National Centre for Sustainable Subsurface Utilization of the Norwegian Continental Shelf

Annual report
2022

Contents

Introduction

NCS2030 – National Centre for Sustainable Subsurface Utilization of the Norwegian Continental Shelf is one out of three research centres within petroleum ("petrosenter") in Norway today. NCS2030 was awarded in 2021 by the Research Council of Norway and started up January 2022. The University of Stavanger (UiS) is hosting the centre and NORCE, IFE and the University of Bergen (UiB) are its research partners.

The centre is financed by the Research Council of Norway, six oil and energy companies, and with resources from the four academic partners and two technology companies. NCS2030 is thereby one of the largest research and industry consortia in Norway. The centre includes more than 70 interdisciplinary researchers and shall, during the centre lifetime (5-8 years), educate the future experts within subsurface understanding. The centre aim is to educate 17 PhD students and 40 master students. During the centre's first year, Centre researchers have, in collaboration with the industry partners, defined 26 subprojects within the centre activities.

The centre vision is to create a sustainable subsurface value chain for reaching national and global net-zero emission targets and providing energy security. This requires interdisciplinary work. Through the partners' competence within petroleum, geology, offshore technology, economy, and digitalization, and building on tools and competence developed within the IOR-Centre, NCS2030 will contribute to solving the sustainability dilemma; utilizing the nation's subsurface resources for energy security while at the same time reducing emissions through energy-efficient recovery methods, cost-efficient CO2 storage and reusing existing infrastructure. Four research areas have been emphasized in the centre: subsurface energy systems, net-zero emission production, digitalization, and society.

From left Lisa Watson, Siv Marie Åsen, Ying Guo, Alejandro Escalona, Christian Dye, Zachary Alcorn and Kjersti Riiber.
Photo: Elisabeth Tønnessen/UiS

Partners

Academic partners

University of Stavanger

IFE

NORCE

UNIVERSITAS BERGENSIS

Industrial user partners

equinor

OKEA

vår energi

AkerBP

HALLIBURTON | Landmark

DNO EST - 1971

wintershall dea

slb

Observers

Funded by The Research Council of Norway

petoro

NORWEGIAN PETROLEUM DIRECTORATE

Management, board and committees

Alejandro Escalona
Centre director
University of Stavanger

Ying Guo
Assistant director
NORCE

Christian Dye
Innovation director
IFE

Zachary Alcorn
R&D director
University of Bergen

Siv Marie Åsen
Project coordinator
University of Stavanger

Kjersti Riiber
Communications adviser
University of Stavanger

Board

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Chair
Equinor Energy ASA

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Samuel L. Kvernes (from Sept. 2022) (Aker BP ASA)
Kent Høgseth (DNO Norge AS)
Robert Berendsen (Landmark Graphics AS)
Tormod Slettemeas (Schlumberger Information Solutions AS)
Johanna N. Ravnås (Wintershall Dea Norge)
Audun Fykse (Vår Energi ASA)

Øystein Lund Bø (UiS)
Erlend Vefring (NORCE)
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Chair
Wintershall Dea Norge

Robert Berendsen (Landmark Graphics AS)
Pierre Le Guern (Schlumberger Information Solutions)
Tao Yang (Equinor Energy ASA)
Egil Boye Petersen (Aker BP ASA)
Paul Spencer (Vår Energi ASA)
Odd Kjørholt (DNO Norge AS)
Thomas Lerdahl (OKEA ASA)

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Erik Saenger
Chair
Bochum University, DE

Lesley James (Memorial University of Newfoundland, CA)
Lorena Moscardelli (University of Texas at Austin, US)

Innovation Committee

Egil Boye Petersen
Chair
Aker BP ASA

Helge Bøvik Larsen (UiS)
John Zuta (NORCE)
Johan Kristian Sveen (IFE)
Geir Ersland/Arne Graue (UiB)
Robert Berendsen (Landmark Graphics AS)
Michael Nickel (Schlumberger)
Tao Yang (Equinor Energy ASA)
Paul Spencer (Vår Energi ASA)
Kent Høgseth (DNO Norge AS)
Johanna N. Ravnås (Wintershall Dea Norge)
Thomas Lerdahl (OKEA ASA)

Vision

The primary objective of NCS2030 is to fill knowledge gaps and provide solutions for maximizing value creation of subsurface resources to reach the net-zero emission goals on the Norwegian Continental Shelf (NCS).

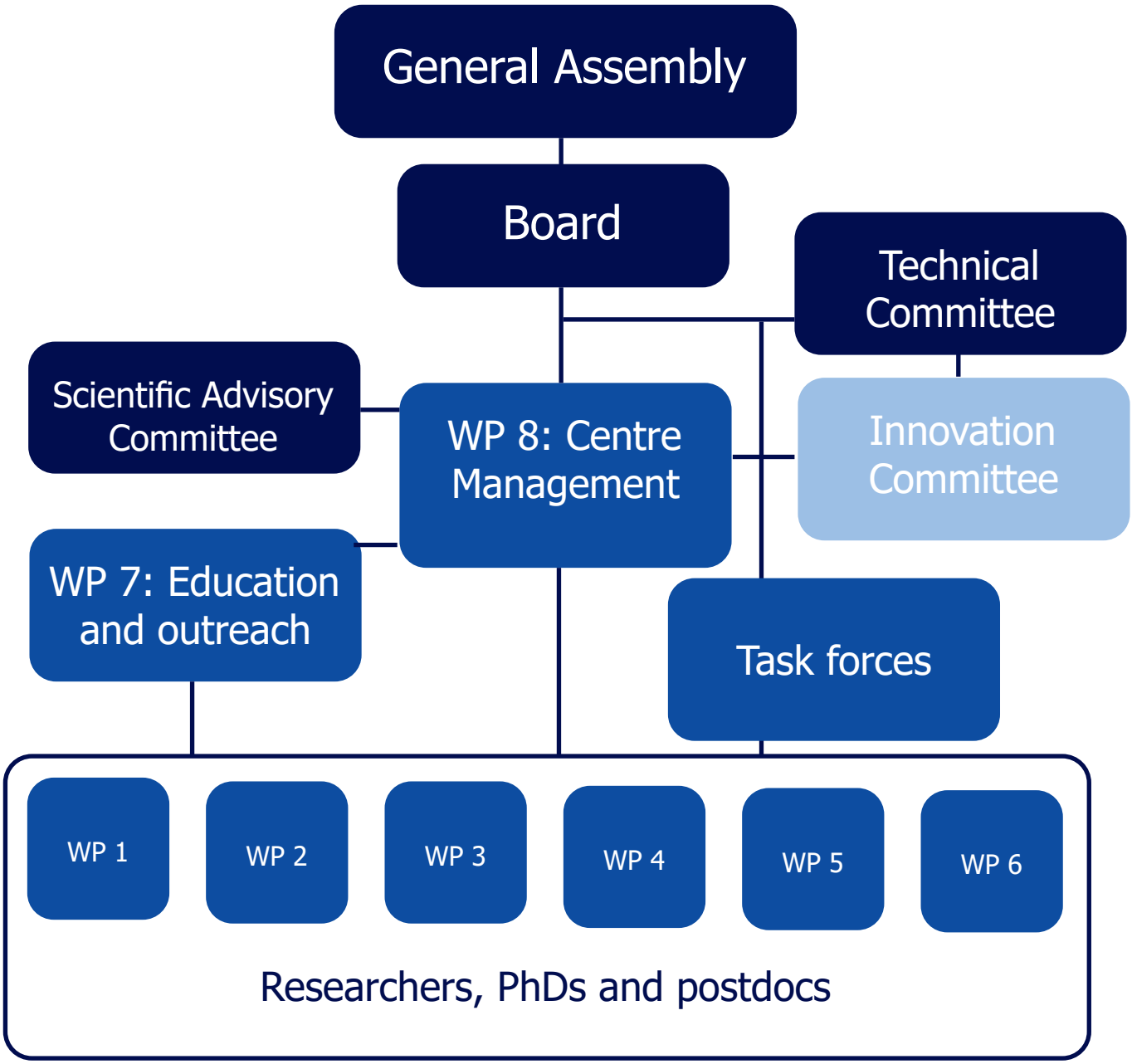
The Intergovernmental Panel on Climate Change's latest report emphasizes that the globe is warming. Rapid action is needed to mitigate climate change. To reach the Paris agreement target, the International Energy Agency (IEA), in its last report, proposes a scenario where none of the new oil reserves will be developed. The Norwegian petroleum industry is preparing its future paths toward Net-Zero Emissions (NZE) by 2050, while continuing to supply the world with energy. An energy mix, with the right combination of fossil and renewable energy sources, together with CO_2 capture and storage (CCS) is a viable option. Norway is one of the most important providers of energy to Europe. We have major opportunities to become a frontrunner in the sustainable energy transition to renewable energy and NZE hydrocarbon production. To transform the Norwegian Continental Shelf into sustainable utilization, a new way of thinking across disciplines and societal acceptance is required. Therefore, it is important to integrate research, education, and innovation to build knowledge and develop technologies towards the optimal utilization of the NCS.

The vision of NCS2030 is to facilitate an energy-efficient, multi-purpose utilization of the NCS subsurface in the transition to a "Sustainable Subsurface Value Chain". This includes both cost- and energy-efficient NZE oil and gas production, utilization of reservoirs for renewable energy production, and storage of CO_2 and other waste disposal in near field areas. Reutilization of existing infrastructure in an optimal manner (circular economy) and connection to other value chains, e.g. CO_2 transport and storage, Blue H_2 production, offshore wind and geothermal energy, are paramount. This vision directly addresses the scope, priorities, and objectives of the Research Center for Petroleum call, and comply with the plan for the petroleum research portfolio as specified by the Research Council of Norway (RCN).

The research themes in the centre represent the basis for research to solve the industry challenges on the Norwegian Continental Shelf. These challenges include:

- 50% emissions cut by 2030 and net-zero by 2050 (stop global warming; CO_2 taxation; taxonomy)
- Exploration and production lifetime and license regulations
- Large scale storage of CO_2 and CO_2-EOR (enhanced oil recovery)
- Reduction of water production and energy consumption
- Development of renewable and sustainable energy sources: H_2 (blue, green), geothermal, offshore wind; and extend life and value of existing infrastructure
- Energy security (energy mix) for accelerating the transition towards a sustainable society

Governance structure



Director's view

Energy security and climate goals are the main challenges humanity is facing, which unfortunately became more evident in 2022 with the war and energy crisis in Europe. With these main challenges in mind, and to contribute to the development of the energy sector offshore Norway by increasing subsurface competence, NCS2030 was awarded by the Research Council of Norway by the end of 2021. The centre started its operations in 2022. With more than 70 researchers from four research partners and with the valuable support of eight user partners and observers, we are in full activity with the establishment of all the different committees and the start-up of 26 research projects across the six technical work packages which is impressive. Further, we have started the hiring of the first wave of PhD positions (seven positions), and by the end of 2022 we have already three in place with the remaining starting early in 2023. Master theses have also been offered, and students are getting engaged. Outreach and education are on top of the agenda, because we need to remind ourselves that society needs to understand the importance of our contributions. Therefore, we have plans for promoting our activities to all levels of society.

Of course, a major highlight of 2022, as the first-year post pandemic, was the opportunity to meet physically, which for many of us was for the first time, appreciating the value of physical meetings and events. Energy Norway 2022 in April was the first glimpse of the physical meetings by celebrating the success of The National IOR Centre of Norway and the start of the NCS2030 centre. This was followed up by numerous meetings where NCS2030 was promoted such as the Arendal Week, ONS, IEA IOR workshop, and many other arenas. As a year end, we arranged a team building in Vitenfabrikken in Sandnes to stress the importance of collaboration, integration, and innovation as part of the centre's vision. The response was very positive with great interest from the participants, highlighting the importance to get to know each other for increased collaboration.

Even though we are just in the starting phase of the centre and still have a long way to go, with many known and unknown challenges ahead, I have confidence in the team. Students, researchers and industry partners are willing to work together and reach the centre goals to contribute to solve the main challenges of society in the years to come.

Alejandro Escalona
Centre Director

Objectives

Towards the end of the National IOR Centre of Norway's life time, the planning of a new Petrocenter started. NCS2030 will continue the work done in the IOR centre, focusing on subsurface sustainability on the Norwegian Continental Shelf.

The vision of the NCS2030 centre is to facilitate an energy-efficient, multi-purpose utilization of the subsurface into a "Sustainable Subsurface Value Chain" to reach the Net-Zero Emission goals on the Norwegian Continental Shelf. Four main research areas are identified, namely **Subsurface energy systems, Net-zero emission production, Digitalization and Society**. The research activities are organized into eight work packages (WP): six WPs in research, one WP in education and outreach and one WP in management.

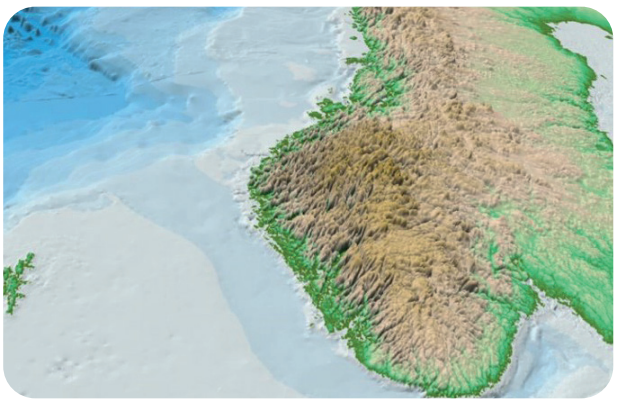
OVERALL AIM

The primary objective of NCS2030 is to fill knowledge gaps and provide solutions for maximizing value creation of subsurface resources to reach the Net Zero Emission (NZE) goals on the Norwegian Continental Shelf (NCS).

SECONDARY OBJECTIVES

- Build integrated near field subsurface holistic models for increasing reserve base and evaluate the potential of geological CO_2 and H_2 storage
- Develop new IOR solutions for improved and accelerated hydrocarbon production at low environmental footprint
- Develop data-driven and machine learning approaches to integrate subsurface characterization, uncertainty quantification and management workflows
- Recommend field cases with high potential for NZE production
- Create awareness and acceptance of NCS2030 activities
- Establish an innovation platform for technology development with industry
- Attract and train future scientists and skilled professionals for the energy transition and disseminate results

The centre will collaborate broadly with academia and hands-on with industry partners and innovation companies. With local anchoring and in proximity to the industrial partners the centre will contribute to strengthen Stavanger's and Norway's roles in the transition of the energy sector and confirm Stavanger's position as the Energy Capital of Norway.



Message from Chair of Board

NCS2030 (National Centre for Sustainable Subsurface Utilization of the Norwegian Continental Shelf) is one of the largest research and industry consortia running in Norway. Including interdisciplinary teams of students and researchers across institutes and academia and a long list of industry partners, starting up a large centre like this requires a lot of effort, good planning, and stamina. Workshops, alignment meetings, collecting and coordination of stakeholder input and feedback – characterize many of the activities in the start-up year.

A kick-off workshop with the partners was arranged in January, followed up with several work package sessions and discussions. Together, the first projects in the centre were defined.

Getting the Consortium Agreement accepted by all the partners was achieved during the summer weeks and the first General Assembly and Board was in place in September, followed by establishment of the Innovation committee, Technical Committee, and the Scientific Advisory Board respectively. All centre 'bodies' are then up and running!

Building the centre identity has been another important focus point this first year. A website has been established giving an overview of centre goals, activities, and key contacts. NCS2030 was also present at both Arendalsuka and ONS – important external arenas for profiling and visibility.

The context is more complex than ever. With the energy crisis in Europe, Norwegian oil and gas has never been more important. At the same time, the world's energy systems must be transformed to drive decarbonization. The challenges are many. The NCS2030 Petrocentre will educate a new generation of professionals, build expertise and find solutions important to solve key challenges in the energy transition. The centre has set ambitious goals to maximize the value creation of energy resources on the NCS, while at the same time achieving the net zero emission goals. It will be exciting to follow and to be a part of the NCS2030 journey.

Camilla Vavik Pedersen (Equinor)
Chair of Board

Message from Scientific Advisory Committee

As the freshly nominated Scientific Advisory Board (SAC), we are very impressed by the breadth and depth of the foreseen research in the NCS2030. In our first meeting, the director of the consortium, Prof. Dr. Alejandro Escalona, explained the structure of the project. The aim is to foster multidisciplinary collaborations across disciplines and entities to reach NCS2030 objectives. Continuous and open communication between universities, research institutes and industry will be crucial to ensure the success of NCS2030.

NCS2030 has been tasked with finding solutions that maximize the value creation of energy resources on the Norwegian continental shelf, while at the same time achieving net zero emission goals. These are not only urgent but highly ambitious goals; however, the SAC feels confident that we will see significant scientific and technological advances during the duration of this project given the high-quality and multidisciplinary nature of these research teams. The suggested research projects will help tackle the ongoing climate crisis while contributing with the energy security of Norway and Europe as a whole. The responsible management of Norwegian petroleum resources in combination with their development to store CO_2, H_2 or wastewater; as well as their evaluation as potential source of geothermal energy is a very promising path.

A big challenge for the whole team will be the continuous effective communication of the different partners with their specific interests during the whole funding period. Industry interests and research interests will not always coincide, however, if managed properly, the benefit on both sides can be immense. The expertise we see in the consortium is already on a world-class level. This will be a unique opportunity to take the project to an even higher level with further development.

We are looking forward to a fruitful collaboration of the SAC with all people working in the NSC2030. An excellent first chance will be the Norway Energy Conference 2023. During our visit, we will focus in our interactions with early-career scientists and how they will be trained to contribute to solve the challenging goals of this project.

Erik Saenger (chair)
Lorena Moscardelli
Lesley James

Meet the members of the Scientific Advisory Committee.

Erik H. Saenger is since 2014 a Professor of Reservoir Engineering and Rock Physics at the Hochschule Bochum and a private lecturer (Venia Legendi) at the Ruhr University Bochum. Since 2020 he is also affiliated with Fraunhofer IEG. He did both his undergraduate and post graduate work in physics and geophysics at the University of Karlsruhe (Germany) and has over 20 years of academic experience since receiving his doctorate degree. He worked from 2001 to 2006 as a post doctoral researcher at the Freie Universitaet Berlin (Germany) as the leader of the numerical rock physics group. From 2006 to 2012 he was a scientific consultant for Spectraseis; from 2007 to 2014 he worked as a research scientist at the Geological Institute at ETH Zurich.

His research interests include scale-dependent estimation of effective elastic properties of fractured and porous rocks, fluid effects on wave propagation, passive seismic data, geothermal applications, and development and implementation of various finite difference approaches to model wave propagation in anisotropic and viscoelastic media. He is Assistant Editor of Geophysics.

Professor Erik H. Saenger

Lorena Moscardelli is a Research Scientist and leader of the State of Texas Advanced Resource Recovery (STARR) programme at the Bureau of Economic Geology. She has vast experience in the realm of geoscience data integration and interpretation aiming at energy resource assessments. She received a degree in Geological Engineering from Central University of Venezuela (2000) and a PhD in Geological Sciences from the University of Texas at Austin (2007). She started her career as an exploration geologist in PDVSA (2000-2003). Prior to her current position, Lorena worked for Equinor (2013-2021) where she performed a wide range of activities from research and exploration in the Americas to field development in the Norwegian Continental Shelf. Her career includes the co-funding and co-direction of the Quantitative Clastic Laboratory (QCL) (2007-2013) and her actual involvement as leader of STARR since 2021. She has a strong interest in understanding the role of geoscience research as part of the ongoing energy transition and she is leading several STARR efforts on that front.

Research Scientist and Principal Investigator Lorena Moscardelli

Dr. Lesley James is a Professor and former Chevron Chair in Petroleum Engineering in the Dept of Process Engineering at Memorial University. Dr. James' research interests focus on sustainable oil production by increasing oil recovery rates through enhanced and improved oil recovery. Currently, her focus is on maximizing recovery from offshore Newfoundland and Labrador oil and gas fields through understanding the fluid-fluid and rock-fluid interactions and particularly examining miscible/near-miscible fluid injection and optimal EOR strategies for offshore production. Working closely with industry, Dr. James is currently working on the use of CO_2 for offshore oil recovery from complex reservoirs, integrated operations for maximising oil recovery in remote harsh locations, water-alternating-gas using produced natural gas for Hibernia, EOR screening and production optimisation for Hebron, and using Digital Oilfield technologies to increase production and reduce costs. Dr. James has been awarded the Society of Petroleum Engineer's Distinguished Achievement Award for Petroleum Engineering Faculty and serves as mentor for the Student Society of Petroleum Engineers (SSPE), the Student Society of the European Association of Geoscientists and Engineers (EAGE), and the Student Metallurgy & Materials Society (MetSoc).

Professor Lesley James

Centre meetings

2022 was the first year of activity in NCS2030. During autumn the board and committees had their first meetings, leaders were elected and plans for 2023 were set.

BOARD AND GENERAL ASSEMBLY

Camilla Vavik Pedersen from Equinor was elected chair of board at the general assembly meeting 6th September 2022. She has previously been board member in the IOR centre and replaces Thierry Lauprettre from Aker BP, who has served as the chair of board for both NCS2030 (the first couple of months) and the National IOR Centre of Norway. In the first board meeting both the innovation and technical committees were elected (see below).

TECHNICAL COMMITTEE

Mohsen Rafiee from Wintershall Dea was elected leader of the technical committee. The election was held in the meeting 21st October. Another important point on the agenda was to give an overview of the running research projects in the centre. Since the technical committe is the link between the industry and the researchers, the need for a dynamic arena for discussions was brought up. So-called Task Forces are established as a meeting point for in-depth discussions between industry representatives and project leaders.

INNOVATION COMMITTEE

Egil Boye Petersen (Aker BP) was elected committee leader for a two year period. Some agenda points were: The potential way forward; possible future funding by the Research Council of Norway, funding from late participants and private funding sources. The meeting also discussed the importance of monitoring how the generated intellectual properties compares with the companies' user interests and their rights to use the technology developed in the centre.

Industry and researchers gathered at the first technical committee meeting. In front Randi Valestrand (NORCE) and Tina Puntervold (UiS).

From the contact meeting with Research Council of Norway (RCN) in Oslo. All the petrosenters were represented. Front left Ingrid Anne Munz, the main contact person from RCN. From NCS2030 Ying Guo, Siv Marie Åsen and Alejandro Escalona attended. Photo: Private

Once a year the research centres meet the Research Council of Norway (RCN) to sum up their activities and learn from each other.

The Petroleum Research Centres (PETROSENTER) in Norway meet once a year to learn from each other. The goal of the centres is to develop expertise that is important to solve key challenges for the management and value creation of Norwegian petroleum resources. In the contact meetings each centre presents their work. For RCN it is cruical that the centres produce long-term research in close collaboration between R&D-active companies and prominent research groups. The scientific quality of research must be of a high international standard. The centres have been established for a maximum period of eight years.

NCS2030 MEETINGS 2022

- **BOARD AND GENERAL ASSEMBLY**
6 September.

- **INNOVATION COMMITTEE**
30 September.

- **TECHNICAL COMMITTEE**
21 October.

- **CONTACT MEETING – RCN**
17 November.

Research plans and achievements

The centre is divided into seven different work packages. In the coming pages we sum up the work planned in each work package and highlight some achievements.

OUR FOCUS

The centre's advances in science and technology will have its greatest impact on the energy industry by facilitating green transition. The centre will educate and supply the next generation of professionals that will contribute to the transformation of the NCS. Further, the centre will provide opportunities for academia to conduct high-level industry-relevant research. The scientific research results will be published in open access, high-impact science and technology journals. We anticipate publishing a minimum of 150 high-impact papers in scientific peer-reviewed journals during the 8-year lifetime of the centre, as well as 20-30 conference presentations per year. These results will also contribute to create innovative solutions for sustainable field operations to fulfil the set goals on NCS, give guidance for the regulatory framework with the factors influencing the energy sector. NCS2030 will also promote Norway as an attractive technology and knowledge provider worldwide for the sustainable energy sector.

HIGHLIGHT OF ACHIEVEMENTS

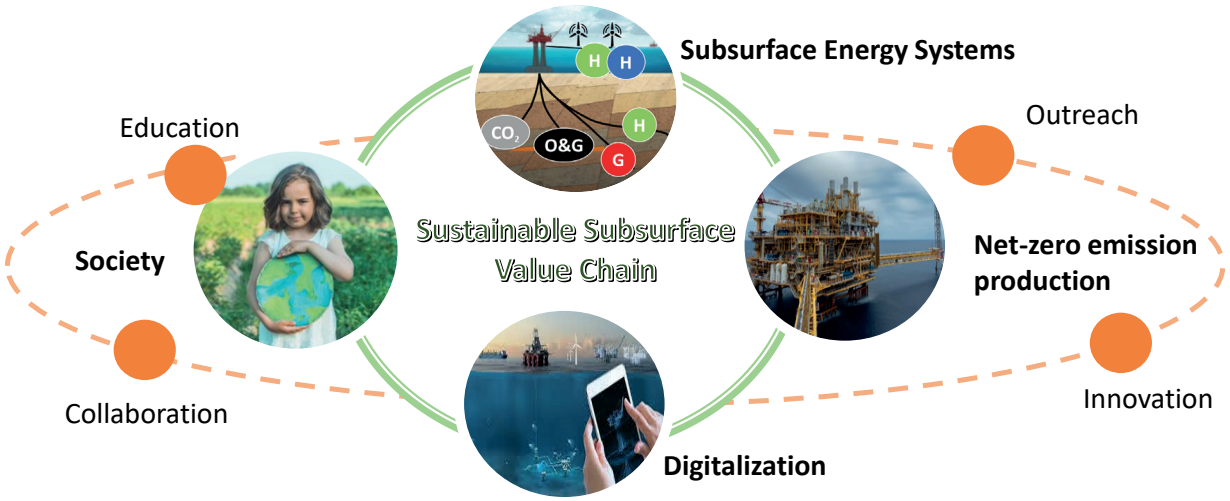
The main results from the centre's first year were to define projects and plans, and establish routines and arenas for discussion and collaboration with the partners. In addition, the following project results have been obtained:

- Within energy systems and digitalization, a collaboration with centre's technology companies have been established to use their expertise and tools for mapping mature near-field resources for optimal use of existing infrastructure.
- Within digitalization new methods for safe data sharing and handling are being developed to avoid data transport from the host institutions' data storage.
- Possible areas for hydrogen storage in salt caverns in the North Sea have been mapped using seismic and well logging data, rock samples and structural maps. Customizing safety procedures for experimental work with hydrogen has commenced.
- Potential fields for reduced water production and for CO2 storage have been selected for the planning of laboratory experiments with respect to pressure, temperature, rock type and chemical compositions of subsurface fluids, and as candidates for implementing life-cycle assessment (LCA) to quantify the GHG emission reduction effect.
- The field modelling tool IORSim developed in the National IOR Centre of Norway (2014-2021), has started its extension for the near wellbore modelling for the advanced IOR processes, and initially with Snorre, Alvheim and Ekofisk fields as test candidates.
- Naturally present tracers 87Sr/86Sr isotopes are investigated for their usefulness in mapping the ability of cap

rocks to contain fluids, either hydrocarbons, temporary stored hydrogen, or permanently stored CO2.

COMMUNICATING RESULTS

The centre was officially launched as the new Petrocenter in the Energy Norway conference in April 2022, as continuation of the IOR Norway conference. A centre webpage and document archive system have been established within the UiS website (www.uis.no/en/NCS2030) as the main communication channel to reach impact and reach out to the scientific community as well as to the general public.



Four research themes of NCS2030 and related activities.

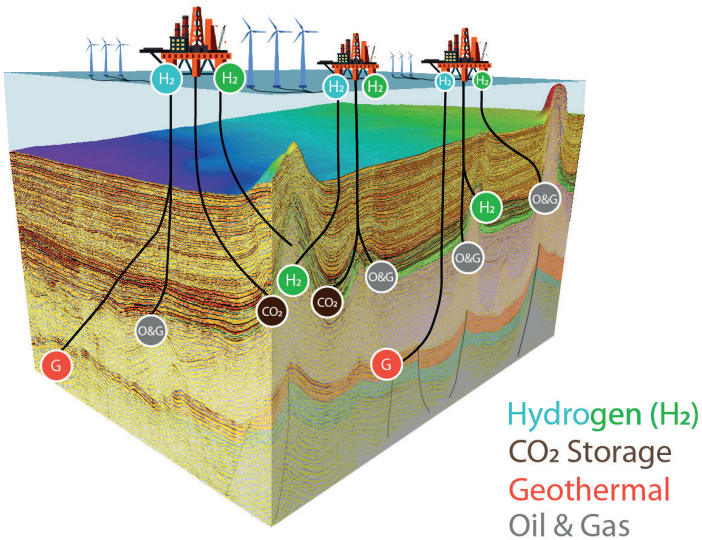
Near field resource evaluation

The growth in energy demand, combined with climate change, requires the use of new integrated strategies and multi-disciplinary methods for the long-term sustainable exploration and exploitation of subsurface energy resources and storage capacity to reach the NZE goals by 2050. Specific targets are:

- Produce an integrated holistic geological model and workflows for a selection of nearby existing infrastructure (hubs; ca. 50km radius) to provide energy and storage opportunities.
- Unlock yet-to-find reserves in mature, near-field areas and provide new energy opportunities to extend the life of existing infrastructure.
- Map fluid migration pathways and model basin-scale fluid dynamics to identify locations of best reservoir facies, reduce failure in exploration drilling, and to reduce environmental impact caused by leakage from storage sites

Seven projects have been defined:

1. WP1.1 Quantitative cross-disciplinary resource evaluation
2. WP1.2 Salt characterization and modelling for the future energy mix (PhD)
3. WP1.3 Basin-scale fluid connectivity
4. WP1.4 Next Generation of Petroleum/CO_2-Brine Petroleum/CO_2-Brine System Models
5. WP1.5 Develop new workflows in the salt province of the Norwegian North Sea for evaluating the potential for CO_2/H_2 storage and geothermal energy
6. WP1.6 Near Field resource evaluation using solutions from the DELFI's Petrotechnical Suite
7. WP1.7 Geothermal energy potential in the Norwegian North Sea: a regional to field-scale evaluation (PhD) (associated project)



Leader: Stéphane Polteau (IFE)

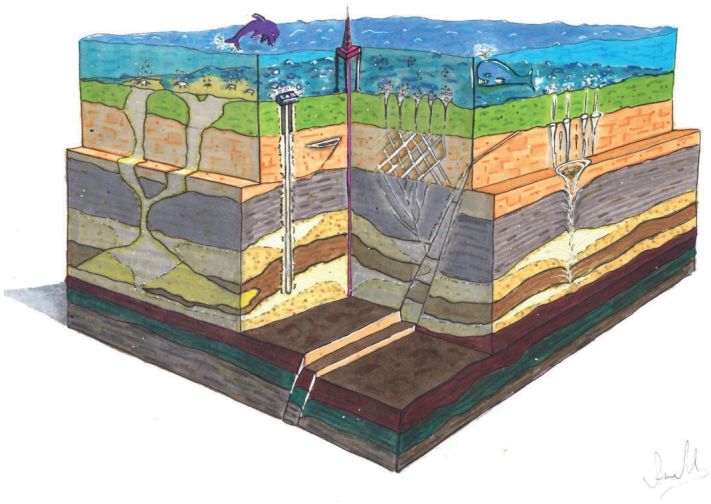
Reservoir utilization for energy transition

Achieving the NZE target by 2050 requires further development of CO_2 sequestration sites and exploration of alternative energy, such as H_2 and heat. Therefore, developing methods and tools that can enhance the capacity of geological sites for storage (CO_2 and H_2), and production of geothermal energy on the NCS is of importance. Specific targets of WP2 are:

- Improve the reservoir energy production strategy with carbon capture and storage.
- Describe and understand H_2 storage and retrieval mechanisms in different geological formations.
- Provide tracer monitoring, leakage remediation and mitigation strategies for waste and energy storage.
- Model reactive flow transport in deformable porous rocks for reliable assessment of storage sites.
- Investigate if HPHT reservoirs can be utilized as geothermal heat mining sites.

Four projects have been defined:

1. WP2.1 Physics of focused fluid flow in sedimentary basins
2. WP2.2 Recommended practice for numerical modeling of geomechanical behavior of various fields on the NCS
3. WP2.3 Tracers and tracing methods for utilization of the NCS in the energy transition
4. WP2.4 Hydrogen storage and back-production in porous media



Leader: Viktoriya Yarushina (IFE)

Net-zero emission (NZE) production

Specific aims of this work package (WP 3) are:

- Develop improved oil recovery concepts for improved, accelerated, profitable and sustainable hydrocarbon production at low environmental foot-print, to reach 50% emission reduction by 2030 and net-zero emissions by 2050.
- Propose new sustainable field development strategies integrated with renewable energy sources offered by the upcoming green offshore industries.

Three projects concerning tight reservoir solutions, CO_2 utilization and improved tracing commenced in 2022. We have started performing a literature review of stimulation methods employed on the Norwegian continental shelf, as stimulation is of importance for efficiently producing tight reservoir hydrocarbons.
Within CO_2 utilization we have identified reservoirs on the Norwegian continental shelf, which will help to guide experimental design and conditions for optimizing CO_2-foam. Related to improved tracing a literature study on methods to determine wettability, including previous work on tracers, has been performed. In parallel, planning of experiments and selection of reversibly sorbing tracer candidates for the feasibility study has taken place.

Three projects have been defined:

1. WP3.1 Tight reservoir solutions (PhD)
2. WP3.2 CO_2 utilization (PhD)
3. WP3.3 Improved tracing

Leader: Tina Puntervold (UiS)

Efficient water management

The amount of water injected, produced and discharged to sea in aging fields on the NCS is increasing. Water handling is energy-intensive and costly, and represents about 50% of the total energy for field operation. Therefore, efficient water management is crucial for field economics and emission reduction. Specific aims of WP4 are:

- To further investigate solutions for improved macroscopic sweep of reservoirs.
- To minimize injection water recirculation with reduced energy needs, thus reducing CO2 emissions.
- To implement LCA methodology for energy system analysis for calculating NZE indicators such as Unit Energy Invested and Energy Recovery Factor.

Three projects have been defined:

1. WP4.1 Deep water diversion for minimizing CO2 footprint
2. WP4.2 Optimization of injection water for IOR (PhD)
3. WP4.3 IORSim modelling for near wellbore geochemistry and geomechanics (PhD)

Leader: Ying Guo (NORCE)

Digital subsurface for decisions

Large amounts of subsurface data are available, but current workflows and programs for subsurface understanding are not optimal, resulting in inadequate utilization of datasets. Using an ensemble of model predictions to support robust decision-making is in its infancy; thus, we must establish consistent decision-making methods. Digitalization and ML are required components of a Sustainable Subsurface Value Chain, and we must integrate knowledge and competence building to make more informed decisions. We will establish a digital infrastructure, i.e., Subsurface Knowledge Cloud (SKC), to provide readily usable data, high-performance computing power, and visualization tools. In WP5:

- We facilitate robust model forecasts with feasible computational cost and better accessibility of big datasets.
- We perform comprehensive and reliable uncertainty quantification for multi-purpose reservoir usage.
- We develop data-driven approaches to integrate ML into subsurface-characterization characterization, uncertainty quantification, and the decision-making process.

Six projects have been defined::

1. WP5.1 Federated Knowledge Cloud for Subsurface Digitalization across Multiple Sites (Ph.D.).
2. WP5.2 Multi-fidelity models, scenario evaluation, and probabilistic forecasts for the digital subsurface (Ph.D.).
3. WP5.3 Reservoir-management workflows for decision-making.
4. WP5.4 Hybrid ensemble algorithms applied to CO_2/H_2 utilization and storage (Ph.D.).
5. WP5.5 Develop and support Knowledge Cloud for Subsurface Digitalization across Multiple Sites.
6. WP5.6 Explore, develop, test, and deploy new automated workflows that utilize cloud storage of data and cloud computing infrastructure.

Leader: Geir Evensen (NORCE)
Deputy leader: Randi Valestrand (NORCE)

Most important work done in WP5 in 2022:

In 2022 we started the research on all projects, announced and hired Ph.D. students, and interacted and discussed with the partners of the NCS2030 centre.

We developed a prototype of the Federated Knowledge Cloud in 2022 and presented it at The November Conference – Brazil and Norway. This prototype will form the basis for further development of the Federated Knowledge Cloud.

We have had a significant effort focused on open-source tools. At the Energy Department in NORCE, we have more than 20 years of experience developing digital methods for petroleum reservoir management. In these methods, we are using an ensemble of models to represent the uncertainty of the underground. We update the model ensemble using measurements while accounting for all the uncertainties in the model and measurements. The developments have led to the Python-Ensemble-Toolbox (PET), published as open source at GitHub. We will use PET in our petroleum applications as well as while working towards the green shift and contributing to accelerating the worldwide growth of renewable energy.

We have also worked with the latest version of another open-source ensemble tool, ERT (Ensemble-based Reservoir Tool) developed by Equinor. Here we have worked with the history matching implementation, contributing to a complete rewrite of the code to improve consistency and efficiency. The PET and ERT workflow managers and history- matching tools are ready for use in the different NCS2030 projects.

Energy policy, economy and society

The role of the Norwegian Continental Shelf (NCS) in the future energy system depends on the national and international business regulations, societal acceptance and licence to operate. The targets of work package 6 are to:

- Address the competitiveness of the NCS in national and international contexts.
- Contribute to sound climate mitigation policies.
- Understand and explain the risk and uncertainty of investments related to WP1-WP5.

Four projects have been defined:

1. WP6.1 NCS, the business climate, and market characteristics (Postdoc)
2. WP6.2 Avoidance of stranded assets
3. WP6.3 Energy transition and the NCS
4. WP6.4 Acceptance evaluation

Leader: Torfinn Harding (UiS)

Education and outreach

The diversification in the energy sector requires skilled professionals with subsurface competences, knowledge in the multiple energy sources, storage options, digitalization and an understanding of the Norwegian Continental Shelf. However, the number of students in energy related topics at the universities in Norway has dramatically declined and the supply of people with subsurface competence is approaching a critical low level. There is a negative perception of energy-related studies and this sector is not considered environmentally friendly. To address these challenges, the specific targets are:

- Attract the next generation of scientists and skilled professionals for the energy transition.
- Educate new professionals at Msc and PhD level in the future energy competences in collaboration with the industry.
- Disseminate the NCS2030 results.

MOST IMPORTANT WORK DONE IN 2022

The first year PhDs are hired, within the research areas of the NCS2030. Master and bachelor students will be involved in the centre through theses and as research assistants. A list of master theses is published in our web page, and this spring the goal is to connect students and supervisors in a ”speed date” event. Two media BSc students are hired as student assistants who will help to create a series of short videos. The purpose of the videos is to inform the public about general activities and people in the centre. Summed up, we have a series of activities to help promote research and the centre through different forms of media other than publications.

EXPECTED OUTCOME 2023

During the second year of the NCS2030, we will focus on public outreach, promoting the activities and results of researchers, PhDs, and master and bachelor students. We will also make a concerted effort to attract master students for thesis projects in 2024. We will continue collaborating with externally associated projects.

- New and updated videos to introduce researchers and PhDs of the centre
- Monthly webinars, beginning in January
- Social or digital media: 1-2 posts per month related to centre activities
- Researcher breakfasts at UiS: participate in up to 2 lectures
- Thesis promotion: virtual meeting to promote centre-related thesis projects to UiB and UiS students
- Recruited PhD’s: 7
- Pint of Science: volunteer in organization and speakers
- Forskningsdagene: 2023 theme is energy and we will promote speakers to the application process
- Geologiens dag: promote activities
- Energy Norway: annually
- Publications in peer-reviewed journals: 5-10
- Conference presentations: 15-20

Lead: Dora Marin (-2022) & Lisa Watson (from December 2022) (both UiS)
Key Personnel: Kjersti Riiber

Collaboration

Cooperation and openness are keywords for NCS2030, and we strive to maintain a good dialogue with our collaborators. Through an active collaboration, we aim to promote applied research of a high scientific level.

International cooperation is a key component of the centre. We aim for high mobility of students and researchers in Europe, North America and Asia. PhD and employee mobility is important both regarding experimental work, but also to strenghten the collaboration between centre researchers and international partners. NCS2030 will enable collaboration between policy makers, field operators, technology providers and academic groups, and will complement established research initiatives to create new solutions through an innovation program. The innovation programme will be developed in collaboration with Validé.

RESEARCH & DEVELOPMENT COOPERATION

NATIONAL

- University of Bergen
- University of Oslo
- University of Tromsø
- Petroleum Research School of Norway

INTERNATIONAL

- The University of Texas at Austin
- Stanford University
- Virginia Tech
- University of Aberdeen
- Imperial College
- University of Basilicata
- Danish Technical University
- RWTH Aachen University
- Memorial University of Newfoundland
- CEPETRO
- Federal University of Rio de Janeiro
- Edith Cowan University
- University of New South Wales
- Teesside University – Net Zero Innovation Centre

Who are we?

Work package leaders

WP1: Stéphane Polteau, IFE
WP2: Viktoriya Yarushina, IFE
WP3: Tina Puntervold, UiS
WP4: Ying Guo, NORCE
WP5: Geir Evensen/Randi Valestrand, NORCE
WP6: Torfinn Harding, UiS
WP7: Lisa Watson, UiS

PhD students

Daniele Blancone, UiS
Hilde Halsøy, UiB
Jungwon Seo, UiS

Researchers

University of Stavanger:
Aksel Hiorth
Aleksandr Mamonov
Chunming Rong
Dora Marín
Jon T. Selvik
Jørgen Juel Andersen
Lisa Watson
Nan Zhang
Nestor Cardozo
Pål Ø. Andersen
Raoof Gholami
Reidar Bratvold
Reidar Korsnes
Skule Strand
Wiktor Weibull

NORCE:
Andreas Stordal
Arild Lohne
Arne Stavland
Atle Blomgren
Auroture V. Omekeh
Ceren J. Ahi
Ingebret Fjelde
Ivar Sandø
Jan Ludvig Vinningland
John Zuta
Kjersti Eikrem
Kristian Fossum
Patrick Raanes
Sigurd Aanonsen
Reza Askarinezhad
Trond Mannseth
Tuhin Bhakta
Xiaodong Luo

IFE:
Alexander Krivokapic
Børre Jacob Antonsen
Hongliang Wang
Jan Sagen
Kari A. Espegren
Kristina Haaskjold
Lan Liu
Laura Ferrando-Climent
Liv Stavsetra
Magnus Wangen
Mari Lyseid Authen
Mario Silva
Olaf Skjæraasen
Reinier van Noort
Sissel O. Viig
Tomas Nordlander

University of Bergen:
Arne Graue

Halliburton Landmark:
Robert Berendsen
Pom Sabharwal
Geovani Christopher
Chafaa Badis
Welton Souza

SLB:
Tormod Slettemeås
Pierre Le Guern
Per Salomonsen
Archit Sharma
Lothar Schulte
Henry Garcia

Introducing the three first PhD candidates at NCS2030; Daniele Blancone, Hilde Halsøy and Jungwon Seo.

Daniele Blancone

The main goal of the project *Salt characterization and modelling for the future energy mix* is to determinate the composition, sealing and thermal properties of the Upper Paleozoic evaporites of the Zechstein Group in the Norwegian North Sea, with the aim of investigate the potential of these sedimentary rocks for both geological storage (both CO_2 and H_2) and possible application for geothermal energy production. The understanding of the lithological heterogeneity distribution in various salt structures is fundamental because the Halite often occurs as part of layered evaporitic sequences (LES) with different lithologies, thus heterogeneity of this layering could affect the quality of the salt reservoir. The project will focus on three main topics:

- Subsurface data interpretation to map characterize the evaporites in the Zechstein Group in terms of geometry, composition, sealing and thermal properties.
- Application of data science/ machine learning techniques to extrapolate evaporites properties away from the well areas, and ultimately predict the best locations for geological storage or geothermal energy production.
- Structural restoration and geomechanical modelling of selected salt structures, to determine their mechanical and thermal evolution, and implications for geological storage/geothermal potential.

Daniele Blancone

ABOUT THE CANDIDATE

I'm Daniele Blancone, I graduated December 2021 at the University of Naples with top degree (110/110 with laude). My background has two parts: Geology applied to engineer construction and structural and petroleum geology. Although my background is already broad, my interest and strength points are focused in structural geology, field work in geological survey, displacement and throw analysis fault, seismic interpretation, well log analysis, and reservoir characterization. My hobbies are nature, hiking, trekking, camping and fishing.

Hilde Halsøy

Hilde Halsøy works on the project *Optimizing CO2 foam for EOR and CO2 storage on the NCS*. Foam for mobility control can mitigate CO_2 injection challenges by efficiently increasing CO_2 viscosity and reducing it relative permeability. Foam injection involves injecting a foaming agent (surfactant) with gas, such as carbon dioxide (CO_2) either simultaneously (co-injection) or in alternating slugs (SAG). CO_2 foam injection is a field-tested technique proven to mitigate poor CO_2 sweep efficiencies. Previous CO_2 foam field tests using surfactant-stabilized foam have been reported as technical successes (evidence of foam creation, improved sweep, and enhanced oil recovery) in the literature, whereas others were deemed unsuccessful

due to injectivity problems and limited foam propagation into the reservoir. Thus, an improved foam system (increased stability and mobility control) is required. Therefore a more thorough understanding of size-dependent displacement mechanisms is needed to improve predictive modeling of CO_2 foam to advance the technology for EOR and associated CO_2 storage. Path forward:

- Screen, characterize, and optimize CO_2 foam formulations at reservoir conditions, which are suitable for different rock types, brine salinities and temperatures encountered in selected NCS reservoirs.
- Systematically determine the impacts of key reservoir parameters on CO_2 foam performance and evaluate field-scale controls on combined CO_2 EOR and CO_2 storage efficiency
- Perform detailed modeling and numerical reservoir simulation to upscale the CO_2 foam technology and determine optimal CO_2 storage and displacement strategies in selected NCS reservoirs

Hilde Halsøy

ABOUT THE CANDIDATE

Hilde Halsøy is one of the PhD candidates in work package 2, Net zero CO_2 emissions. She started her PhD work in October 2022. Her main supervisor is Zachary Paul Alcorn from University of Bergen.

Jungwon Seo

I will be working on the NCS2030 project, *Federated Knowledge Cloud for Subsurface Digitalization across Multiple Sites*. The project aims to develop and implement a federated knowledge cloud that enables data management and services for authorized users anywhere. I will be responsible for maintaining the two cloud data hubs hosted at the UiS and Green Mountain data centers and developing advanced data-driven models using federated learning with realistic field data from multiple fields.

The project's goal is to utilize the multi-site data effectively to improve the decisions throughout an operations lifetime, reduce cost, increase recovery, improve health and safety, and reduce environmental impact. Additionally, I will focus on developing computationally efficient physics-informed ML and MF models for subsurface characterization and optimization workflows and making tools for automated labeling, quality checking, stamping, and preparation of available datasets for effective model input and ML.

Jungwon Seo

ABOUT THE CANDIDATE

I am a computer science professional from South Korea with a background in both academia and industry. I completed my bachelor's degree in Seoul and my master's degree at the University of Stavanger (UiS). With several years of experience working as a software engineer in both corporates and startups, I am now pursuing a PhD under the supervision of Chunming Rong and Nan Zhang at UiS, focusing on building a federated knowledge cloud. My interests lie in cloud computing, machine learning, and blockchain, with a specific focus on how they can be utilized in the development of a FedKC.

Associated projects

As the centre builds up its activities, other projects contribute to our goals. These projects include academic, research or industry projects with different sources of funding.

Defining Future Subsurface Education Needs in Collaboration with the Energy Industry (SUBSET)

This project (SUBSET) aims to increase the relevance of subsurface course content to actual needs in the energy industry of the future by establishing an arena for dialogue and collaboration between academia and industry.

Project leader Lisa Watson

The SUBSET project's activities will target a better understanding of the knowledge gaps within subsurface competencies required for the energy transition, how to bridge these gaps, and how to increase the interaction between industry and academia.

The goal is to provide a richer educational experience for the students and continued knowledge exchange between academia and industry. We foresee that the project will increase industry relevance of subsurface education and will create value for all project stakeholders.

The main components of the project include dialogue with all stakeholders, design of improved or new course content, and identification of methods that will maximise the learning experience. The work-plan includes running pilot courses to test the outcome and collect feedback for their evaluation.

The Department of Energy Resources at University of Stavanger (UiS) initiated and will coordinate the project. The department for Continuing Education (EVU) and University Pedagogy Department (UNIPED) at UiS will contribute to the project deliverables.

INTPART: Brazil-Norway Research Education and Competence transfer

The objective of this project is to establish long-term excellent collaboration within Improved Oil Recovery (IOR) education and research groups in Norway and Brazil. Partners are NORCE (project manager), University of Stavanger / National Centre for Sustainable Subsurface Utilization of the Norwegian Continental Shelf (NCS2030), and the University of Campinas in Brazil (UNICAMP)/ Energy Production Innovation Center (EPIC).

Main activities are exchange of students (MSc and PhD) and researchers, development of courses, webinars/workshops/seminars, and development of joint research projects. Research Professor Ingebret Fjelde at NORCE is leading the project.

Project leader Ingebret Fjelde

Twinning to Sustainable Energy Transition (Twinn2SET)

The European Union is facing a pressing challenge to transition into a carbon neutral economy by 2050. Researchers from UiS are participating in a new research project to investigate the key elements of this transition.

The intermediate target is 55% CO2 reduction emissions in comparison to 1990. Climate neutrality goals will be implemented via the EU Green Deal, namely the EU's industrial strategy. However, careful strategic, large-scale investments in enabling technologies and processes are required which will be relevant to each member state's strengths and weaknesses. This way, resilient societies can be built around sustainable energy transition pathways for each state. Twinn2set is part of the Twinning Coordination and Support action, which aims to improve cooperation and capacity building between partners.

The project is coordinated by FORTH in Greece, while Prof. Raoof Gholami is the project leader representing the Department of Energy resources at UiS.

Twinn2set had its kick-off in Chania Crete on October 2nd. Prof. Alejandro Escalona and Associate Professor Dora Marin were the other members of the UiS team that participated in this meeting. This initiative acts as an associated collaborative project to the NCS2030 centre at UiS and other research projects at the Department of Energy Resources.

Raoof Gholami is project leader for both Twinn2SET and SURE

Subsurface Utilization for Renewable Energy (SURE)

This is a research group at the Department of Energy Resources at UiS. The group focuses on three prime areas that are the major drivers towards a carbon neutral future.

- Underground Hydrogen Storage;
- Geothermal Reservoirs; and
- Carbon Geo-sequestration.

The demand to become carbon neutral by 2050 requires a shift from fossil fuels to renewable energy and the decarbonisation of heavy industry using Carbon Capture and Storage (CCS) technology. The group help the department to build its competencies on these matters and to take national and international leadership role in the energy transition era. The group will be focusing on three prime areas that are the major drivers towards a carbon neutral future.

Projects associated to the NCS2030 research centre include: Geothermal energy potential in the Norwegian North Sea with PhD candidate Anaelle Gullevic; Trapping mechanisms and interactions of H_2 in geological porous media with PhD candidate Wendpanga Jean Donald Minougou; and CO_2 utilization and storage with postdoctoral researcher Mojtaba Ghaed.

Around 70 researchers met in the first annual seminar and team building for NCS2030. People got to know each other better, and at the same time opportunities and challenges were discussed.

The seminar was held in Vitenfabrikken in Sandnes. Vitenfabrikken is a museum and science centre. There are three floors of interactive exhibitions as well as a planetarium, a Tesla coil, an audience workshop and Makerspace. One of the attractions is the Lego Challenge, which the NCS2030 researchers were asked to participate in. The challenge was to build the strongest bridge in just 20 minutes.

JOINING FORCES

Prior to this the participants got an introduction to the centre they're now a part of. Centre director Alejandro Escalona (UiS) welcomed everyone and gave a "pep-talk". Chair of board Camilla Vavik Pedersen talked about the industry's expectations. She is representing Equinor, and know better than many that starting up a large centre like NCS2030 requires a lot of effort, good planning, and stamina.

Chief engineer Sølvi Amundrud from the Norwegian Petroleum Directorate (NPD) presented NPD's resource report and their views of the centre's role for energy- and climate sustainability. Finally, the academic partners gave an overview of their expertise and roles in the centre. Ying Guo presented NORCE, Christian Dye presented IFE, Zachary Alcorn talked about University of Bergen and Alejandro Escalona talked about University of Stavanger.

Chair of board, Camilla Vavik Pedersen (Equinor)

Two group work sessions were arranged. First, the participants were asked to list crossdisciplinary challenges and opportunities in reaching the centre's objectives. In the second session Validé gave an introduction to innovation and commercialization. How do we go from basic research to innovation projects? This was the task the participants had to solve.

RESEARCHER'S CHALLENGES

Some of the researchers suggested that the research centre focus too much on student education and not enough on staff/researcher education. They asked for the possibility to arrange workshops for researchers, focusing on presentation skills. Speakers need to project their voice and seem interested in their topic. Another suggestion brought up in the seminar, was the possibility to do more crossover work to geothermal, hydrogen, etc. The centre aims to arrange researcher gatherings at least once a year, bringing researchers and industry representatives together.

Teambuilding at Vitenfabrikken

Lisa Watson, leader work package 7.

NCS2030 director Alejandro Escalona.

Photos: Kjersti Riiber

Skule Strand, Jungwon Seo and Sølvi Amundrud.

Sissel Opsahl Viig.

Anaelle Guillevic, Ingebret Fjelde, Siv Marie Åsen, Kjersti Riiber and Hilde Halsøy won the Lego Challenge at Vitenfabrikken.

Energy Norway 2022

The first Energy Norway conference was arranged 25-26 April 2022. Theme: Subsurface utilization for energy transition.

The conference is an annual meeting place for subsurface professionals in Norway and international communities, policy makers, regulatory bodies, and students. The 2022 edition marked the transition between the two research centres, The National IOR Centre of Norway (2013-2021) and NCS2030 (2022-).

IF STAVANGER SUCCEEDS ...

Terje Lien Aasland, Minister of Petroleum and Energy, sent his greetings in a recorded speak, wishing the University of Stavanger (UiS) with partners NORCE, IFE and University of Bergen (UiB) all the best for the new research centre NCS2030.

”The foundation for the petroleum adventure was laid here. And this area will also play a key role in writing the next chapters of this adventure. If Stavanger succeeds in the green transition, then Norway succeeds,” the minister said in his speech.

In the opening session, former leader of the national IOR Centre, now pro-rector for research at UiS, Prof. Merete Vadla Madland gave a symbolic baton to Ying Guo who has led the IOR Centre the last two and a half years. Guo passed the baton on to Alejandro Escalona who will lead the new research centre, NCS2030.

The conference was streamed and you can see recordings from both conference days at uis.no.

STUDENT COMPETITON

An important part of the Energy Norway conference is to involve our students, from master to PhD level. Each year we arrange a poster competition, the Skjæveland Award, where students are encouraged to participate with a scientific poster as well as a one-minute stand-up to present their research. The award is given to a young researcher who shows excellence, courage and innovation in his or her research, and should motivate for further bold moves towards optimizing oil and gas production.

In the 2022 edition of the conference, Aleksandra Sæle from UiB was awarded the Skjæveland Award.

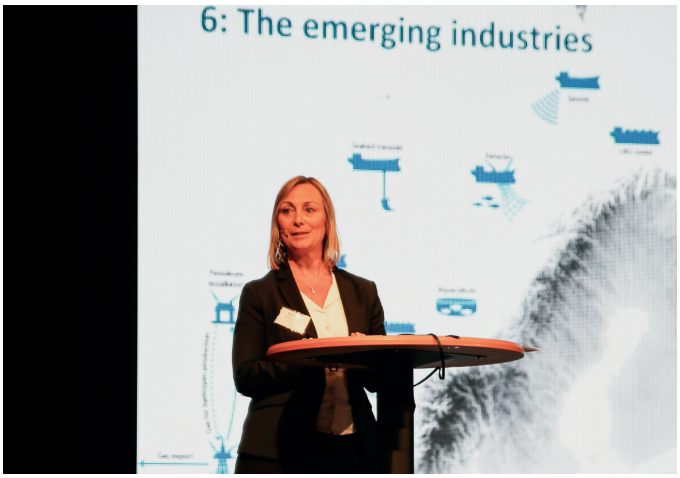
This award got its name after Professor Emeritus Svein M. Skjæveland. Skjæveland has for many years contributed in teaching, research, management and organisation at UiS.

CONFERENCE TOPICS

Our aim is that Energy Norway will continue to be an important meeting place for subsurface professionals in Norway and international communities, policy makers, regulatory bodies and students. Main topics in 2022 were:

- The future of the Norwegian continental Shelf
- Energy-efficient hydrocarbon recovery
- Subsurface opportunities
- Digital subsurface
- Value of data and better decisions

Alejandro Escalona, Merete Vadla Madland and Ying Guo.



Kjersti Dahle Grov, NPD.

Photos: Kjersti Riiber

Tor Øyvind Skeiseid, Malin Torsæter, Hamid Nick and Arne Stavland.

Pernille Wik, Frida Augusta Gudimand and Hallvard Holm Høgemo

Aleksandra Sæle won the Skjæveland Award for best poster presentation at Energy Norway 2022. Left: NCS2030 director Alejandro Escalona.

Communication and conferences

The NCS2030 research centre has been present and/or given presentations at the following events in 2022.

ARENDALSUKA

Arendalsuka (Arendal Week) is a democratic meeting place for community engagement. The centre's director Alejandro Escalona presented and took part in the panel debate "Green transition on the Norwegian continental shelf" which was led by IFE, one of the centre's research partners. The centre's activities were central to the debate on how the Norwegian continental shelf can be converted to a sustainable energy system.

ONS (OFFSHORE NORTHERN SEAS)

The centre was visible at UiS' stand during ONS 2022, and the centre's research was presented during the technical programme. In addition, researchers in the centre participated in ONS+ (academic stand-up), where they talked about their research in a popular science way and then took part in the debate. The event was chaired by the centre's director.

FORCE – FORUM FOR IMPROVED OIL AND GAS RECOVERY

NCS2030 has presented its research in several meetings organized by FORCE in the Norwegian Petroleum Directorate's premises. FORCE has also been an arena where industry can give input to the research in the centre, and a meeting place to discuss opportunities for further collaboration. NCS2030 participated in the panel debate during «The 2022 Annual Event FORCE Technical Committee on Energy Efficiency and Environment».

INTERNATIONAL ENERGY AGENCY IEA-EOR/GOT WORKSHOP

NCS2030 and the Norwegian Petroleum Directorate organized the annual, international workshop for the IEA's technological cooperation programme for enhanced oil recovery, IEA-EOR. The centre was strongly represented in the event committee, presented the centre's activities and also gave technical presentations during the workshops which dealt with research on and experience with improved oil recovery, and oil and gas in the context of energy security and transition.

NOVEMBER CONFERENCE, BRAZIL

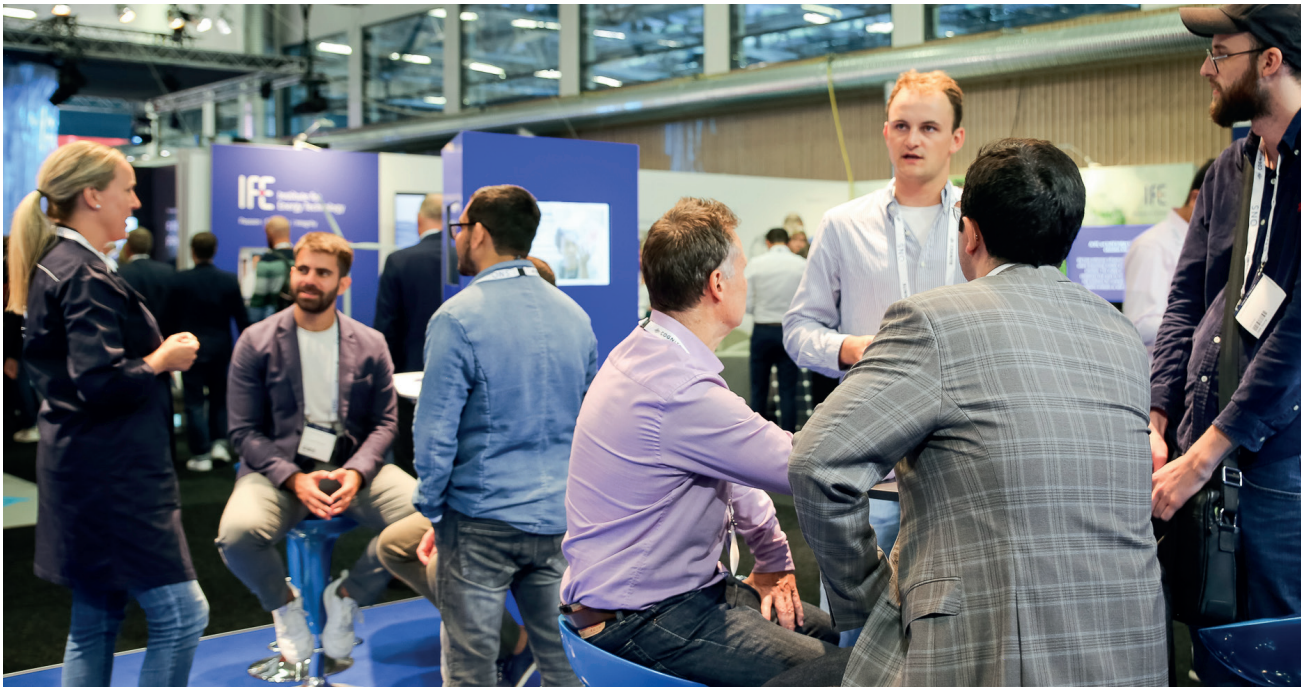
There is a great potential for collaboration with Brazil, and the aim of this conference is to stimulate collaboration between Norwegian and Brazilian academic institutions and companies in the fields of oil and gas, solar and wind power, digitalisation, material technology and marine minerals. Innovation Norway has the formal responsibility for the event. NCS2030 and its partners were profiled at the November conference with several lectures and, in addition, the centre's deputy chair led a session on «Sustainable future oil and gas». Six researchers from NCS2030 participated both in the conference and in visits to NCS2030 collaboration partners at several universities in Brazil; Federal University of Rio de Janeiro, PUC-Rio and Unicamp.

Blåsemafian visited the UiS stand at ONS.

NCS2030 was presented at Arendalsuka in a debate arranged by IFE.

Wiktor Weibull and Tina Puntervold.

A big screen showed films about UiS and NCS2030.



Publications

Journal articles and part of a book

Abbasi, Jassem; Andersen, Pål Østebø.
Theoretical comparison of two setups for capillary pressure measurement by centrifuge. Heliyon 2022 ;Volum 8.(9) s. -
UIS

Abbasi, Jassem; Zhao, Jiuyu; Ahmed, Sameer; Jiao, Liang; Andersen, Pål Østebø; Cai, Jianchao.
Prediction of permeability of tight sandstones from mercury injection capillary pressure tests assisted by a machine-learning approach. Capillarity 2022 ;Volum 5.(5) s. 91-104
UIS

Andersen, Pål Østebø; Salomonsen, Liva; Sleveland, Dagfinn Søndenaa.
Characteristic Forced and Spontaneous Imbibition Behavior in Strongly Water-Wet Sandstones Based on Experiments and Simulation. Energies 2022 ;Volum 15.(10) s. -
UIS

Bellwald, Benjamin; Stokke, Henrik Henriksen; Winsborrow, Monica; Planke, Sverre; Sættem, Joar; Lebedeva-Ivanova, Nina; Hafeez, Amer; Kurjanski, Bartosz; Myklebust, Reidun Alice; Polteau, Stephane.
Structural and fluid-migration control on hill-hole pair formation: Evidence from high-resolution 3D seismic data from the SW Barents Sea. Geomorphology 2022 ;Volum 420. s. -
IFE UiO UiT

Chalub Cruz, William; Luo, Xiaodong; Petvipusit, Kurt Rachares.
Joint History Matching of Multiple Types of Field Data in a 3D Field-Scale Case Study. Energies 2022 ;Volum 15.(17) s. -
UIS NORCE

Guo, Ying; Grønn, Torbjørn Vevle.
Offshore CCUS Value Chain with a Novel Aqueous Based CO2 Capture Technology. SSRN Electronic Journal 2022
NORCE

Guo, Ying.
Energy Transition to the Blue Economy: The Role of Science and Technology. I: Blue Economy An Ocean Science Perspective. Springer 2022 ISBN 978-981-19-5065-0. s. 200-250, NORCE

Guo, Ying.
Offshore CCUS Value Chain with a Novel Aqueous Based CO2 Capture Technology. 16th Greenhouse Gas Control Technologies Conference 2022 (GHGT-16) 2022
NORCE

Liu, Ye; Zhang, Qidi; Zhang, Nan; Lv, Jintao; Gong, Meichen; Cao, Jie.
Enhancement of thin-section image using super-resolution method with application to the mineral segmentation and classification in tight sandstone reservoir. Journal of Petroleum Science and Engineering 2022 ;Volum 216. s. -
UIS

Zhang, Xin-Lei; Xiao, Heng; Luo, Xiaodong; He, Guowei.
Ensemble Kalman method for learning turbulence models from indirect observation data. Journal of Fluid Mechanics 2022 ;Volum 949. s. -
NORCE

Conference contributions and scolarly presentations

Alcorn, Zachary Paul.
CO2 Foam from Laboratory to Field Scale. Energy Norway 2022; 2022-04-25 - 2022-04-26
UiB

Chunming, Rong.
Federated Knowledge Cloud for Energy AI by the National Centre NCS2030 of Norway. The November Conference - Brazil and Norway; 2022-11-07 - 2022-11-09
UIS

Escalona Varela, Alejandro.
Academic Stand-up. Offshore northern seas; 2022-08-29 - 2022-08-29
UIS

Escalona Varela, Alejandro.
Contribution of NCS2030 to the energy transition. IEA EOR TCP workshop and joint EOR/GOT-symposium; 2022-11-22 - 2022-11-24, UIS

Escalona Varela, Alejandro.
National Centre for Sustainable Utilization of the Norwegian Continental Shelf. Joining Forces: Solving the energy challenge together; 2022-04-05 - 2022-04-06, UIS

Publications

Escalona Varela, Alejandro.
NCS2030 – A national research centre for meeting the subsurface challenges of the energy sector and building a sustainable Norwegian Continental Shelf. Offshore northern seas; 2022-08-29 - 2022-09-01
UIS

Escalona Varela, Alejandro.
Towards a sustainable subsurface value chain: NCS2030 national research center, Norway. Centre for Sustainable Subsurface Resources; 2022-09-07 - 2022-09-08
UIS

Escalona Varela, Alejandro; Ashton, Nicholas J.; Dahle, Kjersti; trellevik, ole; Foss, Martin Smedstad.
Grønn omstilling på norsk kontinentalsokkel. Arelnalsuka; 2022-08-15 - 2022-08-15
UIS IFE

Escalona Varela, Alejandro; Marin, Dora; Skjørestad, Håkon.
Energy Transition, the Norwegian Continental Shelf as a Sustainable Subsurface Energy System. GET; 2022-11-07 - 2022-11-09
UIS

Evensen, Geir.
Data-Assimilation Fundamentals: Introduction and ensemble methods. Foredrag; 2022-04-07 - 2022-04-07
NORCE

Evensen, Geir.
Data-Assimilation Fundamentals: Using iterative methods to handle nonlinearity. Seminar; 2022-05-19 - 2022-05-19
NORCE

Evensen, Geir.
The approximations made when deriving data-assimilation methods. Data Assimilation – Mathematical Foundation and Applications; 2022-02-20 - 2022-02-26
NORCE

Gholami, Raoof.
Who wants CCS for Eneregy Mix. Vestland CCUS 2022; 2022-11-22 - 2022-11-23
UIS

Grishko, Elena V.; Yarushina, Viktoriya M.; Bobrova, Maria; Stanchits, Sergei; Minakov, Alexander; Stukachev, Vladimir.
Experimental and numerical investigation of acoustic emission and its moment tensors in sandstones during failure based on the elastoplastic approach. EGU General Assembly 2022; 2022-05-23 - 2022-05-27
IFE UiO

Guo, Ying.
Sustainable Future Oil and Gas industry on The Norwegian Continental Shelf. November Conference, Rio Brazil; 2022-11-07 - 2022-11-09
NORCE

Guo, Ying.
Sustainable utilization of subsurface on Norwegian Continental Shelf - Importance of digital information. SPDM Online conference; 2022-11-28 - 2022-12-02
NORCE

Harding, Torfinn.
Demand side vs supply side climate policies. - UiS Clean Energy Law and Economics Conference,; 2022-11-18
UIS

Harding, Torfinn.
“NCS and the business climate”. - energy-norway-2022:; 2022-04-25 - 2022-04-26
UIS

Luo, Xiaodong; Chalub Cruz, William.
Ensemble Reservoir Data Assimilation with Generic Constraints. ECMOR 2022; 2022-09-05 - 2022-09-07
UIS NORCE

Marin, Dora; cedeño, andres; Rojo, Luis Alberto; Escalona, Alejandro; Dyskeland, Joakim; Skarstein, Guro Laurentze Sætre.
Importance of Evaporitic Successions in Geothermal Energy and Near Field Exploration in the Norwegian North Sea. 83rd EAGE Annual Conference & Exhibition; 2022-06-06 - 2022-06-09
UIS

Marin, Dora; Escalona, Alejandro; Cardozo, Nestor.
Challenges and opportunities for underground storage in salt caverns of the Norwegian North Sea. Third EAGE Global Energy Transition Conference

Publications

and Exhibition; 2022-11-07 - 2022-11-09
UIS

Polteau, Stephane.
Reservoir and Basin-Scale Fluid Migration. Energy Norway 2022; 2022-04-25 - 2022-04-26
IFE

Polteau, Stephane; Wang, Hongliang; Yarushina, Viktoriya M..
Coupled hydromechanical modeling of focused fluid flow structures. EGU General Assembly 2022; 2022-05-23 - 2022-05-27
IFE

Puntervold, Tina.
FORCE Annual Event Panel Debate. 2022 Annual Event FORCE Technical Committee on Energy Efficiency and Environment; 2022-11-17 - 2022-11-17
UIS

Puntervold, Tina.
IOR-Centre to NCS2030. IEA EOR TCP workshop and joint EOR/GOT-symposium; 2022-11-22 - 2022-11-24
UIS

Puntervold, Tina.
NCS2030 - a research centre for sustainable utilization of the Norwegian continental shelf. EOR/IOR FORCE seminar; 2022-11-16 - 2022-11-16
UIS

Puntervold, Tina.
NCS2030 - IOR/EOR aspects. EOR/IOR FORCE seminar; 2022-11-16 - 2022-11-16
UIS

Puntervold, Tina; Marin, Dora.
Subsurface utilization for energy transition. Academic Stand-Up; 2022-08-29 - 2022-08-29
UIS

Wang, Hongliang; Yarushina, Viktoriya M.; Podladchikov, Yury.
Modelling focused fluid flow: What matters?. EGU General Assembly 2022; 2022-05-23 - 2022-05-27
IFE

Yarushina, Viktoriya M..
NCS2030 - WP2. ONS 2022; 2022-08-29 - 2022-09-01
IFE

Zhang, Xin-Lei; Xiao, Heng; Luo, Xiaodong; He, Guowei.
Learning neural network-based turbulence models with ensemble Kalman method. Annual EnKF Workshop 2022; 2022-05-30 - 2022-06-02
NORCE

www.uis.no/en/ncs2030

NCS 2030

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