PhD Programme
Process, Energy and Automation Engineering

Annual Report 2018

University of South-Eastern Norway
Process, Energy, and Automation Engineering

University of South-Eastern Norway (USN) has approximately 18 000 students and 1600 employees. The PhD programme in Process, Energy and Automation Engineering was established in 2009. 8 candidates were awarded the PhD degree in 2018 and 28 PhD students were enrolled in the programme at the end of the year. The programme is mainly affiliated with Department of Process, Energy and Environmental Technology and Department of Electrical Engineering, Information Technology and Cybernetics at USN.

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Faculty of Technology, Natural Sciences and Maritime Sciences
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PhD programme committee 2018:

Prof. Klaus-Joachim Jens (chairman)
Prof. Britt M. E. Moldestad
Prof. Magne Waskaas ² / Prof. Bernt Lie ²
Per Morten Hansen ³ / Nora C.I. Furuvik⁴ (PhD students)
Helga Veronica Tinnesand⁵ / Cathrine H. Fagerli⁹ (PhD programme administrator)
Prof. Lars-André Tokheim⁷ / Cathrine H. Fagerli⁸ (PhD programme coordinator)

Report by:

Siri Luise Tveitan
PhD Coordinator
Email: siril.tveitan@usn.no

Per Morten Hansen,
Associate Professor
Email: Per.M.Hansen@usn.no

¹ Until September 2018
² From September 2018
³ Until October 2018
⁴ From October 2018
⁵ Until September 2018
⁶ From September 2018
⁷ Until September 2018
⁸ From September 2018
⁹ Until October 2018
Personnel affiliated with the PhD programme

**Academic staff**

Rune Bakke (Prof.)
Wenche H. Bergland (Assoc. Prof.)
Dag Bjerketvedt (Prof.)
David L. Di Ruscio (Assoc. Prof.)
Carlos A. S. Dinamarca (Assoc. Prof.)
Marianne S. Eikeland (Assoc. Prof.)
Dag-Arne Eimer (Adj. Prof.)
Geir Elseth (Adj. Assoc. Prof.)
André V. Gaathaug (Assoc. Prof.)
Bjørn Glemmestad (Adj. Assoc. Prof.)
Svein Thore Hagen (Prof.)
Maths Halstensen (Assoc. Prof.)
Finn Aa. Haugen (Docent)
Gunne J. Hegglid (Adj. Prof.)
Klaus-Joachim Jens (Prof.)
Bernt Lie (Prof.)
Svein O. Linge (Prof.)
Joachim Lundberg (Assoc. Prof.)
Ola Marius Lysaker (Prof.)
Morten C. Melaaen (Prof.)
Britt M. E. Moldestad (Prof.)
Saba Mylvaganam (Prof.)
Carlos Pfeiffer (Prof.)
Chandana Ratnayake (Adj. Prof.)
Wilhelm G. J. Rondeel (Adj. Prof.)
Roshan Sharma (Assoc. Prof.)
Nils-Olav Skeie (Assoc. Prof.)
Rajan K. Thapa (Assoc. Prof.)
Lars-André Tokheim (Prof.)
Håkon Viumdal (Assoc. Prof.)
Knut Vågsæther (Prof.)
Eshetu Janka Wakjera (Researcher)
Magne Waskaas (Prof.)
Lars Erik Øi (Prof.)

**PhD students**

Cornelius E. Agu
Christian Ahoba-Sam
Hassan Ali
Ronnie J. R. Anseth
Shadi Attar
Janitha Bandara
Christian Berg
Ole Magnus Brastein
Khim Chhantyal
Mahesh P. Ediriweera
Nora C.I. Furuvik
Nirmal Ghimire
Per Morten Hansen
Ingrid Bokn Haugland
Mathias R. Henriksen
M. H. Wathsala N. Jinadasa
M. Asanthi M. Jinasena
Morten H. Jondahl
Amila C. Kahawalage
Sumudu Karunarathne
Helge Lorenen
Samee Maharjan
Anjana T. Malagalage
Laura A. Marcano
Shohreh Monshizadeh
Anirudh B. T. Nelabhotla
J. Manjula Edirisinghe V. P.
Veralia G. Sánchez
Michał Sposob
Fasil A. Tassew
Ramesh Timsina
Ludmila Vesjolaja
Juan Ignacio Videla
Liubomyr Vytvytskyi
Prasanna K. W. Welahettige
Thomas Øyvang
Postdoc fellows

Gamunu Samarakoon Arachchige (PhD)

Technical and administrative staff (shared with other USN units)

Cathrine H. Fagerli (Adviser)
Eivind Fjeldalen (Head Engineer)
Per Kristian Fylkesnes (Head Engineer)
Fredrik Hansen (Senior Engineer)
Hildegunn H. Haugen (Senior Engineer)
Svein Thore Hagen (Department Head, Electrical Eng., Information Tech. and Cybernetics)
Klaus-Joachim Jens (Department Head, Process, Energy and Environmental Technology)
Øyvind Johansen (Head Engineer)
Arve Lorentzen (Senior Engineer)
Morten C. Melaaen (Dean)
H. Veronica Tinnesand (Senior Adviser)

PhD dissertations 2018

2018-1: Christian Ahoba-Sam: "Low temperature methanol synthesis catalysed by a copper nanoparticle-alkoxide system" (main supervisor: Prof. Klaus-Joachim Jens)

2018-2: Anjana Tharanga Malagalage: "Pneumatic conveying and storage of wet particles to illustrate offshore drill cutting handling" (main supervisor: Adj. Prof. Chandana Ratnayake)

2018-3: Khim Chhantyal: "Sensor Data Fusion based Modelling of Drilling Fluid Return Flow through Open Channels" (main supervisor: Prof. Saba Mylvaganam)

2018-4: Michał Sposob: "Biological hydrogen sulfide removal with nitrate" (main supervisor: Assoc. Prof. Carlos Dinamarca)

2018-5: Per Morten Hansen: "Experimental and theoretical studies of rapid phase transitions in CO2" (main supervisor: Prof. Knut Vågsæther)

2018-6: Ronnie Joakim Ramsdal Anseth: "Online monitoring of fouling layers in pipeworks with Electrical Impedance Spectroscopy" (main supervisor: Prof. Magne Waskaas)


2018-8: Thomas Øyvvang: "Enhanced power capability of generator units for increased operational security" (main supervisor: Prof. Bernt Lie)
Research groups
Five research groups are affiliated with the PhD programme, these are listed alphabetically and described below.

Energy and CO₂ Capture (ECC)
The research group *Energy and CO₂ capture* (headed by Prof. Rune Bakke) is doing research on solutions required for the society to switch from fossil fuel based energy dependence to a carbon neutral energy matrix. This transition requires parallel efforts on:

- Reduction in waste of energy by implementation of more efficient processes, buildings etc., applying analysis of energy systems and thermodynamics
- Transition measures to reduce the environmental impacts of exploration and utilization of fossil resources and adapting such for growing renewable fractions
- Carbon capture and sequestration (CCS) from point source emissions
- Technology to support more use of carbon neutral renewable energy

The overall goal of the ECC research group is to make significant contributions to innovative solutions to the climate challenge, developing concepts for robust energy matrices and reducing the environmental impact of energy technology. Visit our dedicated CO₂ research website to learn more about us: [www.co2-lab.com](http://www.co2-lab.com)

USN is a partner in "Bio4Fuels", a Norwegian Centre for Environment-friendly Energy Research (FME). The Centre aims to develop technology for conversion of biomass and different types of organic residues to sustainable fuels and energy.

Hydro Power, Transmission and Distribution (HPTD)
The group *Hydro Power, Transmission and Distribution* (headed by Prof. Svein Thore Hagen) is doing research on methods to produce more electrical power from the Norwegian hydropower system. This may be achieved by mathematical models or improved measuring techniques. It is also important to ensure reliable transmission and distribution of electrical power to all customers. Many components in the grid may be highly stressed, caused by e.g. high temperatures.

USN also participates in the Norwegian Research Centre for Hydropower Technology – HydroCen, another Centre for Environment-friendly Energy Research (FME). The main objective of HydroCen is to enable the Norwegian hydropower sector to meet complex challenges and exploit new opportunities through innovative technological solutions.

Thomas Øyvang took over the responsibility as head of the HPTD research group in January 2019.
Telemark Process Safety, Combustion and Explosion Laboratory (TPSCEL)

The research group Telemark Process Safety, Combustion and Explosion Laboratory (headed by Prof. Dag Bjerketvedt) is doing research on explosions and other rapid phenomena controlled by flow, heat transfer and chemical reactions. The aim is to improve safety in the society. The research focuses mainly on; i) experimental investigations, ii) numerical computations (CFD) and iii) image processing.

USN is a partner in the FME "Mobile Zero Emission Energy Systems" (MoZEES). The objective of the centre is development of new battery and hydrogen technology for existing as well as future transport applications, on road, rail, and sea.

Self-Monitoring, Analysis and Reporting Technologies (SMART)

The main area for the SMART research group (headed by Assoc. Prof. Nils-Olav Skeie) is optimizing the energy consumption and usage of welfare technology in smart buildings.

The aim of the research group is to develop mathematical models for Self-Monitoring, Analysis and Reporting Technologies (SMART), so as to let models be able to learn from the monitoring and analysis part. These adaptive models can be based on mechanistic (“white”) models and empiric (“black”) models, either as “grey” models or for different usage in the calibration steps of the models. The models should adapt to the way humans are living; humans should not adapt to the functions of a smart building. Applications within the energy consumption area and welfare technology have a lot of common research challenges related to smart buildings.

Telemark Modeling and Control Center (TMCC)

TMCC (headed by Prof. Bernt Lie) is doing research on generic methods within sensor technology, industrial IT, model development with the main emphasis on dynamic models, and model-based analysis and synthesis. Analysis and synthesis include e.g. computational tools and simulation, optimization, design of control systems, monitoring and fault detection. A core idea for TMCC is the transfer of methods and tools between various application areas. TMCC also participates in the HydroCen FME, which was mentioned in the HPTD section.
Cross-faculty research groups
Personnel affiliated with the PEA programme also participate in two cross-faculty research groups which are described below.

*AQUA-USN*

The members of the water research group are from the Department of Environmental and Health Studies and the Department of Process, Energy and Environmental Technology. Research topics are limnology, hydrogeology, hydrology, drinking water, sewage water and sludge treatment, bioenergy, extraction of phosphorus from sewage sludge, fish and fisheries, and ecotoxicology.

*Community Health Care Services to Older People*

The group emphasizes research concerning care to older people in the community healthcare services. It has a strong, but not exclusive focus on patient safety and user involvement in nursing homes and the home care services. To ensure relevance for practice, research is conducted in close collaboration with the community health care services.

The group is a partner of Centre for Caring Research, Southern Norway; a government-supported centre run by the University of South-Eastern Norway in collaboration with the University of Agder. The faculty is involved in the project “Toward a safe home living – behavioural classification as a method to detect unusual behaviour for people living alone”. The main goal of this project is to identify and describe the requirements for a sensor-based behaviour classification system for a safer home living of old and disabled persons living alone.
Research areas

USN is doing research within several different areas, and those related to the PEA programme are listed alphabetically and described below.

Alternative Fuels

Alternative fuels can be utilized in the industry to reduce the consumption of fossil fuels. Net emissions of pollutants such as CO\(_2\) and NO\(_x\) may be reduced, and in many cases the replacement of coal or other fossil fuels is also economically sound for the industry. Moreover, since many alternative fuels are based on waste streams, increased use of such waste-based fuels contributes in solving a waste problem in the society.

CO\(_2\) Capture

The overall goal of our work on CO\(_2\) capture is to find innovative solutions to the climate challenge. This means finding new solutions as well as improving existing ones with regard to optimization of the CO\(_2\) capture process and related environmental challenges. It furthermore comprises collection and transportation solutions for captured CO\(_2\).

Environmental Biotechnology

The environmental biotechnology research focus is on resource recovery, organic waste and water treatment, combined with biofilm research. The work includes fundamental research as well as applied activities.

Gas Explosions and Technical Safety

The focus is on experimental and numerical investigation of pre-mixed combustion, dispersion, ignition, explosions and shock waves in various types of processes, equipment and systems.

Industrial Applications of Electromagnetics

Research in this group is dedicated to modern industrial applications of electromagnetism. The approach is based on solving Maxwell’s equations for static, quasi-static, and dynamic phenomena. The different applications currently being studied are induction heating, quasi-static analysis of sensors exploiting electromagnetic phenomena, estimating parameters of complex cable structures. Subgroups are doing research on electric drive modelling, energy loss reduction, gas-insulated switchgears, induction heating and tomography.

Industrial Automation Applications

Industrial Automation Applications include the use of sensor technology, industrial IT, modelling and simulation, estimation and monitoring, and control and optimization. Different groups are doing research on applied chemometrics, hydropower control, offshore applications, and process control.
Industrial Automation Methods

Industrial Automation Methods include methodological research within the areas of sensor technology, industrial IT, modelling and simulation, estimation and monitoring, and control and optimization. There are groups doing research on model predictive control, sensor technology, state estimation and system identification.

Industrial Flow Processes

Different flow systems are studied using experimental measurement techniques and computational fluid dynamics (CFD). Most of the experimental studies are performed using laser-based techniques such as Laser Doppler Anemometry (LDA), Phase Doppler Anemometry (PDA) and Particle Image Velocimetry (PIV), but other measurement techniques are applied as well.

Powder Science and Technology

The research and development work includes all aspects of handling, storing, processing, separating, and characterizing particulate materials. The research is carried out in cooperation with SINTEF Industry.
Publications 2018


Agu, Cornelius Emeka; Pfeifer, Christoph; Eikeland, Marianne Sørflaten; Tokheim, Lars Andre; Halvorsen, Britt Margrethe. Models for Predicting Average Bubble Diameter and Volumetric Bubble Flux in Deep Fluidized Beds. Industrial & Engineering Chemistry Research 2018; Volume 57. (7) pp 2658-2669

Agu, Cornelius Emeka; Tokheim, Lars-Andre; Eikeland, Marianne Sørflaten; Moldestad, Britt Margrethe Emilie. Improved Models for Predicting Bubble Velocity, Bubble Frequency and Bed Expansion in a Bubbling Fluidized Bed. Chemical engineering research & design 2018; Volume 141. pp 361-371

Ahoba-Sam, Christian; Boodhoo, Kamelia V.K.; Olsbye, Unni; Jens, Klaus-Joachim. Tailoring Cu nanoparticle catalyst for methanol synthesis using the spinning disk reactor. Materials 2018; Volume 11:154. (1) pp 1-12


Andersen, Marius; Sætre, Kai Arne; Fredriksen, Siw; Pfeiffer, Carlos. Simulation of the Pyrolysis Process: from Plastic Waste to Environmental Friendly Fuel. Linköping Electronic Conference Proceedings 2018 (153) pp 303-307

Anene, Azubuike Francis; Fredriksen, Siw Bodil; Sætre, Kai Arne; Tokheim, Lars-Andre. Experimental study of thermal and catalytic pyrolysis of plastic waste components. Sustainability 2018; Volume 10. (11)

Anseth, Ronnie; Skeie, Nils-Olav; Waskaas, Magne. Monitoring of fouling within pipes using Electrical Impedance Spectroscopy. TM. Technisches Messen 2018; Volume 85. (10) pp 627-634

Anseth, Ronnie; Skeie, Nils-Olav; Waskaas, Magne. Preliminary studies on monitoring fouling layers on a charged electrode using Electrical Impedance Spectroscopy. TM. Technisches Messen 2018; Volume 85. (2) pp 137-146

Attar, Shadi; Haugen, Finn. Comparison of different state estimator algorithms applied to a simulated anaerobic digestion reactor. Linköping Electronic Conference Proceedings 2018 (153) pp 118-125


Barczi, Tomas; Kohout, Martin; Kozakovic, Martin; Havlica, Jaromir; Ratnayake, Chandana. Discrete Element Method Simulation and Experimental Validation of Pattern Development in a Rotating Drum Mixer. Chemical Engineering & Technology 2018; Volume 41. (8) pp 1524-1530

Bernhardsen, Ida Mortensen; Perinu, Cristina; Jens, Klaus-Joachim; Pinto, Diego Di Domenico; Knuttila, Hanna K. Absorption and Desorption Study of Alkylamine Promoted DEEA Solvents for CO2 Capture. Chemical Engineering Transactions 2018; Volume 69. pp 193-198

Brastein, Ole Magnus; Perera, Degurunnehalage Wathsala U.; Pfeiffer, Carlos; Skeie, Nils-Olav. Parameter estimation for grey-box models of building thermal behaviour. Energy and Buildings 2018; Volume 169. pp 58-68


Dalen, Christer; Di Ruscio, David Luigi. Performance optimal PI controller tuning based on integrating plus time delay model. Algorithms 2018; Volume 11. (6)


Dupre, Antoine; Mylvaganam, Kanagasabapath. A Simultaneous and Continuous Excitation Method for High-Speed Electrical Impedance Tomography with Reduced Transients and Noise Sensitivity. Sensors 2018; Volume 18. (4) pp 1-14


Eshetu Moges, Melesse; Todt, Daniel; Wakjera, Eshetu Janka; Heistad, Arve; Bakke, Rune. Sludge blanket anaerobic baffled reactor for source-separated blackwater treatment. Water Science and Technology 2018; Volume 78. (6) pp 1249-1259
Halvorsen, Hans-Petter; Grytten, Ola Anton; Svendsen, Martin Veel; Mylvaganam, Kanagasabapath. Environmental Monitoring with focus on Emissions using IoT Platform for Mobile Alert. I: Proceedings of the EAEIE (European Association for Education in Electrical and Information Engineering). IEEE conference proceedings 2018

Hansen, Per Morten; Gaathaug, Andre Vagner; Bjerketvedt, Dag; Vågsæther, Knut. Blast from pressurized carbon dioxide released into a vented atmospheric chamber. Shock Waves 2018; Volume 28. (5) pp 1053-1064


Haugen, Finn. Simulations and real applications of PI and MPC averaging level control in a water resource recovery facility. Linköping Electronic Conference Proceedings 2018 (153) pp 297-302

Haugland, Ingrid Bokn; Chladek, Jana; Halstensen, Maths. A feasibility study of real-time monitoring techniques for scale deposition thickness in pneumatic conveying pipelines. Particulate Science and Technology 2018; Volume 36. (4) pp 481-488

Haugland, Ingrid Bokn; Halstensen, Maths. A Technique for Obtaining Reference Measurements to Calibrate Deposition Models for Pipelines. Chemical Engineering & Technology 2018; Volume 41. (8) pp 1538-1543

Henriksen, Mathias; Gaathaug, Andre Vagner; Lundberg, Joachim. Determination of underexpanded hydrogen jet flame length with a complex nozzle geometry. International journal of hydrogen energy 2018 pp 1-9

Idris, Zulkifli; Kummamuru, Nithin Bharadwaj; Eimer, Dag-Arne. Viscosity Measurement and Correlation of Unloaded and CO2-Loaded 3-Amino-1-propanol Solution. Journal of Chemical and Engineering Data 2018; Volume 63. (5) pp 1454-1459


Jayarathna, Chameera; Chladek, Jana; Balse, Michael; Halvorsen, Britt Margrethe; Tokheim, Lars-Andre. Impact of solids loading and mixture composition on the classification efficiency of a novel cross-flow fluidized bed classifier. Powder Technology 2018; Volume 336. pp 30-44


Jinasena, Asanthi; Sharma, Roshan. Model based Real-Time Flow Rate Estimation in Open Channels with Application to Conventional Drilling. International Conference on Control, Automation and Systems 2018 pp 546-551

Kaluarachchige, Hiromi Ariyaratne Wijesinghe; Ratnayake, Chandana; Melaaen, Morten Christian. CFD modeling of dilute phase pneumatic conveying in a horizontal pipe using Euler–Euler approach. Particulate Science and Technology 2018 pp 1-9


Lohani, Sunil Prasad; Wang, Shuai; Bergland, Wenche Hennie; Bakke, Rune; Østgaard, Kjetil; Bakke, Ingrid. Mapping anaerobic sludge bed community adaptations to manure supernatant in biogas reactors. Scientific Reports 2018; Volume 8.

Malagalage, Anjana Tharanga; Kaluarachchige, Hiromi Ariyaratne Wijesinghe; Ratnayake, Chandana; Melaaen, Morten Christian. Experiments and Simulations for Horizontal Pneumatic Transport of Dry Drill Cuttings. Chemical Engineering & Technology 2018; Volume 41. (8) pp 1531-1537

Malagalage, Anjana Tharanga; Ratnayake, Chandana; Saasen, Arild; Thomassen, Tonje W.; von Hafenbradl, Franz O. Flow properties of drill cuttings with varying drilling fluid content using Jenike Shear testing. Chemical Engineering & Technology 2018; Volume 41. (8) pp 1544-1550

Marcano, Laura; Yazidi, Anis; Manca, Davide; Komulainen, Tiina M. Using the concept of data enclosing tunnel as an online feedback tool for simulator training. Linköping Electronic Conference Proceedings 2018 (153) pp 132-139 OSLOMET USN

Minkkinen, Pentti; Esbensen, Kim H. Sampling of particulate materials with significant spatial heterogeneity - Theoretical modification of grouping and segregation factors involved with correct sampling errors: Fundamental Sampling Error and Grouping and Segregation Error. Analytica Chimica Acta 2018; Volume 1049. pp 47-64

Nelabhotla, Anirudh Bhanu Teja; Saldivar Dinamarca, Carlos Antonio. Electrochemically mediated CO2 reduction for bio-methane production: a review. Reviews in Environmental Science and Biotechnology 2018; Volume 17. (3) pp 531-551

Nordgård, Anna Synnøve Røstad; Bergland, Wenche Hennie; Bakke, Rune; Østgaard, Kjetil; Bakke, Ingrid. Mapping anaerobic sludge bed community adaptations to manure supernatant in biogas reactors. Scientific Reports 2018; Volume 8.

Perera, Colombage Kshanthi Kalyani; Kumara, WAS; Hansen, Fredrik; Mylvaganam, Kanagasabapath; Time, Rune Wiggo. Comparison of gamma densitometry and electrical capacitance measurements applied to hold-up prediction of oil–water flow patterns in horizontal and slightly inclined pipes. Measurement science and technology 2018; Volume 29:065102. (6) pp 1-17


Perinu, Cristina; Bernhardsen, Ida Mortensen; Pinto, Diego Di Domenico; Knuutila, Hanna K; Jens, Klaus-Joachim. NMR Speciation of Aqueous MAPA, Tertiary Amines, and Their Blends in the Presence of CO2: Influence of

Pirir, Ivan; Jinasena, Asanthi; Sharma, Roshan. A dynamic model for drain back to active mud pit combined with a well model during drilling. Journal of Petroleum Science and Engineering 2018; Volume 167. pp 803-818


Solli, Kjell-Arne; Thapa, Rajan Kumar; Moldestad, Britt Margrethe Emilie. Screening of Kinetic Rate Equations for Gasification Simulation Models. Linköping Electronic Conference Proceedings 2018 (142) pp 105-112

Sposob, Michal; Cydzik-Kwiatkowska, Agnieszka; Bakke, Rune; Dinamarca, Carlos. Temperature-induced changes in a microbial community under autotrophic denitrification with sulfide. Process Biochemistry 2018; Volume 69. pp 161-168

Sund, Sveinung Martinus; Plouvier, Marianne; Lie, Bernt. Comparison of simulation tools for dynamic models. Linköping Electronic Conference Proceedings 2018 (153) pp 177-184


Torsen, Arne O.; Smistad, Harris J.; Tveit, Håkon; Hansen, Ole C.; Bjørtuft, Vegard G.; Furuvik, Nora C.I.; Moldestad, Britt M.E. Simulation of CO2 storage in the North Sea. Linköping Electronic Conference Proceedings 2018 (153) pp 255-262


Vytvytskyi, Liubomyr; Lie, Bernt. Mechanistic model for Francis turbines in OpenModelica. IFAC-PapersOnLine 2018; Volume 51. (2) pp 103-108

Vågsæther, Knut; Gaathaug, Andre Vagner; Bjerketvedt, Dag. PIV-measurements of reactant flow in hydrogen-air explosions. International journal of hydrogen energy 2018; Volume 44. (17) pp 8799-8806


Winkler, Dietmar. Analysing the stability of an islanded hydro-electric power system.
Wen, Qinxue; Ji, Ye; Hao, Yaru; Huang, Long; Chen, Zhiqiang; Sposob, Michal. Effect of sodium chloride on polyhydroxyalkanoate production from food waste fermentation leachate under different organic loading rate. Bioresource Technology 2018; Volume 267. pp 133-140


Øi, Lars Erik; Sætre, Kai Arne; Hamborg, Espen Steinseth. Comparison of simulation tools to fit and predict performance data of CO2 absorption into monoethanol amine at CO2 Technology Centre Mongstad (TCM). Linköping Electronic Conference Proceedings 2018 (153) pp 230-235

Øyvang, Thomas; Hegglid, Gunne John; Lie, Bernt. Models of synchronous generators with excitation system, for transient power system studies. IFAC-PapersOnLine 2018; Volume 51. (2) pp 91-96

Øyvang, Thomas; Nøland, Jonas Kristiansen; Hegglid, Gunne John; Lie, Bernt. Online Model-Based Thermal Prediction for Flexible Control of an Air-Cooled Hydrogenerator. IEEE transactions on industrial electronics 2018; Volume S. (99) pp 6311-6320

National scientific publication points gained since the start-up of the PhD programme. (PEM = Department of Process, Energy and Environmental Technology; EIK = Department of Electrical Engineering, Information Technology and Cybernetics.)
## Enrolled PhD students and their research topics (December 31. 2018)

<table>
<thead>
<tr>
<th>PhD student</th>
<th>Research topic</th>
<th>Main supervisor</th>
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<tbody>
<tr>
<td>Cornelius E. Agu</td>
<td>Biofuel production via gasification</td>
<td>Britt M. E. Moldestad</td>
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<tr>
<td>Hassan Ali</td>
<td>Cost estimation of partial CO(_2) capture</td>
<td>Lars Erik Øi</td>
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<tr>
<td>Shadi Attar</td>
<td>Model-based monitoring and control of biogas reactors in wastewater treatment plants</td>
<td>Finn Aa. Haugen</td>
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<td>Janitha C. Bandara</td>
<td>Simulation and parameter optimization of fluidized bed biomass gasification</td>
<td>Marianne S. Eikeland</td>
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<tr>
<td>Christian Berg</td>
<td>Modeling for automatic control and estimation of influx and loss during drilling operations</td>
<td>Bernt Lie</td>
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<td>Ole Magnus Brastein</td>
<td>Adaptive calibration of mathematical models for energy usage in buildings</td>
<td>Nils-Olav Skeie</td>
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<td>Mahesh P. Ediriweera</td>
<td>A study of corrosive wear in gas-particle systems</td>
<td>Chandana Ratnayake</td>
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<tr>
<td>Nora C.I. Furuvik</td>
<td>Modelling of ash melts in gasification of biomass</td>
<td>Britt M. E. Moldestad</td>
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<tr>
<td>Nirmal Ghimire</td>
<td>Anaerobic digestion of lignocellulosic substrate for biogas</td>
<td>Wenche H. Bergland</td>
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<tr>
<td>Mathias R. Henriksen</td>
<td>Combustion properties of vented materials from Li-ion batteries – Battery Safety</td>
<td>Dag Bjerketvedt</td>
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<tr>
<td>M. H. Wathsala N. Jinadasa</td>
<td>Process analytical technology applied to CO(_2) solvents</td>
<td>Maths Halstensen</td>
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<tr>
<td>M. Asanthi M. Mahesha Jinasena</td>
<td>Models and estimators for flow of topside drilling fluid</td>
<td>Roshan Sharma</td>
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<tr>
<td>Morten H. Jondahl</td>
<td>Estimation of flow rate and rheological properties of drilling fluids, using multi sensor data fusion</td>
<td>Håkon Viiumdal</td>
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<tr>
<td>Amila C. Kahawalage</td>
<td>Optimized and increased use of refuse derived fuel in cement kilns</td>
<td>Lars-André Tokheim</td>
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<td>Sumudu Karunaratne</td>
<td>Physiochemical data for amine based CO(_2) capture process</td>
<td>Lars Erik Øi</td>
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<td>Helge Lorenzen</td>
<td>Real time observation and analysis of GRID signals for optimal control of GRID performance</td>
<td>Saba Mylvaganam</td>
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<td>Samee Maharjan</td>
<td>An image-processing framework for high-speed films from combustion and gas explosion experiments</td>
<td>Ola Marius Lysaker</td>
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<tr>
<td>Laura A. Marcano</td>
<td>Process simulation and learning technologies</td>
<td>Tiina Komulainen (HiOA)</td>
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<tr>
<td>Shohreh Monshizadeh</td>
<td>Flexible hydropower unit - Power system analysis and impact on power losses and operational security</td>
<td>Gunne J. Hegglid</td>
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<tr>
<td>Anirudh B. T. Nelabhotla</td>
<td>Electrochemical unit integration in methanogenic reactors</td>
<td>Carlos Dinamarca</td>
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<tr>
<td>J. Manjula Edirisinghe V. P.</td>
<td>Transient stability in high voltage power systems</td>
<td>Gunne J. Hegglid</td>
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<td>Veralia G. Sánchez</td>
<td>Smart house technology (Behavior classification as a method to detect unusual behavior for people living alone)</td>
<td>Nils-Olav Skeie</td>
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<tr>
<td>Name</td>
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<td>Supervisor</td>
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<td>Fasil A. Tassew</td>
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Ongoing research projects

**Sulphide removal from wastewater streams (2013-2018)**

The project is conducted by USN with the support of YARA AS and a public PhD position. This is a study of fundamental mechanisms, design and optimization of fluidized bed biological sulphide removal. A PhD student was engaged in the project in 2014. The project leader is Assoc. Prof. Carlos Dinamarca. Dr. Dinamarca is co-advising the PhD student together with Prof. Rune Bakke from the ECC research group.

**Improved efficiency of offshore drill cuttings handling processes (2014-2018)**

The aim of the project, which use principles of powder technology, is to improve the understanding of offshore drill cuttings handling processes. The main focus is on cuttings-transport, storage and retrieving. SINTEF Industry coordinates the project in collaboration with USN (national academic partner) and Missouri University of Science and Technology (international academic institute). The project is funded by the Research Council of Norway under the PETROMAKS2 programme. DNO International ASA is an additional sponsor. One PhD student, which is supervised by Prof. Chandana Ratnayake and Arild Saasen (DNO International ASA), is employed by SINTEF Industry. Prof. Morten C. Melaaen and Assoc. Prof. W.K. Hiromi Ariyaratne have also participated in the project.

**Hy3DRM - 3D risk management for hydrogen installations (2015-2018)**

USN and Gexcon cooperate in this project. USN’s tasks are (1) to measure the flow-field in front of a propagating flame in hydrogen-air gas explosions and (2) to perform numerical simulations of the experiments using an USN in-house code. The experimental results will be used as inputs to the combustion reaction model in the FLACS software. The project is funded by the Norwegian Research Council and the project participants. Prof. Knut Vågsæther and Prof. Dag Bjerketvedt from the TPSCEL research group run the USN part of the project.

**Low energy penalty solvents (2015-2018)**

The aim of the project is to develop CO2 solvents that give a lower energy demand in post-combustion CO2 capture processes. These processes involve absorption and regeneration. The project builds on results and insight achieved in the ‘Better and more intelligently formulated CO2 absorbents’ project. A funding of 8.5 MNOK has been provided by the Norwegian Research Council through Gassnova/CLIMIT. The project is run by USN in collaboration with NTNU and University of Austin, Texas. Prof. Klaus-Joachim Jens from the ECC research group manages the project.

**Optimized and increased use of refuse-derived fuel as a substitute for coal at the Norcem Brevik cement plant (2015-2019)**

The goal of this BIA project is to be able to use at least 75 % waste derived fuels at the Norcem cement plant in Brevik without negative impacts on emissions, process conditions or product quality. Participants in the research consortium are Norcem, SINTEF, USN, Multivector, Norsk Gjenvinning, Renor and Aixergee. The project has received funding from the Norwegian Research Council. Prof.
Lars-André Tokheim from the ECC research group participates in the project and supervises one PhD student partly funded by the Telemark County Council.

**CO₂stCap - Cutting cost of CO₂ capture in process industry (2015-2019)**

This four-year project is funded by the Norwegian CLIMIT–Demo programme via Gassnova and The Swedish Energy Agency. The main focus of the project is partial CO₂ capture, techno-economical analyses and cost estimation. Project participants include USN, SINTEF Industry, Norcem Brevik AS, Elkem AS, SSAB, Aga Linde AB, Swerea/Mefos, Inventia, Chalmers University of Technology and IEAGHG. One PhD student, which is supervised by Prof. Lars Erik Øi from the ECC research group, is engaged in the project. The project budget is 25 MNOK.

**Effective handling of bulk solids with focus on reduction of erosion and scale-formation (2015-2019)**

The research project is funded by the Research Council of Norway through the BIA programme and three industrial partners (Alstom Norway, Hydro Aluminium and Omya Hustadmarmor). The aim of the project is to get a better understanding of erosion and scale-formation in powder handling systems such as in pneumatic transport. The project is coordinated by SINTEF Industry in collaboration with USN and SINTEF Materials and Chemistry. Two PhD candidates enrolled in the doctoral programme at USN are engaged in the project. Assoc. Prof. Maths Halstensen and Prof. Chandana Ratnayake are the main supervisors of the PhD candidates.

**Shock wave boundary-layer interaction (2016-2019)**

A six months research project on shock wave boundary-layer interaction (SWBLI) in a gas explosion-driven shock tube was carried out at California Institute of Technology (Caltech) Graduate Aerospace Laboratories (GalCit) in 2016. The formation of Mach stem structures after a shock reflection off a wall was filmed using USN’s ultra-high-speed camera at 0.5 million frames per second. The project, which was run by Prof. Dag Bjerketvedt from the TPSCEL research group, was sponsored by Caltech, USN and SINTEF Industry. The project scope and duration has been extended.

**3D printing in metal – a review of the cold spray process (2016-2018)**

Kraemer AS and the industry incubator Proventia is developing an entrepreneurial idea of 3D printing in metal. Three members of the USN research group “Telemark Process Safety, Combustion and Explosion Laboratory” are consultants in the project. The project is partially funded by "Oslofjordfondet". The cold spray process for 3D-printing in metal is closely related to compressible flow that is one of the expertise areas of the research group at USN. The project participants from USN are Assoc. Prof. Joachim Lundberg (project leader), Assoc. Prof. André Vagner Gaathaug and Prof. Knut Vågsæther.

**Biogas 2020 (2016-2019)**

The aim of the project is to increase the cooperation on biogas research in the Öresund-Kattegat-Skagerrak region. USN’s contributions include research on efficient biogas production processes. The project is funded by the EU research programme “Interreg Öresund-Kattegat-Skagerrak” and has a budget of approximately 12 MEUR. Municipalities, research institutes and academic institutions in
the region participate in the project. One PhD candidate, which is supervised by Prof. Rune Bakke and Assoc. Prof. Wenche H. Bergland from the ECC research group, is engaged in the project.

**Semi-kidd - Sensors and models for improved kick/loss detection in drilling (2016-2020)**

The Semi-kidd project is funded by the Research Council of Norway under the PETROMAKS2 programme. The project is a collaboration between USN (project manager: Prof. Bernt Lie), Equinor, MHWirth, Kelda, Cybernetic Drilling Technology, Sensor Technology, Teknova and NTNU. In brief, the idea is to improve models and information on the return flow of drill mud from oil drilling, and thereby have a more accurate measure of whether drill mud is leaked into the underground formation (loss) or whether oil/gas prematurely leaks out from the reservoir to the drill string (kick) with the danger of blow-out. The project involves four PhD studies (three at USN, one at NTNU) and a large RnD project at Teknova.

**FME HydroCen - Norwegian research centre for hydropower technology (2016-2024)**

The Centre of Environment-Friendly Energy (FME) called HydroCen develops knowledge and technology so hydropower can meet new challenges and enable the transition to a fully renewable energy system. An objective of HydroCen, which is administrated by The Norwegian Research Centre for Hydropower Technology, is to double the hydro power value in Norway by 2050. The USN research group Hydro Power, Transmission and Distribution (HPTD) is a member of the HydroCen Work Package (WP) 2 that concerns turbine and generators.

**Ammonia combustion at Yara (2017-2018)**

USN is doing research on ammonia combustion properties in mixtures for Yara ASA. The project, which is both an experimental and theoretical study, is headed by Prof. Knut Vågsæther from the TPSCEL research group.

**Diesel burner design for Wärtsilä (2017-2018)**

The project focuses on diesel spray nozzle-design based on droplet-size distributions. The experimental determination of the droplet-sizes, which use image-based techniques, provides an input to the nozzle construction and operation parameters. Assoc. Prof. Joachim Lundberg from the TPSCEL research group is in charge of the activity.

**Sustainable biogas (2017-2019)**

This industrial innovation project aims to find new applications and new substrates for biogas and biofertilizer, thereby increasing the biogas production in Norway. The project, which is managed by Greve Biogass AS, is partially funded via the ENERGIX research programme. The total budget is 22 MNOK. USN is responsible for the work package New substrates. In addition, USN participates in several other work packages. Prof. Rune Bakke, Assoc. Prof. Carlos Dinamarca and scientist Eshetu Janka Wakjera, which are all members of the ECC research group, are central in the project. In addition to USN, the project participants are (alphabetically ordered): Avfall Norge AS, BAMA
Gruppen AS, Gartnerhallen AS, IVAR IKS, Lca.no AS, Lindum Avfall AS, Lunds Universitet, NIBIO, NMBU, Oslo EGE, Oslo Vann og Avløp, Skagerak Naturgass AS, SINTEF Industry and Østfoldforskning AS.

**PyroGas – Production of biogas fuels and biocarbon reductants from paper production side streams by combining anaerobic digestion and pyrolysis technology (2017-2020)**

This is an industrial innovation project supported by the ENERGIX programme. Several industrial companies and research institutes participate in the project. The participants include USN, Norske Skog Saugbrugs AS, RISE PFI AS, Cambi Technology AS and Eramet Norway AS. The goal is to produce biofuels and biocarbon reduction agents out of waste materials from the paper industry, by combining anaerobic digestion and pyrolysis. The overall budget is 36 MNOK. One PhD candidate at USN, which is supervised by Assoc. Prof. Wenche H. Bergland and Prof. Rune Bakke from the ECC research group, is involved in this project.

**HEFTY - High efficiency fertilizer technology (2017-2020)**

The full title of this industrial innovation project is: *Exploiting multi scale simulation and control in developing next generation high efficiency fertilizer technologies*. The project is a collaboration between USN, Yara (project owner) and SINTEF. The main goal is to improve fertilizer production by reducing recycle ratio (off spec/product size ratio), and by improving production stability in granulation plants. To achieve this, an improved dynamic model of the granulation loop should be developed and later used for improving the control strategy. The total budget is 15 MNOK. The project is partially funded by the Norwegian Research Council. One PhD candidate from USN, which is supervised by Prof. Bernt Lie and Docent Finn Aakre Haugen from the TMCC research group, is involved in the project.

**FME Bio4Fuels – Norwegian centre for sustainable bio-based fuels and energy (2017-2024)**

The Centre of Environment-Friendly Energy (FME) called Bio4Fuels is funded by the Norwegian Research Council and is a collaboration between NMBU, NIBIO, NTNU, PFI, SINTEF, USN, IFE and several international partners. The main objective is to develop innovative technology and support industries to realize economic and sustainable conversion of lignocellulosic biomass and organic residues to transportation fuels, along with added value chemicals, heat and power. Klaus-Joachim Jens is the project leader from USN. Two PhD candidates from USN, which is supervised by Assoc. Prof. Marianne Eikeland and Prof. Britt Moldestad from the ECC research group, are involved in the project.

**FME MoZEES - Mobile zero emission energy systems (2017-2025)**

The Centre of Environment-Friendly Energy (FME) called MoZEES focus on battery and hydrogen value chains, systems, and applications where Norway can take leading position in the future. The project has a total budget of 260 MNOK. The TPSCEL research group at USN is leading the safety task in the centre. One PhD candidate from USN, which is supervised by Prof. Dag Bjerketvedt, Prof. Knut Vågsæther and Assoc. Prof. Joachim Lundberg, is involved in this project.
The ELSE project (“Elektrifisert Sementproduksjon” in Norwegian) is managed by Norcem, and with USN and SINTEF as project partners. The project is partly funded partly by Norcem and partly through the Gassnova Climit Demo program. The aim is to utilize electricity – instead of fuels – to decarbonate the raw meal. This will eliminate N₂, H₂O and (excess) O₂ in the calciner exit gas, which will then be a more or less pure CO₂ stream. This means that a CO₂ separation plant is not necessary, which may reduce the CO₂ capture costs. Besides, the fuel generated CO₂ will be eliminated, so less CO₂ is produced in the calcination process. Prof. Lars-André Tokheim and Prof. Lars Erik Øi from the ECC research group participate in the project.
Some of the PhD students and supervisors associated with the PhD programme Process, Energy and Automation Engineering (photo: Øivind Idar Urkedal).