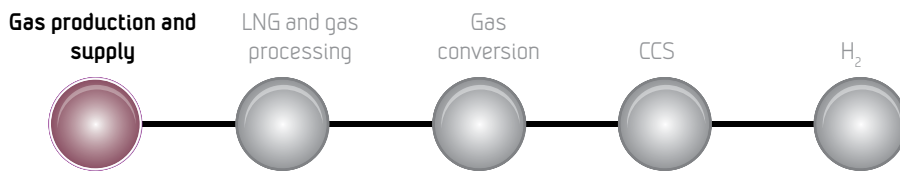
This project is focusing on degradation and lifetime fundamentals related to low temperature PEM fuel cells for stationary power and combined heat & power generation. Through enhanced understanding of degradation and failure mechanisms and development of accelerated stress test protocols, sensitivity matrix and lifetime a prediction model, this project shall enable a lifetime of 40 000 hours at realistic operation conditions for stationary systems. The project is coordinated by SINTEF and funded by FCH JU with national co-funding through the Research Council of Norway RENERGI Programme. This is a 3.5 year project. Budget: 2.8 M€.

NORCOAT Nordic Initiative for Low Cost Fuel Cell Bipolar Plate Coatings

Contact:
Anders.Odegard@sintef.no

The main objective is new and improved coatings for stainless steel bipolar plates for PEM fuel cells, to ensure 10 000 hours lifetime and high feasibility for low cost mass production. Partners include PowerCell, Impact Coatings, VTT, Outokumpu and Kromatek. The project is partially funded by TEKES and the Nordic Innovation Centre. This is a 2 year project. Budget: 10.6 MNOK.

Selection of national R&D projects



Reservoir management & production optimization

Contact:
Bjarne.Foss@ntnu.no

This program shall develop methods, technology and work processes for real-time reservoir management and production optimization. Natural gas related activities for increased recovery and accelerated production include:

- Optimization-based control in shale gas production
- Value chain optimization in the petroleum industries
- Production Optimization of Remote Operated Gas Wells

Contact:
Bjarne.Foss@ntnu.no
www.ntnu.no/iocenter

SFI on Integrated Operations (IO centre)

The centre works on gas value chain optimization and integrated modeling, for a multifield asset integrated optimization benchmark consisting of two gas-condensate reservoirs, an oil reservoir and a downstream LNG plant recovery system. The benchmark will be used to evaluate life-cycle production strategies and to assess the business value of value chain optimization.

GassOpt Advanced

Contact:
Vibeke.Norstebo@sintef.no

Gas quality is the main bottleneck for optimal utilization of the pipeline infrastructure in the North Sea. In November, a new version of GassOptTKL was delivered to Statoil and Gassco, with improved modelling of gas quality, processing plants and compressors. The tool is used for a wide range of transport capacity studies. The project is funded by Statoil and Gassco.



FlareCheck - Flare systems overpressure protection

A series of industrial projects where the reliability of overpressure protection of flare systems is validated through a combination of simulations and reliability calculations. Applied at Kårstø, Kollsnes and Mongstad processing plants in conjunction with several plant extension projects.

Contact:
Sture.Holmstrom@sintef.no

RAMONA

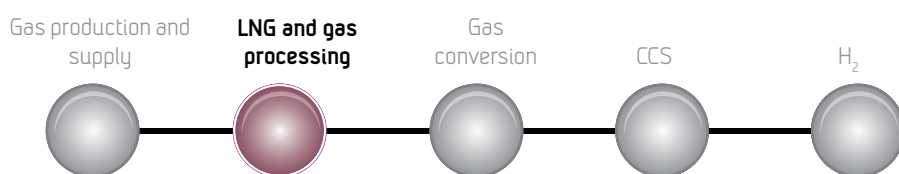
The main objective is to develop new theory, methods and tools to optimize the security of supply and capacity utilization in offshore gas production, processing and transportation systems. Project partners are: SINTEF, NTNU, UiS, UiB, CognIT, Gassco and Statoil. This is a 5 year project. Budget: 30 MNOK.

Contacts:
Kjetil.Midthun@sintef.no
Asgeir.Tomasgard@ntnu.no

BEEDIST - Basic Energy Efficient DISTillation Technology

Design and control of new integrated distillation column configurations which may give energy savings in the range of 20-40%. The project is supported by GASSMAKS (NFR). Budget: 10 MNOK.

Contact:
Ivar.J.Halvorsen@sintef.no



EFFORT - Energy efficiency in offshore platforms

Capture, transport and utilisation of surplus heat and energy for power production and other applications are emphasised in this project. Partners are Statoil, Shell, Petrobras, TOTAL, NTNU, SINTEF Energy Research and PETROMAKS (NFR). Budget: 30 MNOK.

Contact:
Petter.Neksa@sintef.no

RECCO2 - Recovery of CO₂ from high pressure natural gas

The objective is CO₂ removal from high pressure natural gas streams using a polymeric blend membrane. The project includes material development, pilot construction, durability tests and simulations. Project led by the MEMFO research group at NTNU with the industrial partner Statoil and funded by GASSMAKS (NFR).

Contact:
may-britt.hagg@chemeng.ntnu.no

Enabling low-emission LNG systems

The project focuses on knowledge and tools for evaluation, operation and design of innovative, environmentally safe, cost-effective and energy-efficient LNG systems. This is a 5 year project supported by PETROMAKS (NFR). Budget: 43.8 MNOK.

Contact:
Mona.J.Molnvik@sintef.no

Use of LNG on ship

The use of LNG on ship has been a commercial success and the international interest is growing fast. Marintek (SINTEF) is leading the technology development in this area. Today, about 26 ships are in operation using LNG as fuel, 15 ships are under construction and 10 ships in prospect. The main competence and contribution from Marintek is in the engine technology development. New challenges are the handling of varying gas quality and unburned hydrocarbons.

Contact:
Per.Einang@marintek.sintef.no



BigLNG - Commercial LNG-fuelled cargo vessels

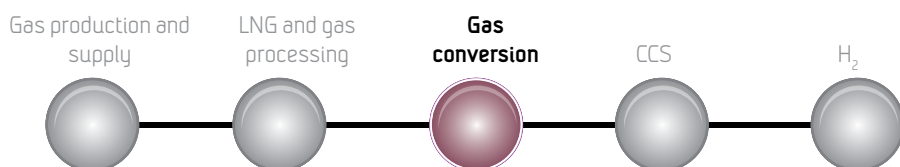
Development of new types of LNG-fuelled cargo vessels. The outcome of the BigLNG project is two LNG-fuelled Rolls Royce ships currently under construction for operation along the Norwegian coast and in the North Sea.

Contact:
Per.M.Einang@marintek.sintef.no

LNG Shipping - Decision Support in LNG Supply Chains

The LNG value chain is a network of different planning elements and options which have to be synchronized to achieve optimal resource utilization. Cooperation between Statoil, GDF Suez and SINTEF. Sponsors are MAROFF (NFR) and industrial partners. This is a 4 year project.

Contact:
Frode.Romo@sintef.no



inGAP - Innovative Natural Gas Processes and Products

inGAP is a Centre of Research-based Innovation (SFI), appointed by NFR. inGAP is headed by the University of Oslo with SINTEF, NTNU, Borealis, Statoil, Ineos and Haldor Topsoe as active partners. Its vision is value creation in natural-gas processes through rational design of processes and products based on atomistic and mechanistic insight in catalyst and reactor parameters under operative conditions. This is a 5 - 8 year project.



www.ingap.uio.no

GassMat - Integration models for industrial clusters producing materials and energy

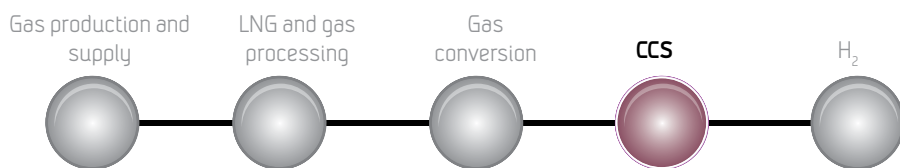
The project assesses the potential for environmentally justifiable utilization and industrial processing of natural gas, together with deposits of ore/minerals in the Barents/Northern Region. It considers the establishment of gas-based industrial clusters producing materials and CCS implementation. The project partners are Statoil, LKAB, Celsa, Fesil, Alstom, NTNU, SINTEF and GASSMAKS (NFR).

Contact:
Jack.A.Odegard@sintef.no

Techno-economic evaluations of natural gas-based processes

Preliminary evaluations of several natural gas conversion processes under different conditions. Project supported by GASSMAKS (NFR).

Contact:
Elisabeth.Tangstad@sintef.no



CO₂ Field Lab

CO₂ Field Lab is an international collaboration between Norway, France, and the United Kingdom. The main objective of the project is to assure and increase carbon storage safety by obtaining valuable knowledge about monitoring of CO₂ migration in geological formations. This will enable detection of possible CO₂ leakage at the earliest possible stage. This is a 4 year project. Budget: 11 M€.

Contact:
Maria.Barrio@sintef.no
www.sintef.no/co2fieldlab

www.BIGCCS.no

More on the FMEs:
www.cedren.no
www.cenbio.no
www.nowitech.no
www.forskningssradet.no/energisenter

BIGCCS Centre - International CCS Research Centre

The centre is one of the eight FMEs in Norway. It seeks to realize full-scale CO₂ management for power production and industrial processes through long-term, basic research, encompassing the entire CO₂ chain. 26 partners from eight countries. Budget: 45 M€.



CO2Mix

The aim is to provide accurate measurements of selected physical properties of CO₂-rich mixtures, with focus on identified knowledge gaps for mixtures relevant for CCS conditioning and transport. Phase equilibrium measurements will be performed by SINTEF/NTNU. CO2Mix is organized as a task in BIGCCS. This is a 4 year project. Budget: 46 MNOK.

Contact:
Sigurd.W.Lovseth@sintef.no

BIGCO2

CO₂ management technologies for future power generation. The BIGCO2 consortium includes equipment manufacturers, oil and energy companies, research institutes and universities. This is a 5 year project under CLIMIT (NFR). Budget: 16 M€.



BIGCLC

Demonstration of chemical looping technology in natural gas power generation with CO₂ capture. This is a 4 year project under CLIMIT (NFR). Budget: 12 M€.

Contact:
Marie.Bysveen@sintef.no

CCERT - PhD programme in CO₂ Capture, Enabling Research and Technologies

The programme will create knowledge and provide a theoretical basis for the development and design of substantially improved process technologies for CO₂ capture. Statoil, Shell TN, Metso Power Oy, DNV and CLIMIT (NFR) are financial partners. Budget: 16 MNOK.

Contact:
Hallvard.Svendsen@ntnu.no

SOLvit

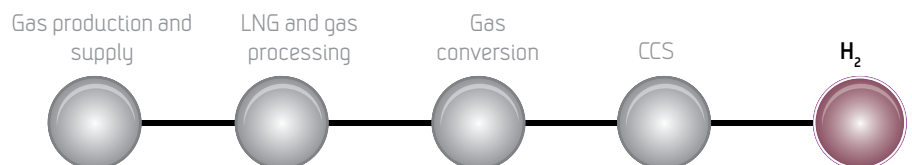
Cost-effective technology for post-combustion CO₂ capture. Phase I focuses on testing alternative amine solvents. The programme includes the construction of a new pilot plant for absorption technology with a full-scale high tower in Trondheim. Partners are Aker Clean Carbon, SINTEF and NTNU. Sponsors: Gassnova, NFR, Scottish Power, E.ON and Statkraft. This is 8 year project. Budget: 317 MNOK.

www.sintef.no/co2capture

CO2 Dynamics

The issues of pipeline transport of CO₂ are addressed through in-depth thermodynamics and fluid dynamics investigations on single-phase (liquid) and two-phase (gas-liquid) flow of CO₂ with impurities. Project partners: Gassco AS, Statoil Petroleum AS, Vattenfall Research and Development AB, SINTEF Energy Research and NTNU. This is a 4 year project. Budget: 26.5 MNOK.

Contact:
Svend.T.Munkejord@sintef.no
www.sintef.no/Projectweb/CO2-Dynamics



HyPilot

Preparing for a national pilot test centre for hydrogen technologies. This is a 2 year project and the final report will be submitted to the Research Council of Norway by the end of 2011. Budget: 2 MNOK.

Contact:
Paullnge.Dahl@sintef.no

Efficient Hydrogen Liquefaction Processes

Improving energy efficiency for liquefaction. RENERGI (NFR). This is a 5 year project. Budget: 11 MNOK.

Contact:
Petter.Neksa@sintef.no



Selection of international R&D projects coordinated by NTNU/SINTEF



Contact:
Paris.Klimantos@ntnu.no

iCap – Innovative CO₂ capture.

The project focuses on post-combustion CO₂ capture techniques using chemical absorption media on combined CO₂/SO₂-removal as well as on the utilization of advanced polymeric and ceramic membrane materials. The consortium has 15 partners from leading European R&D organizations, industry, as well as Australia and China. This is a 4 year project. Budget: 6.6 M€.

DECARBit - Enabling advanced pre-combustion technologies and plants

Development of pre-combustion and new capture technologies with aiming to achieve a capture cost of 15€/t CO₂. Plans for pilot testing are included in the project. The DECARBit consortium consists of 21 partners from 10 countries and receives co-funding by the EU FP7. This is a 4 year project. Budget: 15.5 M€.



<http://decarbit.com>

ECCO - European value chain for CO₂

The objective is to identify how CCS can become economically viable. It includes establishing recommendations for how a European infrastructure for CCS could be built, and identifying how CCS value chains could be established. There are 19 partners in the project, with background from power generation, oil and gas production and R&D. ECCO is partly funded by the European Commission with co-funding through its industrial partners. This is a 3 year project. Budget: 5.3 M€.



www.sintef.no/ecco

Research program between SINTEF and Indian Institute of Petroleum on CO₂ capture

The aim is to develop an adsorption based process for post-combustion CCS through preparation of new adsorbent formulations, analysis of these under static and dynamic conditions and use of the derived parameters in process development. The project is financed by the Norwegian Embassy in India. This is a 4 year project. Budget: 3.6 MNOK.



Contact:
Duncan.Akporiaye@sintef.no

SUSPLAN – Integration of renewable energy into the European energy system

Development of regional and European-wide guidelines for more efficient integration of renewable energy into future infrastructures. SUSPLAN will simultaneously assess future scenarios for electricity, heating and gas infrastructures. EU FP7 project with 16 partners. This is a 3 year project. Budget: 4.7 M€.



www.susplan.eu

H2movesScandinavia/Oslo

H2movesScandinavia is EU's largest project to demonstrate hydrogen as a transportation fuel. Within this is featured 17 fuel cell vehicles and corresponding hydrogen infrastructure in Oslo. SINTEF coordinates H2movesOslo, with the establishment of a refueling station. This is a 2 year FCH JU project with Norwegian co-funding from Transnova. Budget: 19.3 M€.



Contacts:
Ulrich.Buenger@ntnu.no
Steffen.Moller-Holst@sintef.no
www.h2moves.eu

NEXPEL-Next generation PEM Electrolyzer

Demonstration of an efficient PEM electrolyser integrated with renewable energy sources to support the establishment of hydrogen as an energy carrier in a range of near future applications. Coordinated by SINTEF with 8 European partners. FCH JU project with co-funding through RENERGI (NFR). This is a 3 year project. Budget: 26.4 MNOK.



Contact:
Magnus.S.Thomassen@sintef.no



Other international projects with NTNU/SINTEF participation

CO2ReMoVe - Geological storage of CO₂

Monitoring and verification techniques for deep subsurface CO₂ storage. The project is co-funded (8 M€) by EU FP6 and carried out by a consortium of 31 industrial, research and service organizations, all with elaborate experience in CO₂ geological storage. This is a 5 year project. Budget: 15 M€.

www.co2remove.eu

CACHET-II - Carbon dioxide Capture and Hydrogen Production with Membranes

The aim is to develop innovative membrane reactors for increased energy efficiency of pre-combustion CO₂ capture in natural gas- and coal-fired power plants. Pd-based hydrogen selective membranes and high temperature sulphur removal are of particular focus. EU project with 8 partners. This is a 3 year project. Budget: 4 M€.



Contact: Thijs.Peters@sintef.no
www.CACHET2.eu

CESAR - CO₂ Enhanced Separation and Recovery

Development of low cost post-combustion CO₂ capture technology towards economically feasible solutions for both new power plants and retrofitting existing plants. The primary objective is to decrease the cost of capture down to 15 €/tCO₂. Major contribution of 4 M€ from the EU FP7 with additional funding from industrial partners. This is a 3 year project. Budget: 7.1 M€.



Contact:
Thor.Mejdell@sintef.no,
Hanne.Kvamsdal@sintef.no
www.co2cesar.eu

COCATE

The objective is to analyse the conditions for pooling of CO₂ capture and transportation systems from smaller CO₂-emitting industrial facilities. Partners: IFP Energies Nouvelle, Le Havre Region Development Agency, Geogreen, Accoat, SINTEF Energy Research, DNV, TNO, Port of Rotterdam NV and SANERI. This is a 3 year project. Budget: 4.5 M€.

Contact:
Jo.Husebye@sintef.no

NanoGLOWA - Nano materials against global warming

NanoGLOWA brings together universities, power plant operators, industry and SMEs in order to develop optimal nanostructured membranes and installations for CO₂ capture from power plants. The MEMFO research group at NTNU is a major partner. This is a 5 year project under EU FP6. Budget: 12.5 M€.



www.nanoglowa.com

NanoMOF - Nanoporous Metal-organic Frameworks for production

The objective is engineering of metal-organic frameworks (MOFs) for industrial applications in catalysis, gas storage, and gas purification by using modular construction approach of MOFs for pore size engineering and functionalization. The project will go beyond discovery and integrate MOFs into industrially important value added products. There are 17 project partners. This is a 4 year project. Budget: 5 MNOK.



Contact:
Jasmina.Hafizovic.Cavka@sintef.no
www.nanomof-project.eu

Next-GTL - processes for gas to liquids

The project addresses the most critical and costly step to produce liquid fuel from natural gas using conventional routes, e.g. the stage of syngas production, as well as alternative routes to convert natural gas to liquid transportable products. This to explore routes particularly suited for remote areas. This is a EU FP7 large-scale project which started in 2009 and has 23 European partners. Budget: 12.6 M€.



Contact:
Michael.Stocker@sintef.no
www.next-gtl.eu





Contact:
Ornolv.B.Vistad@sintef.no

OCMOL – gas to liquids based on oxidative coupling of methane

The project aims at developing an chemical route adapted to the exploitation of small gas reservoirs from both a technical and an economic point of view. The OCMOL partnership gathers 17 entities from 9 countries, among them SINTEF. Support is provided by the European Commission through EU FP7 with up to 7.5 M€. This is a 5 year project. Budget: 11.5 M€.



www.naturalhy.net

NATURALHY

Testing of critical components of a hydrogen system by adding hydrogen to natural gas in existing networks. The project comprised 39 partners and was co-financed by the EU FP6. This is a 5 year project. Budget: 17 M€.



Contact:
Marie-Laure.Fontaine@sintef.no

EFFIPRO - Efficient and robust fuel cell with novel ceramic proton conducting electrolyte

The project aims to develop stable and robust electrolytes and electrodes for proton conducting solid oxide fuel cells (PC-SOFCs) in order to have the technology available by 2020 for early applications such as distributed power, auxiliary and general power needs in heavy transportation (ships, trucks). This is a 2 year project with 7 partners; UiO, CNRS-IMN, CSIC, SINTEF, Jülich Forschungszentrum, Risø-DTU, Cerpotech. Budget: 2.5 M€.



Research groups and networks

The MEMFO Research Group

The MEMFO group at the Department of Chemical Engineering NTNU has been active since 1994. It focuses on membrane gas separation and liquid separation.

www.chemeng.ntnu.no/memfo

KinCat – The Petrochemistry and Catalysis Gemini Centre at NTNU/SINTEF

Research and education in catalysis and petrochemistry, including surface science, adsorption and physical studies of porous materials, reaction kinetics and process engineering.

www.ntnu.edu/chemeng/kincat

CO2NET

CO2NET is a Carbon Dioxide Knowledge Sharing Network, which was initially set up under the EU FP5. It is now an industry-led, self-funded network and comprises more than 30 major companies and organizations in Europe, USA and Australia extensively involved in the development of CCS.



www.co2net.com

FCH-JU - Fuel Cells and Hydrogen Joint Undertaking

FCH JU is a public-private partnership supporting research, technological development and demonstration (RTD) activities in fuel cell and hydrogen technologies in Europe. Its aim is to accelerate the market introduction of these technologies, realizing their potential as an instrument in achieving a carbon-lean energy system.



www.ec.europa.eu/research/fch

N.ERGHY - New European Research Grouping for HYdrogen

N.ERGHY represents around 70 R&D institutions in Europe with a total of more than 2000 researchers working in the field of hydrogen and fuel cells. Both NTNU and SINTEF are members of N.ERGHY, and SINTEF is represented in the Executive Board, chairing the Application Area Transportation and Refuelling Infrastructure. N.ERGHY is one of the three members of FCH JU, along with the European Commission and the Industrial Grouping.



IEA-Hydrogen Implementing Agreement

Norway is member of IEA-Hydrogen Implementing Agreement (HIA). SINTEF ICT is leading IEA-HIA Task 23 Small scale reforming for on-site hydrogen supply and the work is funded by NFR. Organizations from several countries are participating, including among others Statoil, Tokyo Gas and GDF Suez.



National priorities



www.og21.org

Active involvement in OG21

Oil and gas in the 21st century (OG21) has elaborated a new strategy and the original eight Technology Target Areas (TTA) have been reduced to four:

1. Energy efficient and environmentally sustainable technologies
2. Exploration and increased recovery
3. Cost-efficient drilling and intervention
4. Future technologies for production, processing and transportation

Gas technology is mainly covered within the new TTA-4. Efforts are made from GTS for gas technology to be maintained as an important part of the OG21 strategy.

Energi21

Energi21 is the Norwegian strategy for energy research, development, demonstration and commercialization of industrial solutions. A report prepared by representatives from industry, government, universities and other research communities, among them SINTEF and NTNU, describes the industry's ambitions and goals for the 2010 strategy. One of the Technology Target Areas is further development of cost-effective solutions for CO₂ capture, transport and storage.



Contacts:

Contacts: Petter.Stoa@sintef.no

Arne.M.Bredsen@ntnu.no

www.energi21.no



Maritim21



From left: Tor Svensen, DNV; Elisabeth Grieg, Grieg Int.; Helle Hømmer, Cefor; Torfinn Kildal, Kongsberg Maritime; Harald Ellingsen, NTNU Marin; Tore Ulstein, Ulstein Group; Oddvar Eide, MARINTEK; Trygve Eiken, Wärtsilä; Tor S. Andersen, Røpp Marine; Yngvil Åsheim, NR and Trond Giske, NHD.

www.maritim21.no

Contact:

Erik.Dyrkoren@marintek.sintef.no

www.sintef.no/geonor

Marintek has been central in developing the Maritim21 strategy, in close co-operation with DNV, the Norwegian Ship Owners Association and over 100 Norwegian maritime companies. This document was handed to the Minister of Trade and Industry Trond Giske on 30th June 2010. LNG as a marine fuel is an important brick in the Maritim21 strategy and will therefore be a prioritized area for future publicly funded maritime R&D programs.

GeoNor, Industrial value creation in the Northern Areas

The feasibility study "GeoNor: Industrial value creation based on geological resources in the Northern Areas" was conducted in 2010 with financial support from the program Barents 2020 (administrated by the Ministry of Foreign Affairs), the 3 Northern counties and the Executive Committee for Northern Norway. The work has been conducted by Norut (Narvik og Alta), SINTEF Nord AS, Norges geologiske undersøkelse (NGU), NTNU and SINTEF.

The objective of the study has been to analyse in more depth the resource situation (both gas and minerals) in the region and explore the possibilities to develop specific industrial cases. It was also of interest to evaluate how the present framework affects the wanted development, in line with the ambitions that the governmental strategy for the Northern areas.



Internationalization

Strong participation at NFR Shanghai EXPO seminar

NFR arranged a seminar 21-22 May on renewable energy sources and CCS during the EXPO 2010 in Shanghai, China. The seminar presented major R&D actions and priorities in Norway and aimed to increase the collaboration between Norway and China on targeted R&D. NTNU and SINTEF were strongly represented among the presenters on all four covered topics; CCS, offshore wind, solar and hydropower.



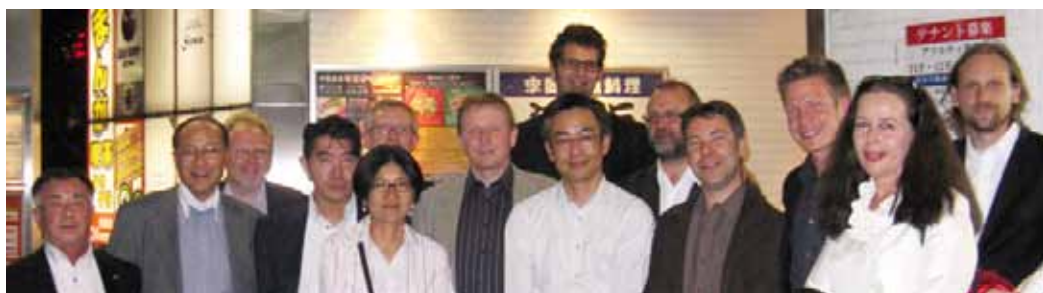
Prof. Ruzhu Wang,
Manager of the SJTU delegation

Contact:
Jens.Hetland@sintef.no

Joint Research Center between NTNU and Shanghai Jiao Tong University

NTNU (Thematic Strategic Area Energy) and Shanghai Jiao Tong University (SJTU) signed an Agreement on Joint Research Center in Sustainable Energy on May 26 2010. To develop the collaboration, two successful workshops took place in 2011, in Shanghai (May) and Trondheim (September). Projects within different areas were developed through scientific discussions and social activities, along with an intention to collaborate also on education. Related to gas, LNG technology was identified as particularly interesting area of interaction, but further areas may be included.

Contacts:
Arne.M.Bredesen@ntnu.no
Truls.Gundersen@ntnu.no



From left: Mr. Tani, Mr. Yasumi,
Prof. Blekkan, Mr. Ikeda, Prof. Norby,
Mr. Yokogawa, Mr. Lund, Mr. Pütz,
Mr. Hasegawa, Mr. Oftedal, Dr. Møller-Holst,
Mr. Simonsen, Ms. Oftedal and Mr. Kruse.

Collaboration Norway - Japan on hydrogen

A delegation counting around 10 Norwegian representatives, including industry, NTNU, SINTEF, UiO and Transnova visited Japan in October 2010. The visit was facilitated by the Norwegian Embassy and Innovation Norway's office in Tokyo. The program contained visits to research institutions and the major Japanese car manufacturers, Mazda, Toyota and Nissan. The objective was to consolidate bilateral cooperation in form of project activities, and to pave the way for receiving Japanese produced fuel cell vehicles to Norway.

Toyota's subsequent visit to Norway in spring 2011 may lead to deployment of Toyota's fuel cell vehicles in Norway. The collaboration will be continued under the auspice of an MoU between SINTEF and AIST (Japan), as well as within the newly developed Norwegian Environment Technology Center (NETC)-initiative. NETC is a joint effort towards Japan, Korea, Singapore and China. It includes Statoil, DnV, Innovation Norway and SINTEF and targets on key technology areas such as CCS, LNG and offshore wind.



SINTEF do Brasil

SINTEF is setting up a research foundation with headquarters in Rio de Janeiro in Brazil. The Instituto SINTEF do Brazil will play an important role in reinforcing SINTEF's position in the international research and development market and was officially opened on 17 February 2011 by Trond Giske, Norway's Minister of Trade and Industry. SINTEF's interest in Brazil is primarily due to a large and growing market for R&D in the petroleum sector, and collaborations with the oil companies Petrobras and Statoil in Brazil, as well as its research partners, are already in place.

Contact:
Oyvind.Hellan@sintefbrasil.org.br

NTNU delegation to India

A visit to India by a delegation from NTNU took place 6 - 12 February 2011. The main objective was to map research and educational cooperation with key partner institutions in India, in cooperation with Innovation Norway. The delegation consisted of nine professional groups, of which "Energy" was represented by Membrane technology for CO₂ capture and bio energy, Energy and society, Solar energy and Green innovation. The Energy group visited institutions in Chennai (former name Madras) and Delhi. The application of membranes developed in the Memfo group headed by Prof. May-Brit Hägg in the upgrading of biogas received particular interest.

Education

Prize for PhD theses

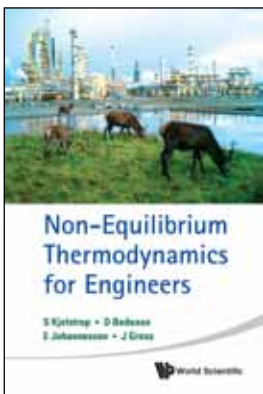
The PhD thesis of Kirill Glavatskiy on "Multicomponent Interfacial Transport : Described by the Square Gradient Model during Evaporation and Condensation" was awarded a Springer Prize as an exceptional thesis and was published by the Springer Publishing Company. The thesis deals with liquid/vapor phase transition. (ISBN: 9783642152665)

The PhD thesis of Isabella Inzolli on "Coupled Transports of Heat and Mass at the Surface of and inside Silicalite" came in second for the Ilya Prigogine Prize at the 10th Joint European Thermodynamics Conference in Copenhagen, Denmark. Inzolli studied gas adsorption in catalytic materials. This prize is awarded every second year.

Textbook on Non-Equilibrium Thermodynamics

Professors Signe Kjelstrup and Dick Bedeaux, Department of Chemistry, NTNU, Eivind Johannessen, Statoil, and Professor Joachim Gross, Univ. of Stuttgart, Germany, have published a textbook on *Non-Equilibrium Thermodynamics for Engineers*. The book is published by World Scientific. In his review Prof. Krzysztof J. Ptasiński, member of the EGY Book Review Panel, writes: "This book is one of the most significant contributions in the field of modern engineering thermodynamics."

Contacts:
Signe.Kjelstrup@chem.ntnu.no
Dick.Bedeaux@chem.ntnu.no



PhD theses in gas technology

The following list summarizes all candidates in gas technology that have been awarded the PhD degree at NTNU in 2010 and 2011.

Last name	First name	Dpt.*	Title
Bakhtiary	Hamidreza Davijany	IKP	Performance assessment of a packed bed microstructured reactor - heat exchanger for methanol synthesis from syngas
Borge	Tone	IKP	Development of hybride membrane materials (mixed matrix membranes)
Dupuy	Pablo Matías	IKP	Droplet Deposition in High-Pressure Natural-Gas Streams
Eirås	Sara Boulosa	IKP	Comparative study of selected catalysts for methane partial oxidation
Flaten	Ellen Marie	IKP	The effect of MEG (mono ethylene glycol) on the precipitation kinetics of calcium carbonate related to natural gas production from subsea wells
Shu	Zhi	IMT	Uncertainty Assessment of Wave Loads and Ultimate Strength of Tankers and Bulk Carriers in a Reliability Framework
Zhao	Dongju	IMT	Processing and properties of direct reduced iron pellets containing material for control of steel structure
Manum	Henrik	IKP	Simple implementation of optimal control for process systems
Weydahl	Torleif	EPT	A framework for mixing-reaction closure with the Linear Eddy Model
Berglihn	Olaf Trygve	IKP	Dynamic simulation on a thermodynamic canonical basis
He	Li	IKP	Sorption Enhanced Steam Reforming of Biomass-Derived Compounds: Process and Material
Hessen	Erik Troien	IKP	Thermodynamic models for CO ₂ absorption
Patruno	Luciano Emanuel	IKP	Experimental and Numerical Investigations of Liquid Fragmentation and Droplet Generation for Gas Processing at High Pressures
Rusten	Hans Kristian	IKP	Simulation and modelling of hydrogen production by sorption enhanced steam methane reforming in fixed bed reactors
de Leebeek	Angela	EPT	A Roll Wave and Slug Tracking Scheme for Gas-Liquid Pipe Flow
Nord	Lars	EPT	Pre-combustion CO ₂ capture: Analysis of integrated reforming combined cycle
Baumann Ofstad	Axel	IMT	Increasing the Lifetime of PEM Fuel Cells: A Characterization of some Degradation Mechanisms
Lervik	Ingrid Anne	IMT	Electrocatalysis of the Oxygen Evolution Reaction. A comparative study of Anodically Formed and Nanostructured Iridium Oxides
Akhtar	Shahid	IMT	Hydrogen porosity in Al-Si foundry alloys
Myklebust	Jogeir	IØT	Techno-economic modelling of value chains based on natural gas – with consideration of CO ₂ emissions
Aronu	Ugochukwu Edwin	IKP	Amine and amino acid absorbents for CO ₂ capture
Eide-Haugmo	Ingvild	IKP	Environmental impacts and aspects of absorbents used for CO ₂ capture
Hayer	Fatemeh.	IKP	Direct Synthesis of Dimethyl Ether in Microstructured Reactors
He	Xuezhong	IKP	Development of Hollow Fiber Carbon Membranes for CO ₂ Separation
Huang	Fan	IKP	3D Carbon/polyaniline Nanostructures for Energy Storage
Phan	Xuyen Kim	IKP	Catalyst formulations for use in microstructured reactors for conversion of synthesis gas to liquids
Yang	Jia	IKP	A Steady-State Isotopic Transient Kinetic Study of Cobalt Catalysts: Mechanistic understanding of the Effects of Cobalt Particle Size, Supports and Promoters
Mihai	Oana	IKP	Partial Oxidation of Methane by Chemical Looping
Tsakoumis	Nikolaos	IKP	Deactivation of Cobalt based Fischer-Tropsch Catalysts
Kazi	Saima Sultana	IKP	Calcium based CO ₂ acceptors for sorption enhanced steam methane reforming)
Zakeri	Ali	IKP	Characterization of packing materials for CO ₂ absorption
Panahi	Mehdi	IKP	Plantwide control for economically optimal operation of chemical plants – Applications to GTL plants and CO ₂ capturing processes
Seteklev	Alf Eddie	IKP	Experimental characterization of column internals at low and elevated pressures
Karimi	Mehdi	IKP	CO ₂ capture and power production integration; optimization and conceptual design studies
Bruder	Peter	IKP	Solvent development and testing for postcombustion carbon dioxide capture
Petar	Aleksic	EPT	Experimental investigation of thermal effects in a hydrogen cryo-adsorption storage system
Olaf	Brekke	EPT	An Experimental Investigation of Offshore Gas Turbine Intake Air Filter Performance

* EPT - Department of Energy and Process Engineering, IPT - Department of Petroleum Engineering and Applied Geophysics, IKJ - Department of Chemistry, IKP - Department of Chemical Engineering, IMT - Department of Marine Technology, IØT - Department of Industrial Economics and Technology Management



ROOKIE - Integrated Operations Field Laboratory

Contact:
Michael.Golan@ntnu.no

Operations lab at NTNU where students have access to live data and remote control and monitoring of two gas wells in Oklahoma – a unique hands-on education experience.

IEAGHG International CCS Summer School



The Summer School 2010 was arranged on 22-28 August by GTS in collaboration with BIGCCS, SUCCESS and UNIS. The venue for the summer school was the town Longyearbyen in Svalbard at 78°N. 56 students from 32 countries, and 30 expert lecturers and mentors attended the one-week programme. The target group for the summer school was young scientists, e.g. PhD students and Post docs with background in engineering, geo-technologies, socio-economics. The goal was to provide students with diverse backgrounds a broad understanding of CCS and encourage their active participation in this area.

(IEAGHG - The IEA Greenhouse Gas R&D Programme)

Contact: Maria.Barrio@sintef.no
www.ntnu.no/gass

Picture: Atle Mørk, SINTEF (red jacket, centre), demonstrates some sandstone drill cores. Adventdalen outside Longyearbyen is the site of Norway's first experiment designed to investigate full-scale CO₂ storage technology. Photo: A. Lilliestråle

CCS website



GTS has during 2010 produced an educational website on CCS. The website covers all aspects of CCS; from capture to transport and storage. It provides in depth knowledge about gas separation technology, thermodynamics, etc., necessary for public with a general technical background to understand the main principles behind CCS.

www.ntnu.no/ccs

Student excursions to Tjeldbergodden and Melkøya



In 2010, GTS, in collaboration with Statoil, organized a student excursion to Statoil Tjeldbergodden, one of the world's largest and most modern methanol plants. In 2011, the student excursion went to Statoil Melkøya, the first production plant of LNG in Europe. Both years 12 MSc and PhD students from different engineering schools at NTNU participated in the 5 day programme. The purpose was to give the students an understanding of how a modern processing plant is operated.

Contact:
Hilde.J.Venik@chemeng.ntnu.no
www.ntnu.no/gass

Students at Tjeldbergodden. Photo: D. Gunawardana

Natural gas subject

www.ipt.ntnu.no/~jsg
www.ntnu.no/studier/emner/
TPG4140

The Natural gas subject became part of the curricula at NTNU in 2010 and was held in english with invited lecturers from both academia and industry. Around 80 students completed the course in 2010.



Internal events

Technical seminar series arranged by GTS:

Eirik Falck da Silva, SINTEF Materials and Chemistry, 18 February 2010:

Environmental impact of CO₂ capture solvents

Sivert Vist, Statoil, 26 April 2010:

Experience from start-up and operation of Europe's first and the world's northernmost LNG plant

Anders H. Strømman, NTNU, 11 May 2010:

Life Cycle Assessment of Carbon Capture and Storage Processes

Baraka Celestin Sempuga, University of Witwatersrand, South Africa, 14 September 2010:

Making the impossible possible through clever use of thermodynamics:

Using thermodynamics in a new way to design innovative and energy efficient processes - from combustion to natural gas liquefaction

Michael Golan, NTNU, 2 November 2010:

GTS in collaboration with the Petroleum Centre of Better Resource Utilization:

Technological challenges of shale gas exploitation

Unni Olsbye, University of Oslo, 23 November 2010:

Catalytic processes "in the GAP" from macro- to nano-science

Henning Struchtrup, University of Victoria, Canada, 7 September 2011:

Macroscopic Modelling of Rarefied and Vacuum Gas Flows

Dag Stenersen, SINTEF Marin, 28 September 2011:

Gas fuelled ships

Sverre Diesen, Senter for Strategiske Studier, 27 October 2011:

Ambisjoner, aktivitet og aktører - Den strategiske balansen i nordområdene i bevegelse

The seminars were attended by 30-50 scientists and students from NTNU and SINTEF as well as representatives from industry working with gas technology R&D.



www.ntnu.no/gass/seminars





Gas Technology Centre NTNU-SINTEF



Associate Professor
Hilde Venvik
+ 47 73 59 28 31
Hilde.J.Venvik@chemeng.ntnu.no



Vice President Gas Technology
Maria Barrio
+ 47 73 59 42 75
Maria.Barrio@sintef.no

Coordinator: Torstein G. Skarsgard, torstein.skarsgard@ntnu.no

Visiting address: Sem Saelands vei 11, Trondheim , Norway
www.ntnu.no/gass www.sintef.no/gass

Strategic partner:

