



**ANNUAL REPORT**

**2019**

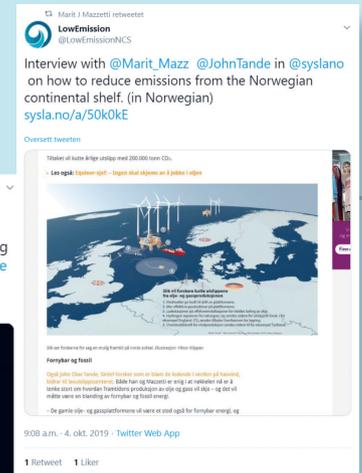
# Selected highlights



## August



## October





# Contents

05	2019 by numbers
06	2019 in review
09	Collaboration will solve the green paradox
12	Message from the Chair
13	Message from the Acting Director
14	<i>LowEmission</i> in brief
18	Vision and goals
21	Research plan and strategy
26	Innovation strategy
28	Organisation
32	Partners
36	International cooperation
37	Research activities and results
56	Education and recruitment
58	Recognitions and visibility
60	Communication
63	Appendices



24 INDUSTRY PARTNERS



2 RESEARCH PARTNERS

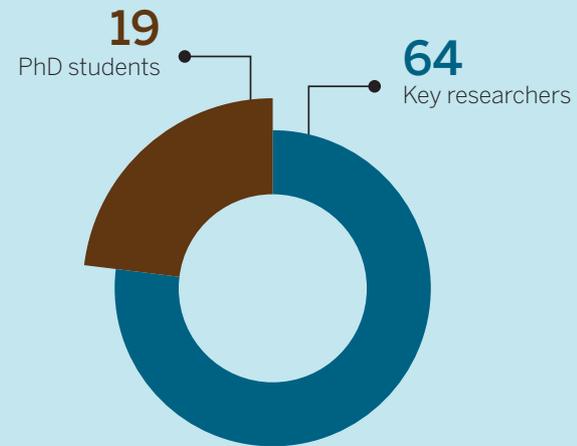
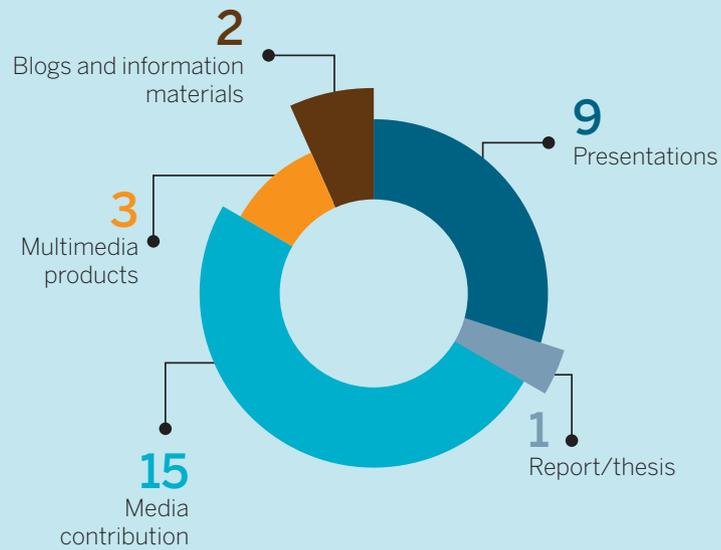


8 YEARS



316 MNOK

# 2019 by numbers



# 2019 in review

*LowEmission* aims to pave the road towards zero-emission production of oil and gas from the Norwegian Continental Shelf (NCS). *LowEmission* develops new technology and concepts for offshore energy systems and integration with renewable power production technologies. The overall objective is to accelerate development and implementation of low-emission offshore technologies on the NCS and help the Norwegian petroleum industry to meet their 2030 and 2050 emission reduction targets.

The Centre will strive to pave the way for zero-emission petroleum production by 2050. *LowEmission* is a platform for innovation, and strong interaction within the Centre will generate spin-off projects and technology transfer possibilities for the industry.

*LowEmission* (the Research Centre for Low-Emission Technology for Petroleum Activities on the Norwegian Continental Shelf) is a Centre for Petroleum Activities (PETROSENTER).







A helicopter is shown in flight, carrying a large component, likely a turbine nacelle, over a floating wind farm. The wind turbines are mounted on a platform in the ocean. The scene is set against a dramatic sunset sky with warm orange and yellow tones. The helicopter is positioned in the upper left quadrant of the image.

# Collaboration, not competition will solve the green paradox

If there's a riddle that defines our time, it must surely be how we get to net zero CO<sub>2</sub> emissions while still delivering energy to billions of people.

*Hywind Tampen floating wind farm - illustration.*

Photo: Equinor

## Collaboration, not competition will solve the green paradox

Different countries have different priorities in tackling this green paradox. While Norway is almost totally reliant on renewable energy for its domestic needs in the form of hydropower, there is a big issue to be addressed.

To keep the world supplied with energy, oil and gas will remain a critical part of the energy mix during the transition to a more flexible energy system. However, the industry consumes vast quantities of energy and is responsible for one-quarter of Norway's CO<sub>2</sub> emissions. That being said, environmental and climate standards in the Norwegian petroleum industry are high compared to other countries, and emissions fell every year between 2015 and 2018.

But to really move the needle, a more collaborative approach is required. Almost all Norwegian oil and gas companies have joined *LowEmission*, which has more than 80% coverage of the licenses on the Norwegian Continental Shelf. In addition to oil and gas operators, a diverse group of experienced vendors are on board and will actively work together with SINTEF and NTNU researchers on solutions that benefit all.

"*LowEmission* sits between many areas of research, from bigger picture climate goals to specific oil and gas projects. The difference with Low Emission is the focus is on reaching net zero emissions for the production of oil and gas. It's



Kristin Jordal, SINTEF Energy Research.

a very clear and attractive mandate," explains Kristin Jordal, Senior Research Scientist at SINTEF Energy Research.

She believes that's the reason so many industrial partners have chosen collaboration as a complement to competition and joined *LowEmission*. "The solutions we plan to develop are not the core business of oil and gas companies, but represent methods and technology developed from the interplay between new need, excellent expertise in the companies and strategic research in a variety of disciplines they all need," adds Kristin.

Industrial buy-in is always hoped for in such a large research centre, but the scale of interest has both surprised and delighted the Centre management. The reasons given are many and varied, yet all highlight the importance of coming together to solve the green paradox, representing real transition opportunities making the ambitious goals reachable, and fostering new business opportunities.

"It's our goal to be a key player in the future energy transition, and the *LowEmission*

Centre fits that goal perfectly. This is all about cooperation, and we need to stand together. If industry doesn't engage with research, we are not going to achieve what we need to as a collective," explains Jan Petter Pettersen, an asset manager at Repsol Norway.

Jan Petter joined five of his colleagues at a recent *LowEmission* workshop, highlighting the importance of taking part to find solutions that everyone can benefit from. "Besides power from shore, there is an industry-wide struggle to find good low-emission solutions," he says.

Charlotte Berge, Field Development Director for Lundin Norway, agrees that industry needs to take a collective approach: "This issue is far bigger than any one company, so collaboration is essential."

Charlotte adds that developing new technology is a key focus area, and that she is pleased with the early progress: "The special projects identified are spot on and the teams are motivated so it will be exciting to watch. We are happy to share data and excited to see what we can achieve together.

# Message from the Chair

The 2015 Paris Agreement requests each country to outline and communicate their post-2020 climate actions, known as their nationally determined contributions (NDCs). Together, these climate actions determine whether the world achieves the long-term goals of the Paris Agreement and reaches global capping of greenhouse gas (GHG) emissions as soon as possible. The EU plays an important role as a global leader in climate policy, and the Green Deal comes at a crucial point in time and intensifies efforts to mitigate climate change and increase energy security.

Norway is a large exporter of oil and gas and a major energy supplier to the EU. We have just (2020) updated our NDC and by this submission have pledged to reduce emissions by at least 50 per cent and towards 55 per cent compared to 1990 levels by 2030. The oil and gas industry is responsible for about 25% of the Norwegian

GHG emissions and it is thus essential that the industry takes its share of the emission cuts to reach Norway's 2030 target, and the Low Emission Center has a very important role to play in this respect.

The timeframe (2019-2026) and objectives of the PETROSENTER Low Emission are very well aligned with the Norwegian 2030 target and the research will span from reducing the offshore energy consumption to limiting, or even removing, the CO<sub>2</sub> emissions from the heat and power generation.

I am very proud to be part of this PETROSENTER and look forward to working with this large group of oil and gas operators, suppliers and research organizations to develop and implement technology solutions that will have a real impact on offshore GHG emissions.

Hege Rognø  
Chair of the Board, *LowEmission*



## Hege Rognø

Hege Rognø has more than 30 years of experience from the oil industry, both from field operations, business development and technology development. She has international experience (UK, Australia) and in 2009-12 she headed Equinor's East Coast Canada office in St. John's. Since 2016, she has been heading Equinor's technology development within Low Carbon Oil&Gas Technologies including Low Carbon Power&Heat solutions for offshore/onshore applications.

# Message from the Acting Director

*LowEmission* is well underway and we are all working towards a common goal – zero emission oil and gas production on the Norwegian Continental Shelf (NCS) by 2050.

Activities so far have focused on initiating work in the various technology areas. The deliverables have centred around outlining state-of-the-art technology, and initiating experimental work involving HSE processes and preparing technical equipment. On the management side, the focus was on the Consortium Agreement and the governing structure.

Lower cost electrification is a pillar of *LowEmission*. In one case studies, we look at potential 10-15% cost reduction on implementation. In another, we look into a hybrid solution that combines different technologies, like *offshore wind* coupled with *combined cycle gas turbines*, or the use of alternative fuels like H<sub>2</sub> and NH<sub>3</sub> in combination with batteries.

Reducing energy consumption from oil drilling platforms is another goal. One example deals with reducing water injection in wells. Water injections makes up about 50% of total emissi-

ons from platforms today. We are looking at both topside and subsea projects.

Three important focus areas in moving forward have been identified:

**Accelerating technology development:** If the industry is to remain leading in the global low emission technology effort, technology development rate must increase. This is important, not only to secure technology export to other oil & gas producing countries, but also to decrease costs in the long run, ultimately making the technologies implementable globally.

**Reducing costs:** We strive to find new and efficient solutions to reduce development costs. This includes production equipment with less weight, less need for, and better use of materials. Automatization, digitalisation and smart utilization of concepts are key.

**Communication:** Communication in 2019 centred around implementation of energy efficient and renewable technology. The Centre had meetings and workshops with parties from the Norwegian O&G industry and was



## Marit Jagtøyen Mazzetti

Dr. Marit Mazzetti is the Acting Director and Centre Manager. She is a Senior Research Scientist at SINTEF Energy Research since 2011 and has more than 25 years of experience from energy and environment research, development and innovation. During the last seven years she has managed large projects on reduction of offshore CO<sub>2</sub> emissions. She is the author of eight patents and 136 publications.

visible through TV, newspapers, national radio, magazines and social medias. The focus on communication will continue in the years to come.

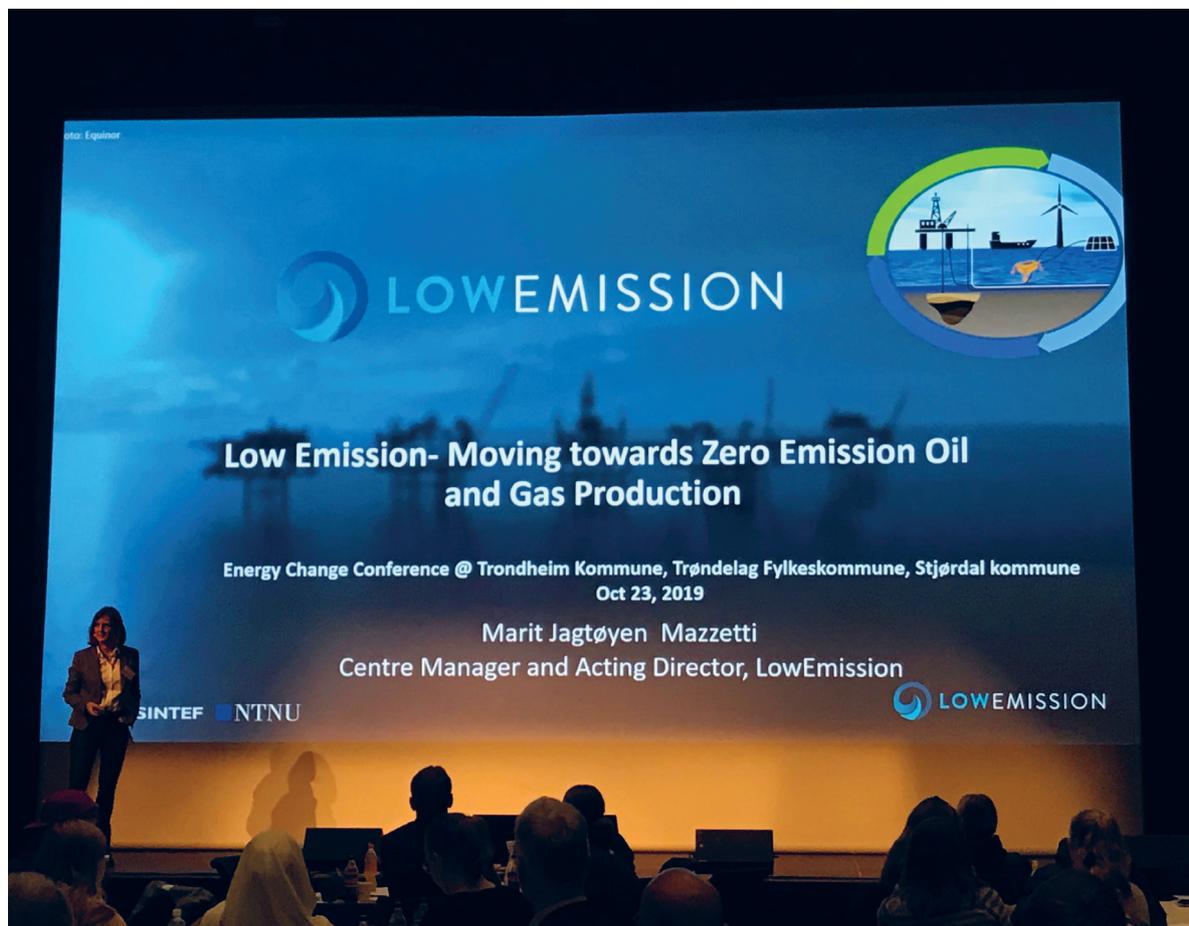
We thank our partners for an excellent first year and hope you are as excited as us about the continuation!

Marit Jagtøyen Mazzetti  
Acting Director and Centre Manager, *LowEmission*

# LowEmission in Brief

*LowEmission* is a Research Centre for Low-emission Technology for Petroleum Activities on the Norwegian Continental Shelf (NCS). World-leading Norwegian and international industrial entities including vendors, operators and energy companies joins forces with globally recognized research groups at SINTEF and NTNU, and other top-rated universities and research institutes. The mission is to pave the road towards zero-emission production of oil and gas from the NCS.

*LowEmission* develops new technology and concepts for offshore energy systems and integration with renewable power production technologies. This will accelerate development and implementation of low-emission offshore technologies on the NCS and help Norwegian industry to meet its 2030 goal of 40 % reduction in greenhouse gas emissions and move towards the 2050 goal of zero emissions from new facilities. *LowEmission* is a platform for innovation, and strong interaction within the Centre will generate spin-off projects and technology transfer possibilities for the industry.



## 2019 ACHIEVEMENTS

For obvious reasons, a research centre in existence for only three months has a limited number of results to report. Still, during the hectic period since the signing of the Consortium Agreement in September 2019, the following was accomplished:

The **research plan and strategy** for the Centre is established. Since the application, the plan has been adjusted and refined with input from partners and researchers.

Most of the *LowEmission* **organization** is established. Leading positions and committees have been filled, and the Centre has obtained a solid number of partners. The exception is the Scientific Committee, which will be set up early 2020.

A framework for **cooperation between partners** is established with the *SP families* as a central element. Sub-project (SP) families are groups of researchers and industry representatives working together to solve issues relevant to the respective SPs. The first annual Consortium Day was held in December.

The Annual **Working Plan (AWP) 2020** was completed before Christmas. This plan is a compilation of all research and management activities to be carried out next year. New AWP's will be developed for each year the Centre is in operation. In addition, several of the SPs have also started their research activities.

Education of **PhD and Postdoc candidates** is a central activity in *LowEmission*. The recruitment process started in 2019 with advertising campaigns, and the first candidates are ready to start their projects in March/April 2020. A candidate production plan for the whole Centre period is in place.

A **communication strategy** was developed. This strategy will serve as the basis for developing communication plans for the coming years.

**Health, Safety and Environment (HSE)** routines are carried out in compliance with requirements set forth in the Centre Consortium Agreement as well as instructions stipulated by the partners. All partners are required to have an implemented HSE policy and a documented management system, complying with the legal requirements

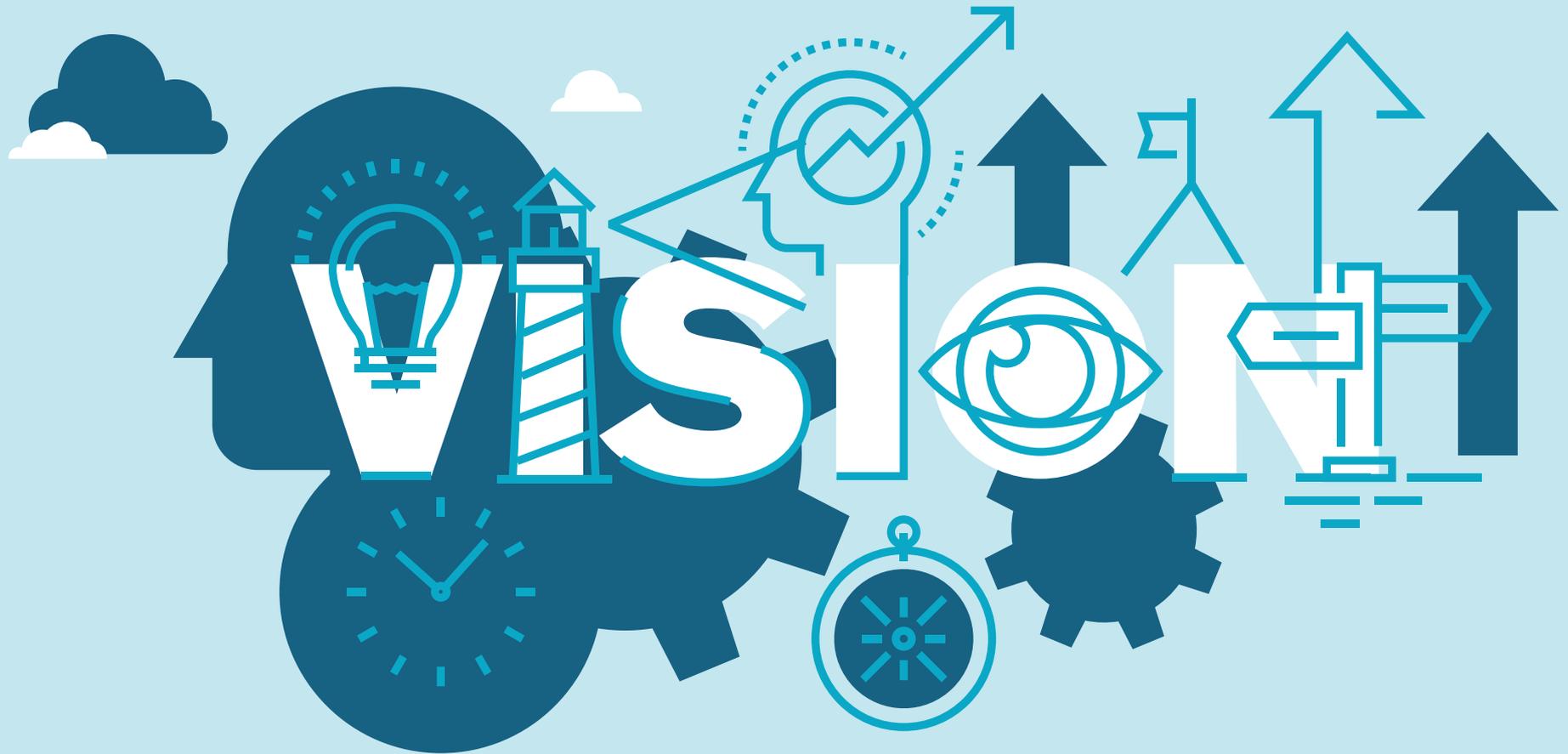
related to control and follow-up of HSE. Incidents, accidents and near misses are reported without undue delay to the Centre, and HSE statistics are presented to the Board on a regular basis.

*Minister of Petroleum and Energy, Kjell-Børge Freiberg cuts the ribbon and opens the Centre in front of enthusiastic SINTEF and NTNU employees.*





# Vision and goals





## Goals

***LowEmission* aims to develop technologies and solutions needed to reduce offshore greenhouse gas emissions on the NCS by 40% within 2030 and to move towards zero emissions in 2050.**

### **Sub-objectives of *LowEmission* are to:**

- Develop solutions for co-optimizing power supply and demand in the offshore energy system.
- Reduce cost of *LowEmission* oil and gas technologies by 5-50 %.
- Develop a digital energy management tool for planning energy use of fields and the CO<sub>2</sub> footprint of operational choices over the life of the field including short- and long-term uncertainty.
- Provide 10-15 innovative solutions for offshore emission reductions.
- Generate 8 KPN, 10 IPN, 4 DEMO and 4 EU spin-off projects.
- Educate 16 PhD students, 2 Post Docs, 30 MSc candidates, and training, recruitment of 20 experts in offshore low-emission technologies.
- Disseminate and communicate project results in 70 journal and conference papers, present in O&G specific workshops and meetings such as ONS and OTC, and disseminate news articles.
- Perform brown and green-field case studies to demonstrate actual emission reductions.

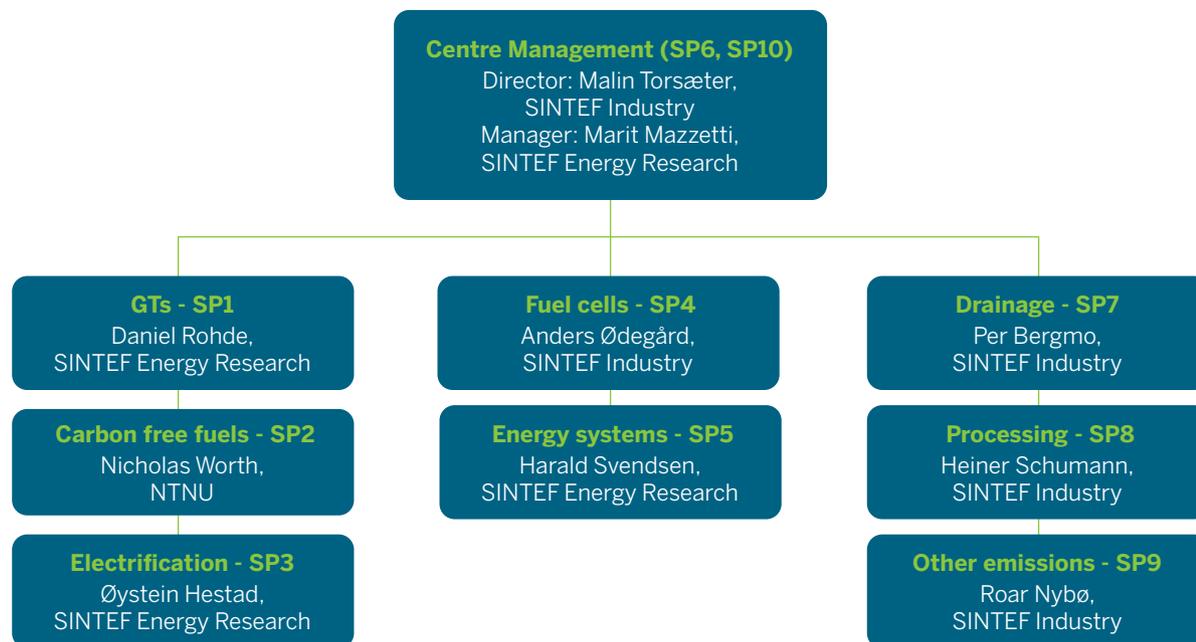
### **The successful outcome of *LowEmission* will enable the industry partners to:**

- Facilitate rapid deployment of low emission technologies and system solutions that reduce offshore O&G-related GHG emissions
- Increase value creation in the Norwegian O&G industry
- Commercialize products based on *LowEmission* results in the international market
- Create new digitalized decision-support and planning tools for operators and vendors
- Perform relevant case studies with emphasis on the system perspective





## SINTEF Energy Research



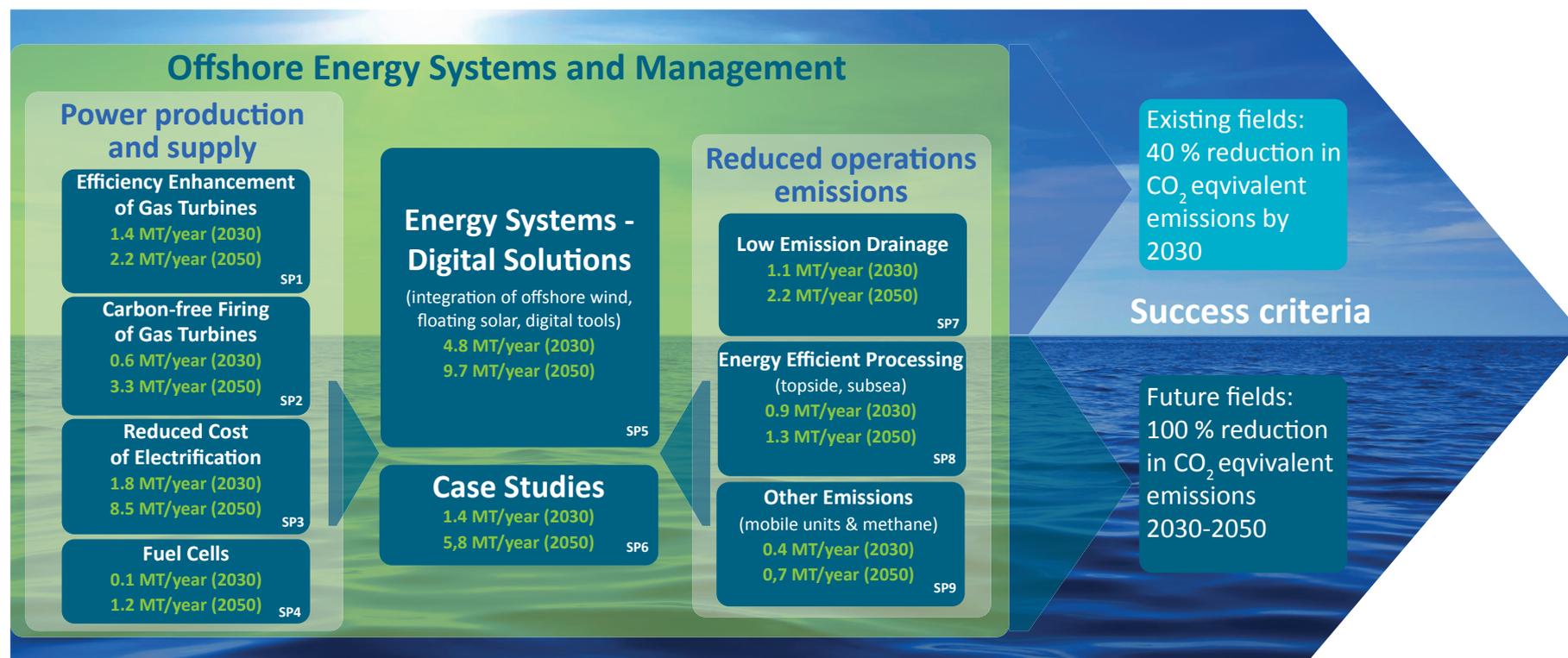
LowEmission work breakdown structure.

The ambitious emission reduction goals of *LowEmission* require extensive and targeted cross-disciplinary research with close involvement of industry experts. The Centre is split into nine sub-projects (SPs). The research topics have been selected based on the impact they will have on reducing offshore CO<sub>2</sub> emissions.

The process for selecting the topics has been extensive and with important inputs from the industry partners. Each SP comprises research tasks and methods that will advance state-of-the-art. The tasks have been selected to balance both short-term and long-term needs to meet the ambitious goals of 30% emission reduction by 2030 and zero emissions by 2050.

The technologies listed in the top half of the centre's structure are generally more likely to be implemented early to have a significant impact

on reducing Norway's emissions by 2030, the technologies in the lower half of the structure have more long-term abilities.

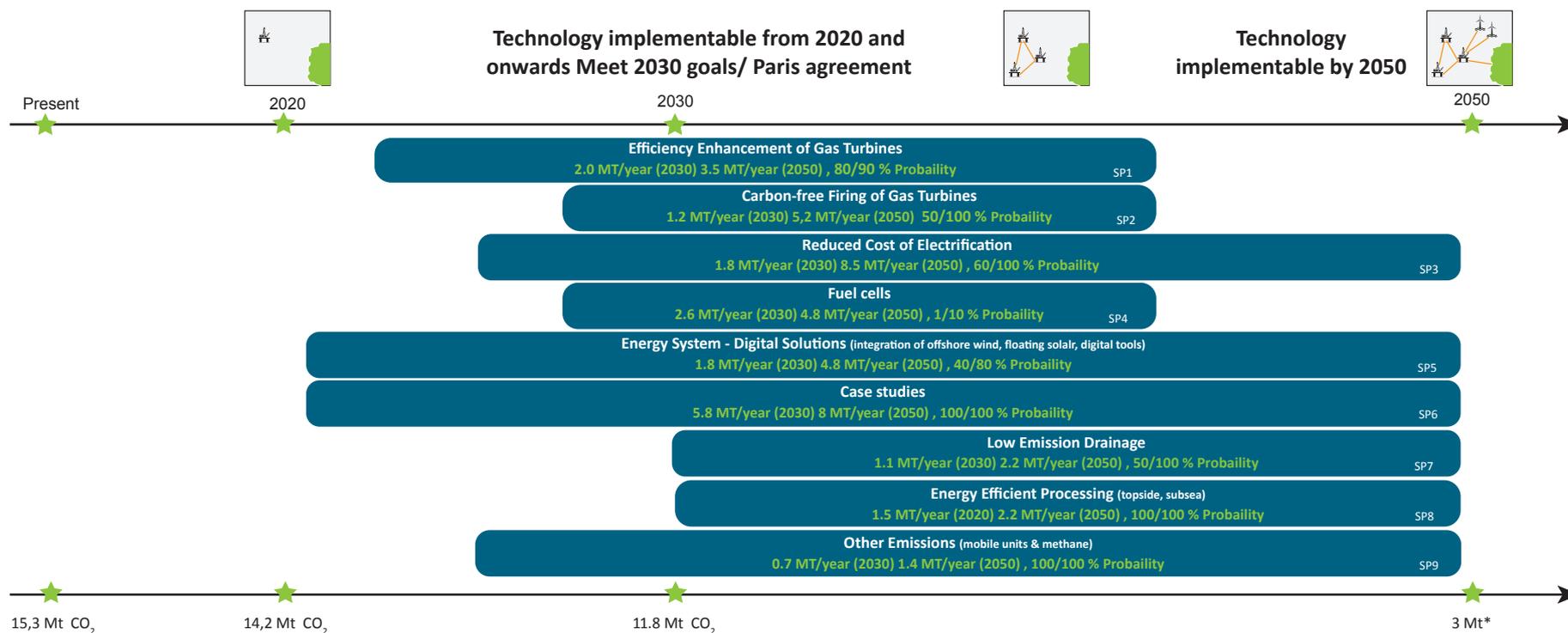


LowEmission Centre structure.

The timeline below shows the likely implementation of the different technologies. There will be close collaboration between the SPs to integrate top-down and bottom-up research

on low emission technologies and solutions. SP6 Case Studies is a sub-project designed to stimulate collaboration between researchers and industry from different parts of the offshore value

chain, hence creating an interface for potential innovations.



Timeline for implementation of Low Emission Technologies.



*Hywind Tampen floating wind farm Snorre platform - illustration.*

Photo: Equinor

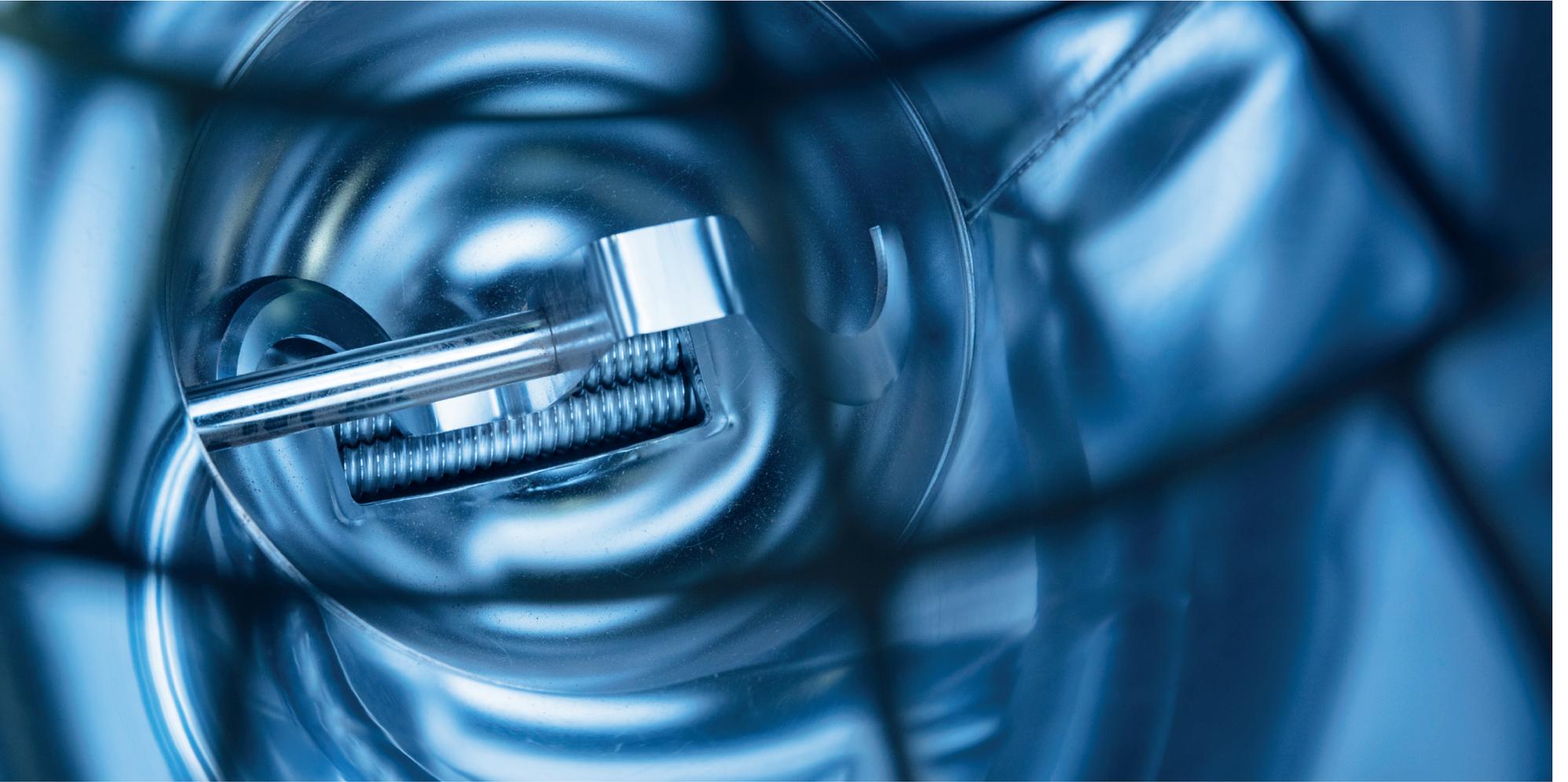
# Innovation strategy

*LowEmission* aims to be a platform for competence building, and the sharing and promotion of innovation and value creation for industry. The partnerships between industry end-users, vendors and research institutions is a driving force, Stimulating the innovation process and Shortening the path from research to commercial products.

*LowEmission* promotes *open innovation* to optimize technology output across company borders and increase the gain for each company involved. The pool of ideas will be greater than that of each company, and partners can commercialize ideas and technologies created outside company borders. By facilitating opportunities for industry to collaborate and bring technologies to the market, the Centre can make a major impact in terms of value creation both on the NCS and around the world.

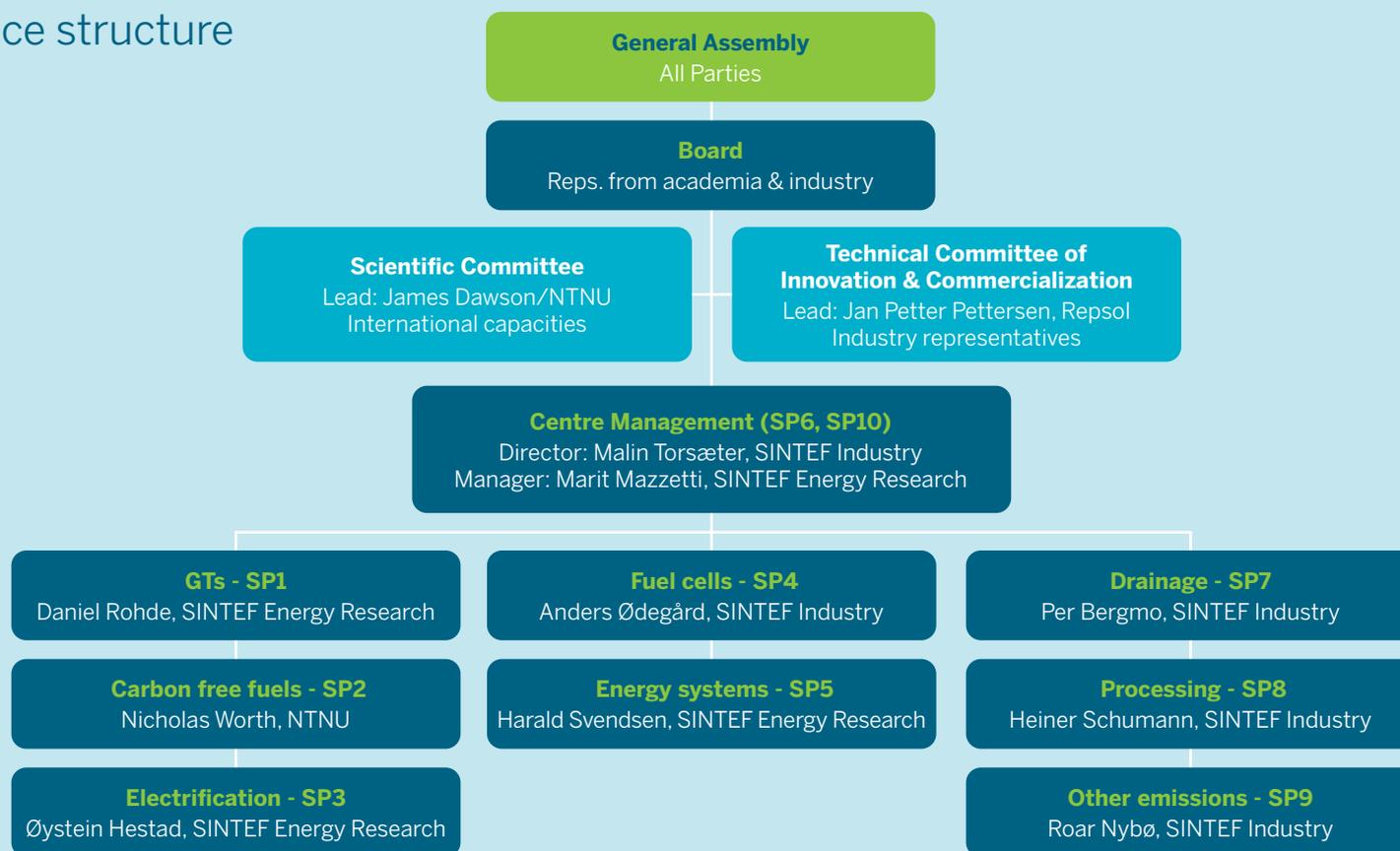
Industry-driven case studies will be conducted through Sub-Project 6 – Case Studies & Innovation, focusing on 1-2 year periods, to show emission reductions from technology implementation on NCS fields. Studies will depend on industry partners making the necessary data available to evaluate emission, weight- and cost reduction. Industry will play a vital role in ensuring implementation through in-kind contributions/expertise. The output will be emission reduction potential and weight/cost data for implementing technologies providing a foundation for spin-offs or demonstration projects..





# Organisation

## Governance structure





**Malin Torsæter**  
**Centre Director**  
 Research Manager  
 SINTEF Industry



**Marit J. Mazzetti**  
**Centre Manager**  
 Senior Research Scientist  
 SINTEF Energy Research

## Centre Management Team



**Stefania O. Gardarsdottir**  
**Centre Operations**  
 Research Scientist  
 SINTEF Energy Research



**Jon Magne Johansen**  
**Business Developer**  
 Senior Business Developer  
 SINTEF Energy Research



**Ragnhild Skorpa**  
**Centre Operations**  
 Research Scientist  
 SINTEF Industry



**Anders Ødegård**  
**Centre Operations**  
 Senior Project Manager  
 SINTEF Industry



**Lars Magne Nonås**  
**Centre Operations**  
 SINTEF Ocean



**James Dawson**  
**Scientific Committee**  
 Professor  
 NTNU



**Jan Petter Pettersen**  
**Technical Committee of Innovation & Commercialisation**  
 Asset Manager Blane  
 Repsol Norge AS

## Board

The Board of the *LowEmission* Research Centre is the operative decision-making body for the execution of *LowEmission* and reports to and is accountable to the Centre assembly which consists of all partners in *LowEmission*. The Board is led by industry with representatives from industry, SINTEF and NTNU.

**SINTEF Energy Research** Mona J. MølInvik

**SINTEF AS** Rune Bredesen

**NTNU** Olav Bolland

**NTNU** Ole-Morten Midtgård

**Equinor** Hege Rognø (Chair)

**Lundin** Charlotte Berge

**Wintershall Dea** Michael Charles

**Repsol** Espen Enge

**Vår Energi** Oddvar Ims

**ABB** Tor-Christian Ystgaard

**TechnipFMC** Marc Cahay

**Aker Solutions** Knut Nyborg

**Siemens** Jenny Larfeldt

**Research Council of Norway** Ingrid Anne Munz  
(observer)

## Scientific Committee

International academic collaboration is of highest importance to the excellence and success of *LowEmission*. To support and stimulate the scientific progress of *LowEmission*, a Scientific Committee will be established in 2020. The Scientific Committee shall be an advisory committee with leading international academic capacities giving guidance towards scientific progress and shall provide strategic advice on scientific focus and priorities. Professor James Dawson (NTNU) will lead the Scientific Committee.

## Technical Committee of Innovation & Commercialization

*LowEmission* strives to be a dynamic centre, targeting challenges of high relevance to industry. To continuously focus on industry-relevant challenges, a Technical Committee of Innovation & Commercialization (TCIC) was established in 2019. The TCIC consists of and is led by industry, and its purpose is to evaluate commercial potential and identify spin-off projects. This includes reviewing Annual Working Plans and evaluate progress in Sub-Projects as well as advising the Board on new research directions. Mr. Jan Petter Petterson (Repsol) is the leader of the TCIC.



NTNU Campus.

# Partners

## Operators:



## Service & vendors:



Research & development:



Public financing:



Associated Research Entities:



Associated agencies:



## Cooperation between partners

**SP families.** A cornerstone in the cooperation between partners is the *Sub-Project Family*. Each SP has invited industry representatives from the partners to join with the researchers in groups (families) to collaborate on issues related to the SP. The SP families discuss such issues as strategies, operational plans for the coming year, communication and dissemination activities, and research results, and will also perform quality assurance of results and publications. SP families will most often meet via Skype or webinars, but physical meetings will also take place.

**Consortium Day.** The first *LowEmission* Research Centre Consortium day was held in Trondheim on December 5, 2019, with more than 80 participants. The whole-day meeting included plenary presentations from industry partners, highlighting their expectations to the Centre and the importance of the petroleum industry to take a leading role in development of low-emission technologies. The leaders of the Sub-Projects (SPs),

gave previews of their activities so far, to warm up the participants for the breakout sessions, which focussed on the issues: 1) Power production and supply, 2) System integration, and 3) Reduced offshore energy consumption. The breakout sessions allowed for discussions on research activities, innovation potential and how to shorten the path from research to implementable technologies, to name a few. Hot topics such as use of hydrogen and renewables in offshore energy systems, abatement of offshore methane emissions, subsea production technologies and material development for reducing cost of electrification, sparked lively discussions and even ideas for new research questions. The Consortium Day will be an annual event throughout the Centre period.

**Mobility and researcher exchange.** An early activity for 2020 is to establish a program for mobility and researcher exchange between partners. PhD and postdoc candidates are encouraged to spend time at other academic institutions, and partner researchers are encouraged to visit consortium partners – for shorter or longer periods.



Acting Centre Director and Centre Manager  
Marit Mazzetti and Centre Director Malin Torsæter



# International cooperation

International collaboration and dissemination are paramount to the excellence and success of *LowEmission*. The Centre capitalises on contributions both from the academic research partners and the industry. The communication and impact of the research results benefits greatly from the international collaboration in the Centre. The international penetration of Norwegian industry will also benefit by the adoption of transnational collaboration schemes. Globally leading universities and research centres secure a high academic tenure, while a strong commitment from the industry shall ensure the implementation of the Centre objectives.

At the academic level, *LowEmission* collaborates and plans to organize researcher exchanges with top-rated international universities and research institutes such as:

- University of Strathclyde, UK
- Technical University of Denmark
- TNO, the Netherlands,
- Carnegie Mellon University, USA
- Lund University, Sweden
- Stanford University, USA
- University of Cambridge, UK

- CERFACS, France
- Imperial College, UK
- Sandia National Laboratories, USA

An exchange program for PhD students and researchers will be established to facilitate shorter (1-2 months) and longer stays abroad (up to one year). One international stay is planned per PhD. 2-3 visiting researchers are planned for 18 months total.

An individual research plan will be developed for each PhD student/postdoc, based on the research needs of the Centre. Furthermore, the Centre will establish collaboration groups between PhD students, supervisors, SINTEF researchers and relevant industry partners to endeavour maximum synergy and integration at the task level. An exchange program for PhD students and researchers will be established to facilitate shorter (1-2 months) and longer stays abroad ( $\approx$  1 year).

# Research activities and results



# SP1



## Efficiency enhancement of gas turbines

### SP DESCRIPTION

This SP focuses on the design of Combined Cycles Gas Turbines (CCGTs) where the exhaust heat runs a Steam Bottoming Cycle (SBC) for additional power generation and increased efficiency. New, compact, and efficient SBC heat exchangers, designed for varying heat transfer and boiling regimes along the heat exchanger tubes, are essential. Design of efficient CCGTs includes development of effective control strategies for gas turbine and CCGT operation.



**Daniel Rohde**

Research Scientist, SINTEF

### Main objective

The main objective is to reduce the emissions related to offshore gas turbine operation. Two approaches are being investigated. The first one is increasing the gas turbine's efficiency during part-load operation. The second approach is to recover heat from the exhaust gas to produce electricity and/or heat in a bottoming cycle. This concept has been implemented before, but the large weight and footprint impede widespread implementation. Focus is therefore one developing more compact and lightweight designs, possibly using other working fluid as steam

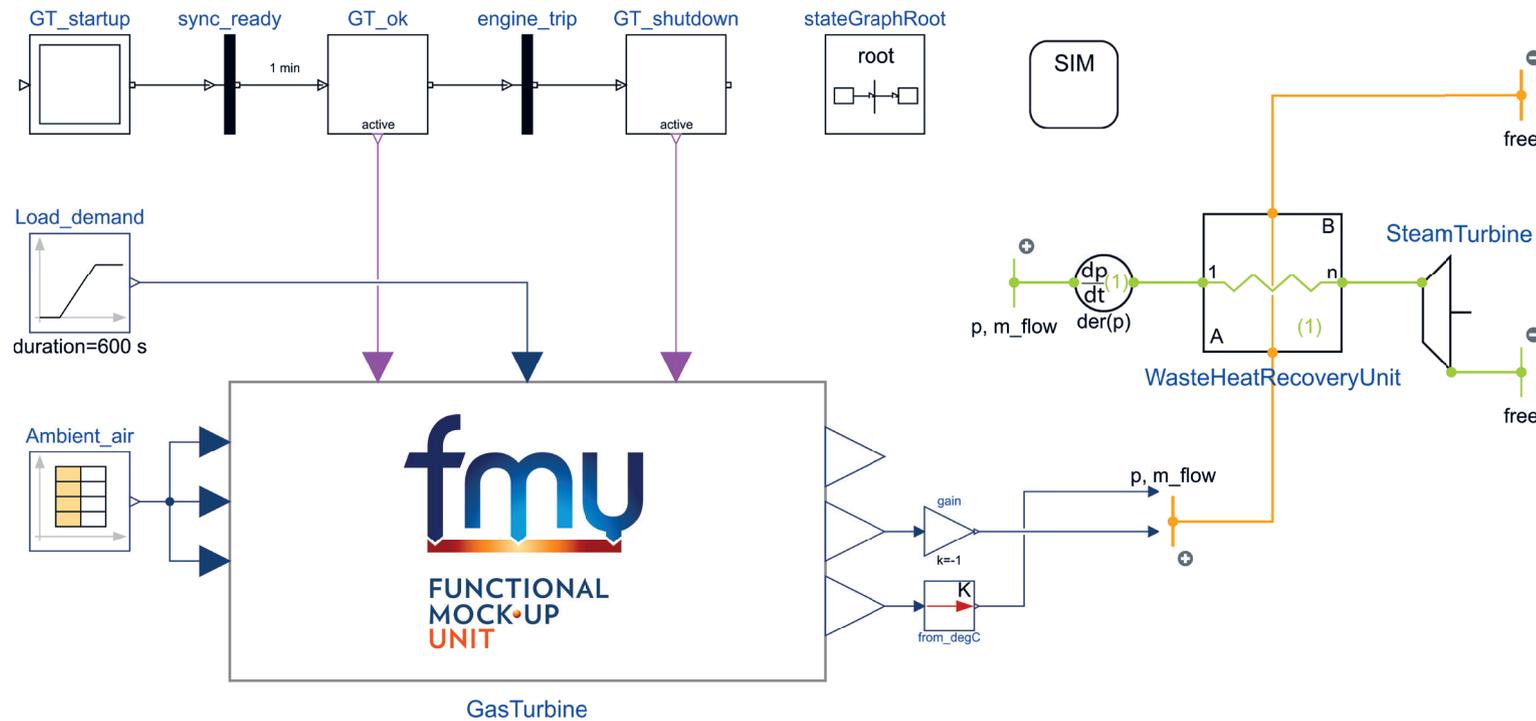
### Main results

- PhD position announced. Topic: "Assessment of alternative concepts for combined cycle gas turbine operation under varying loads".
- A report about gas turbine operation and transient behavior was written as basis for future research.
- A first working fluid screening was performed to compare possible working fluids that can be used in a bottoming cycle (as alternative to steam).

- The dynamic modelling and simulation of a combined cycle gas turbine was initialized in cooperation with Siemens.

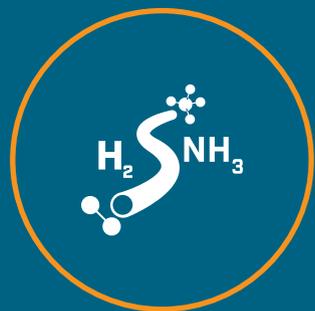
### Impact and innovations

- More efficient gas turbine operation
- Compact bottoming cycle designs, possibly with new working fluids, enabling widespread implementation



Early-stage dynamic simulation model of a combined cycle gas turbine in Dymola.

# SP2



## Carbon-free firing of gas turbines

### SP DESCRIPTION

The SP conducts research and development of gas turbine combustion concepts for hydrogen, and ammonia firing, with the aim of achieving a 100% reduction in CO<sub>2</sub> emissions from gas turbines. The potential use of these fuels will be investigated through targeted improvements to current combustion technology and the development of new combustion technology.



**Nicholas Worth**

Associate Professor, NTNU

### Main objective

The overarching objective of SP2 is to advance the capabilities for carbon-free firing of the gas turbine fleet (existing and future) relevant for deployment on the Norwegian Continental Shelf (NCS). The proposed research approach in SP2 follows two main tracks:

- 1) WP1, NH<sub>3</sub>/H<sub>2</sub>/N<sub>2</sub> blending: The first track will investigate how to optimize hydrogen blending with opportune carbon-free diluents, such as ammonia/nitrogen, that act to *reduce hydrogen reactivity* to obtain a step-in fuel for natural gas. This will provide the GT-manufacturer with guidelines for optimal operation and improved design of the combustion system.
- 2) WP2, Flamesheet: The second track will focus on the gas turbine combustion system *handling of hydrogen reactivity* without dilution, which potentially offers more robust aerodynamics that are flashback resistant.

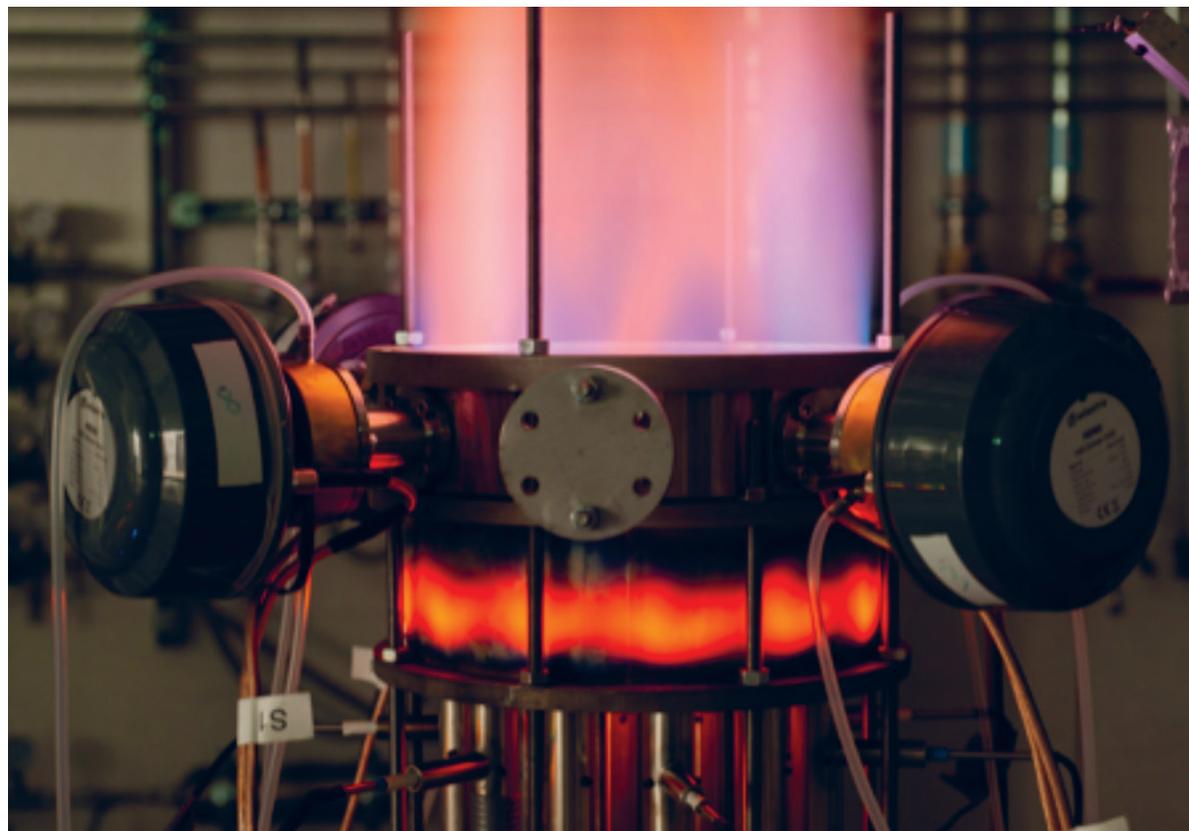
### Main results

The main results in 2019 relate to the planning and organization of upcoming experimental and numerical campaigns in the two tracks, in addition to organization activities associated with research collaborations. The following list of deliverables and milestones has been realised:

- A contract has been signed with Robert Barlow, to work collaboratively with TU Darmstadt on fundamental measurements of ammonia/hydrogen flames structure.
- An experimental plan for SGT750-type burner pressurized combustion testing with ammonia/hydrogen/nitrogen fuel blends has been made.
- An experimental plan for Flamesheet-type burner pressurized combustion testing with undiluted hydrogen has been made.

### Impact and innovations

The work in SP2 is not yet at a stage where impact and innovation can be accurately assessed.



# SP3



## Reduced cost of electrification

### SP DESCRIPTION

This SP develops new technology for electrifying offshore installations. Emphasis is on reducing costs without sacrificing system reliability for the energy system and key components. A novel approach using wet design of high-voltage offshore cables in combination with subsea compensation units to enable long distance AC power transmission will be investigated. This gives lighter cables without the need for a metallic barrier to prevent water ingress, and reduced costs for production and laying the cable.



**Øystein Hestad**  
Research Manager, SINTEF

### Main objective

The gas turbines utilized for offshore power production today emit large quantities of greenhouse gases (GHG). Electrification from shore may drastically reduce these emissions. While the technology for electrification is already available, it is not often used as the price of electrification is high. The emphasis of SP3 is on reducing costs without sacrificing system reliability for the energy system and key components. The main objectives are to:

1. Identify/develop cost-efficient reliable power components for offshore/subsea power distribution
2. Test components/insulation systems based on models of typical load patterns
3. Develop models for estimation of GHG emission reduction due to electrification

### Main results

- Completed preliminary study identifying optimal offshore grid layout with full electrification of the NCS
- Dynamic Mechanical Analysis (DMA), Thermo-Mechanical Analysis (TMA), Differential Scanning Calorimetry (DSC) expe-

periments have been performed on samples taken from three HV 145 kV XLPE land cables. Two of these cables were operated under wet conditions until they suffered breakdown due to water treeing. The third cable has never been in service and is used as a reference in this study.

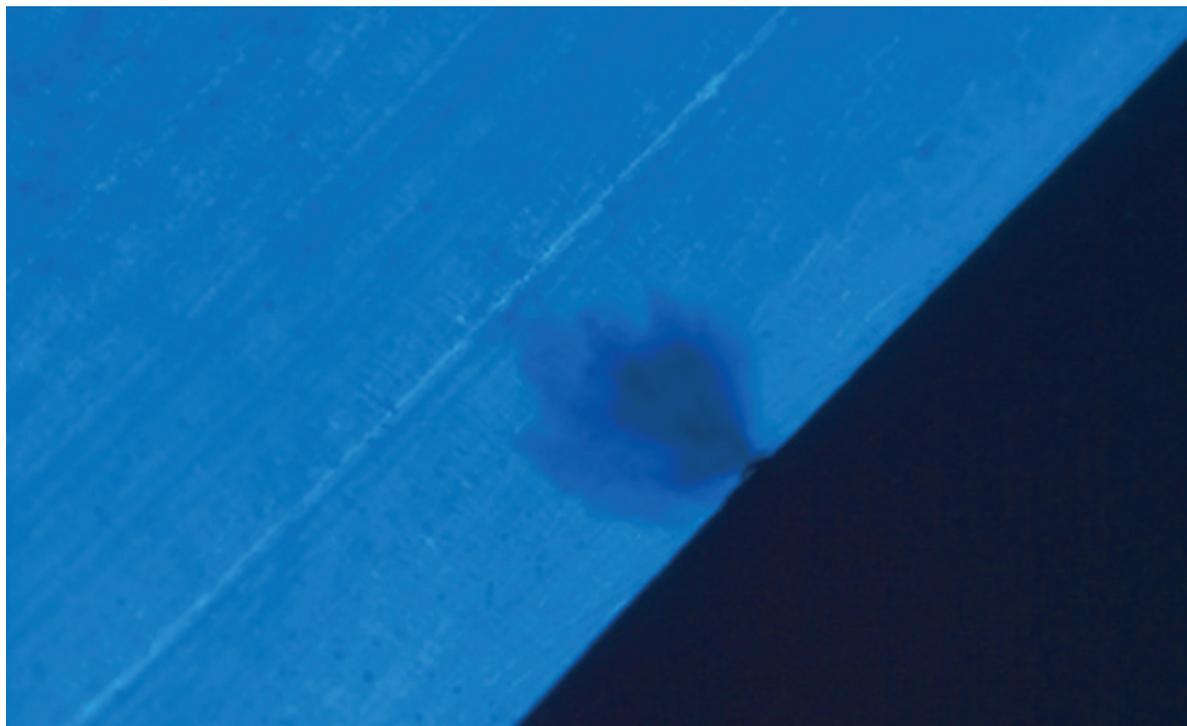
- Review of existing technology was performed, important knowledge gaps like wet mate connectors, cooling of subsea transformers, turrets for FPSOs, and voltage limitations on floating installations due to dynamical vibrations have been identified.
- Initial overview of current tools and methods to quantify GHG emissions associated to power from shore and definition of gaps to address.

### Impact and innovations

- The main goal of the material characterization of aged wet-design cables (ongoing in 2020) is to link chemical and mechanical properties of the XLPE cable insulation with inception and growth of water trees. Preliminary results show differences in thermo mechanical properties between cables close to the insulation where the water trees grow.

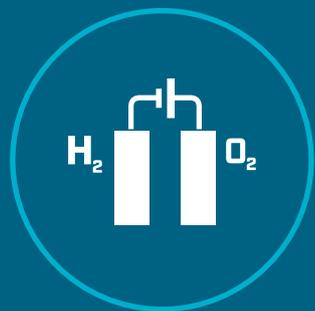
- The analyses of tools and methods to quantify GHG emissions gives a sound basis to

measure the actual environmental impact of electrification.



*Example of a water tree growing from the conductor screen in a 145 kV land cable without an outer water barrier that failed after 18 years in service. Such trees grow in all polymeric materials under the combined action of an electrical field, moisture and ions. On a microscopic level they are essentially a network of water filled sub-micro voids and channels growing along the electrical field direction (radial).*

# SP4



## Fuel cells for zero emission heat and power

### SP DESCRIPTION

This SP investigates the use of fuel cell technology, considering the varying requirements of heat and power, hydrogen management and integration into the offshore energy system. Specific research includes high-efficiency, compact and robust systems fueled with hydrogen and/or ammonia. The development of reversible fuel cell technology for production of electricity and pressurization of dry hydrogen is planned.



**Anders Ødegård**  
Senior Project Manager, SINTEF

### Main objective of SP

The overall objective is to investigate the use of fuel cell technologies on offshore installations, either to replace or hybridise with gas turbines for heat and power supply. The research covers both low and high temperature technologies, respectively PEMFC and SOFC.

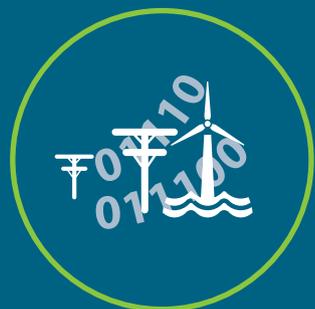
### Main results

- Discussions with project stakeholders on applying fuel cells on offshore installations. Identifying initial opportunities and limitations.
- Test protocols established for detailed characterization and long-term tests of PEMFCs
- Cell-level performance targets defined for the PCFC technology developed by CoorsTek Membrane Sciences (BaZrO<sub>3</sub>-based electrolytes)
- Literature review completed based on key performance indicators for SOFC and PCFC single cells operated in fuel cell, electrolyser and reversible mode.
- Test protocols established for detailed characterization and long-term tests of cells from CoorsTek (fuel cell and electrolyser mode).

### **Impact and innovations**

The work in 2019 has mainly focused on establishing the basis for further work and development in the centre, i.e. identified key features fuel cells must cover and the current status quo in relevant technologies. In itself the work has not yet contributed to major overall impact and innovations.

# SP5



## Energy systems – digital solutions

### SP DESCRIPTION

This SP develops generic methods, models and digital tools for analysis and optimisation of offshore energy systems with renewable energy supply, to enable cost-effective, reliable and stable design and operations of hybrid offshore energy systems with low or no CO<sub>2</sub> emissions. The focus is on power systems, but heat supply is also considered. A key output will be digital solutions that leverage computing power, digital ecosystems, and the huge amount of data among operators.



**Harald Svendsen**

Research Scientist, SINTEF

### Main objective

Integration of low emission technologies – methods, models and digital tools for optimisation and detailed analyses of hybrid offshore energy systems

- Modelling methods and tools for optimal planning and optimal operation of offshore energy systems, incorporating a range of low emission technologies
- Models, controls and calculation methods for high-fidelity analyses assessing hybrid system stability
- Digital tools and frameworks for the integration of tools and data

### Main results

- Review of NCS energy systems, power and heat supply and consumption patterns
- Initiated required adaptation of existing optimisation models and calculation methods for energy system planning and operational phase decision support
- Specified relevant electrical configuration of an offshore hybrid energy system, and initiated development of a power system simulation model for electrical interaction analyses

- Reviewed digitalisation trends and made high-level specifications for software tool integration framework and data spaces

### Impact and innovations

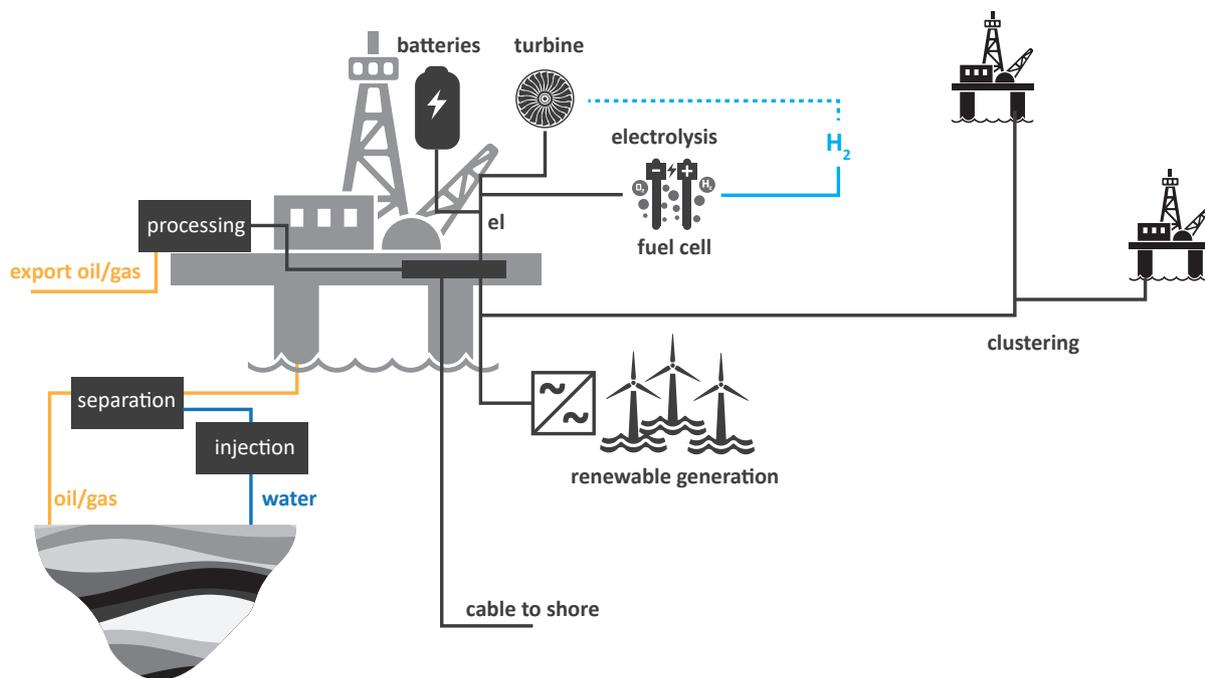
Expected innovations are:

- improved hybrid energy system design and operational strategies
- tested solutions ready for actual implementation

- software modules for integration in digitalised energy management tools
- analysis methods

Expected impacts are:

- increased competitiveness of NCS oil/gas due to lower CO<sub>2</sub> footprint
- accelerated development and deployment of technologies valuable beyond oil, such as renewables, hydrogen, storage, offshore grid.



Offshore energy system.

# SP6



## Case studies & innovation

### SP DESCRIPTION

This SP performs industry-driven case studies over 1-2-year periods to show emission reductions from implementing technologies on the Norwegian Continental Shelf fields. Studies depend on industry partners making the necessary data available to evaluate emission, weight and cost reduction. Industry plays a vital role in ensuring implementation through in-kind contributions/expertise. Studies on the economic aspects of technology development through advanced techno-economic analyses will also be performed.



**Ragnhild Skorpa**  
Research Scientist, SINTEF

### Main objective

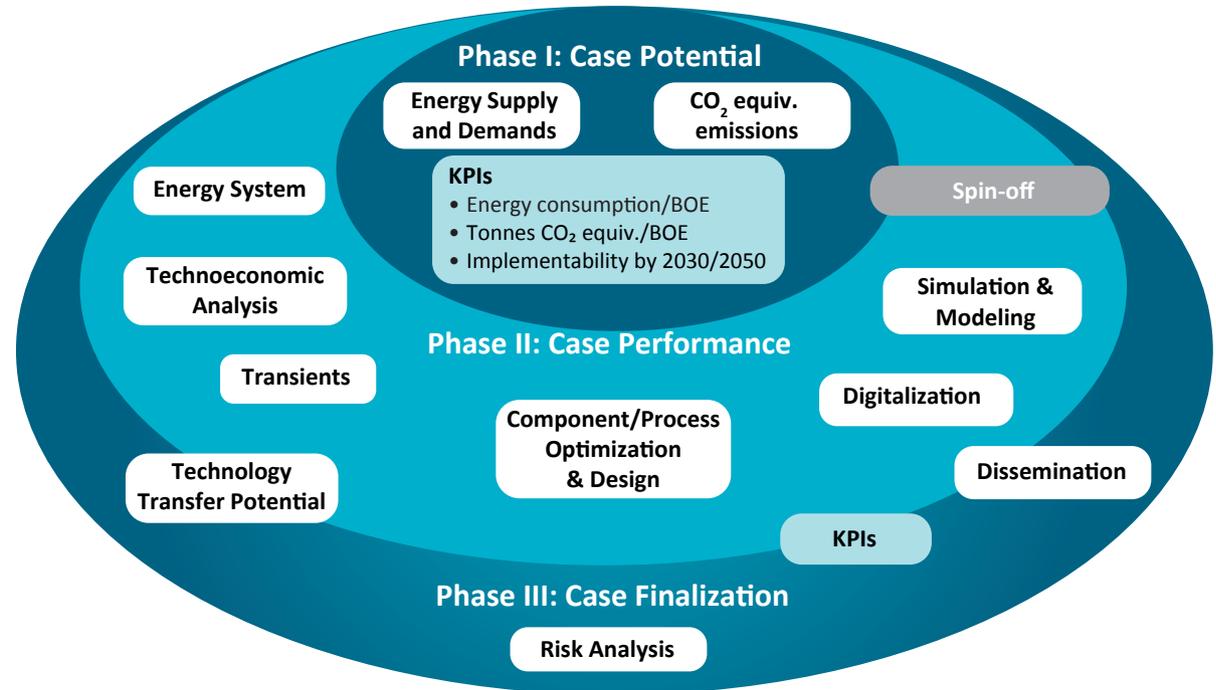
The main goal of the *LowEmission* Case studies is to develop technology concepts that lead to a reduction in offshore energy consumption and/or CO<sub>2</sub> emissions based on the overall *LowEmission* objectives. The industry-driven case studies will be conducted over 1-2 year periods to show emission reduction from implementing technologies on fields on the Norwegian Continental Shelf. Studies will depend on industry partners making available data necessary to evaluate emission, weight- and cost reduction.

### Main results

- A general methodology for the *LowEmission* case studies was developed
- Input on ideas and selection of case study topics was collected from industry and research partners
- A discussion on field-specific case studies was initiated between Repsol and the research partners
- Several concepts for both generic cases and a field-specific study were developed. Further evaluation of those will continue in 2020 in a close dialogue with *LowEmission* industry partners

### Impact and innovations

- Development of 2-4 novel concepts for integrating low emission technologies into existing and greenfield offshore energy systems, whereas 1-2 of these cases will progress into Phase II of the case studies for detailed performance evaluation.
- Use of Innovation strategies funding in 2020 is expected to boost activities in *LowEmission* which have been identified by industry partners to have high impact and short-term implementability potential.



General structure of LowEmission case studies, illustrating the different phases of the studies.

# SP7



## Energy efficient drainage

### SP DESCRIPTION

This SP analyses the energy use for different reservoir drainage strategies. Potential reductions in energy use will be identified, both for implementation on short time scales in mature fields, and on longer time scales for new field developments. The work is performed in close cooperation with industry partners.



**Per Eirik Bergmo**

Research Scientist, SINTEF

### Main objective

Reduce the energy use related to subsurface flow processes. Assess and compare drainage strategies to reduce energy needs while maintaining focus on oil and gas recovery.

- Assess drainage strategies to quantify energy use related to reservoir flow and identify potential reductions
- Develop optimization framework to enable maximized oil and gas recovery combined with reduced energy needs and costs.

### Main results

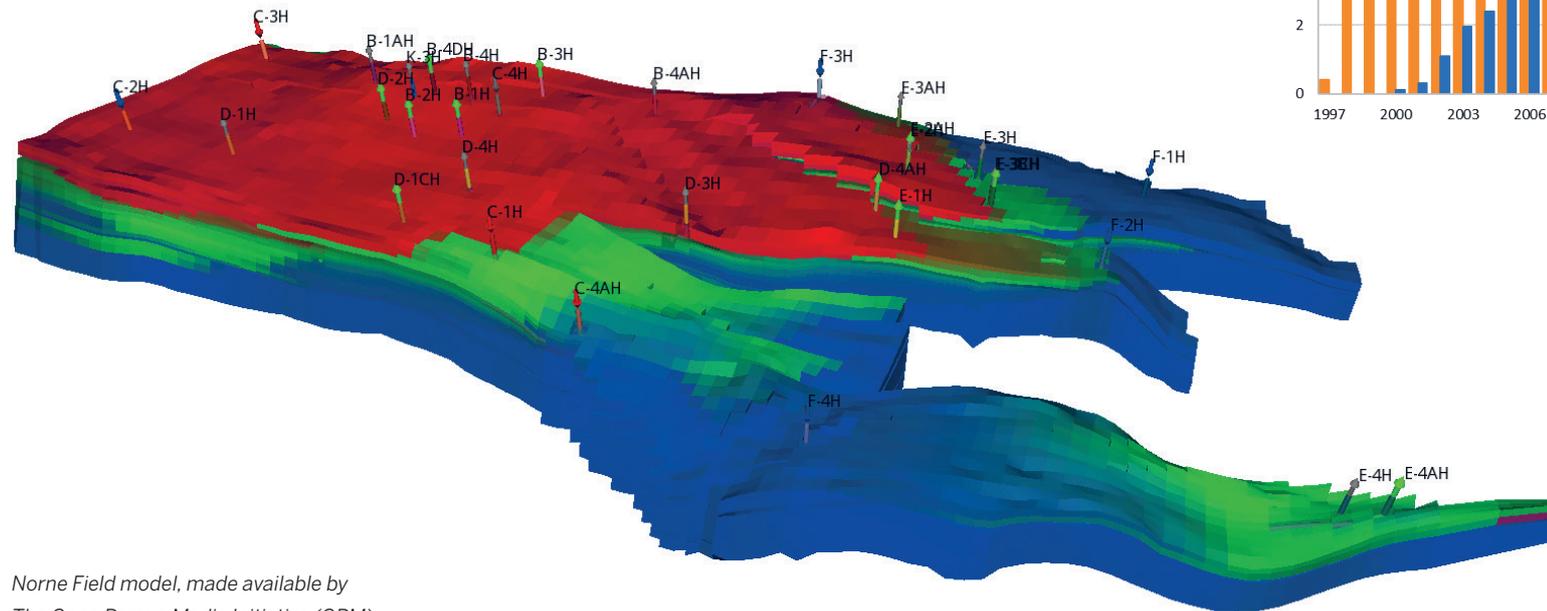
- Industry meetings to get feedback on project plans and to request data and models.
- Scope of work and detailed work plan for the first two years defined.
- Collection and screening of generic models to be used in the SP.
- Modified Norne field model selected for field case studies (figure).
- Announcement and selection of the first PhD candidate. The PhD will focus on developing a framework for co-optimization of energy use and hydrocarbon recovery.

## Impact and innovations

Expected innovations are:

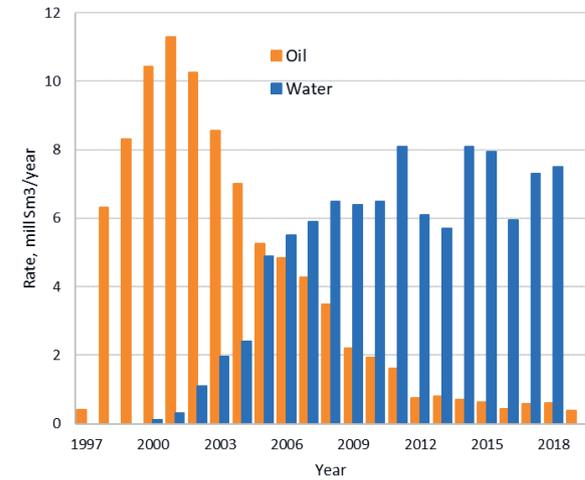
- Assessment methodology for energy consumption for relevant drainage strategies

- Methodology for co-optimization of oil and gas production, energy use and costs
- Guidelines for selecting energy efficient drainage strategies.



Norne Field model, made available by The Open Porous Media Initiative (OPM).

NORNE oil and water production



# SP8



## Energy efficient processing

### SP DESCRIPTION

This SP develops new, and improves existing technologies for subsea, in well and topside processing with minimal energy use in old and new fields on the Norwegian Continental Shelf and support industrial technology uptake.



**Heiner Schümann**

Research Scientist, SINTEF

### Main objective

The main objective of SP8 is to optimize use of and develop new technologies for subsea, in-well and topside processing with minimal energy consumption in brownfields and greenfields on the NCS and supports industrial uptake of the innovations. This will be achieved by:

- Demonstrating energy wastage and identifying the potential for efficiency improvements
- Testing new technologies and concepts and by this accelerate implementation of such (greenfields)
- Demonstrate "non-intrusive" process optimization solutions for existing fields (brownfields)
- Study measures necessary for overcoming challenges arising from future energy supply solutions (e.g. unsteady energy supply, little excess heat)

**Main results**

- The scope of work and working approach for SP8 was defined.
- Topics to be studied were collected. The topics range from single component/technology level to complete production strategies that might be evaluated.
- The process simulator K-Spice (by Kongsberg) was taken into use as modelling tool.

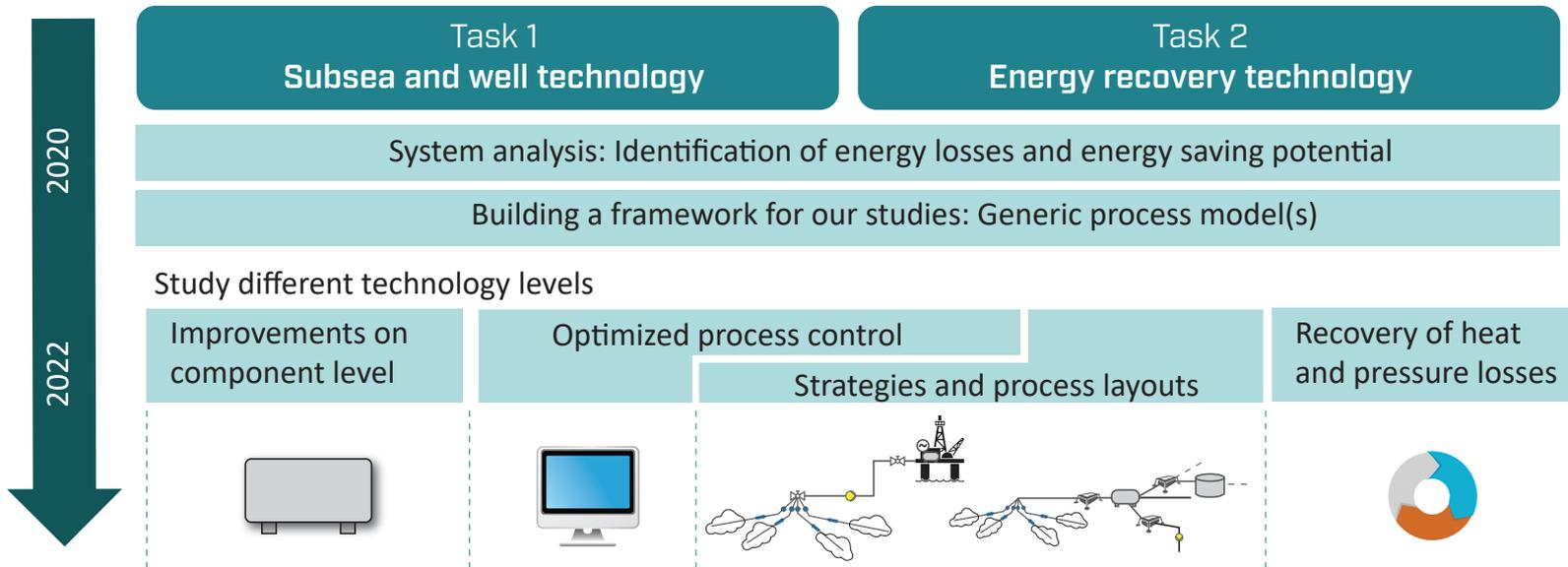
- A PhD candidate was selected and is about to start soon. The PhD will be part of Task 8.1 "Subsea and well technologies" and mainly focus on optimization of production processes. An educational plan was prepared.

**Impact and innovations**

Expected innovations are:

- Guidelines and selection help for new design and improvements of existing production systems

- Example studies comparing and showing the potential of new technologies will simplify and accelerate implementation of such solutions
- Boundary conditions as input to other process parts (SPs) like reservoir or energy production systems.
- Solutions for overcoming problems related to implementation of new energy supply solutions



# SP9



## Other emissions

### SP DESCRIPTION

This SP seeks to reduce emissions from mobile units through logistics optimisation and zero-emission vessels. The development of better technologies for methane emissions mapping and abatement is also planned.



**Roar Nybø**

Senior Business Developer, SINTEF

### **Main objective**

The overall objective is two-fold: to reduce emissions from offshore mobile units by optimizing logistics as well as ensuring utilization of low-emission vessels, and secondly to reduce methane and NMVOC emissions from crude oil tankers and installations.

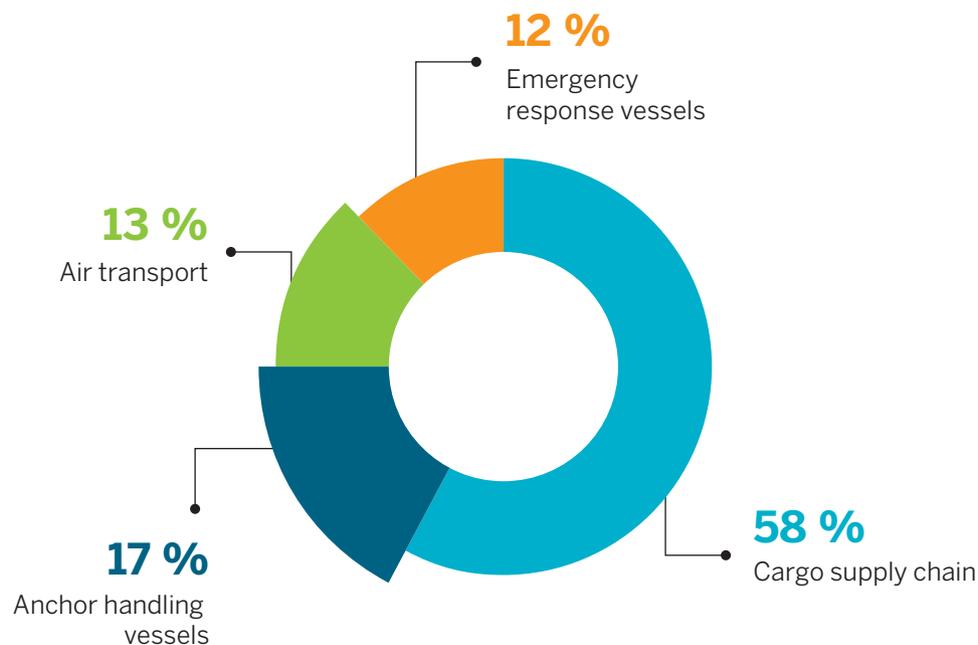
### **Main results**

- A desk top study summarising practices, challenges and tools for offshore upstream logistics in Norway from earlier research projects. The plan for 2020 is to obtain a deeper understanding of the status quo in offshore logistics planning and emissions mitigation measures in cooperation with relevant industry partners and a common direction in the development of a decision support tool for offshore supply fleet planning.
- Under the task “Hydrogen- and battery electrically-driven offshore vessels” SP9 has focused on test protocols for PEMFCs in offshore vessels. We have created a protocol which includes characterization of short stacks and their behaviour under simulated operation.

- We have analysed Methane emission measurement data and identified gaps to be addressed. One identified gap was proper oil characterization procedures. In 2019 we have drafted such a procedure.
- To understand dynamics under loading, we started work on CFD simulation of convection in the liquid and the gas phase in a cargo tanks and drawing experience from an experiment on the loading pipelines.
- There is a major “trust gap” in methane emissions estimates for installations. We have outlined a strategy for improving emission estimates on the Norwegian continental shelf and to pin-point possible “super emitters” which may go under the radar today.

### Impact and innovations

The *LowEmission* center is to be a driver for industry-wide emission reduction efforts. In this regard, SP9 leverages digitalization of logistics, is doing R&D to bring better vessel fuel cells to market and spearheads a search for major methane emitters on the NCS.



*Offshore logistics emissions by category.*

*Adopted from Norlund, 2015.*

# Education and recruitment

Researcher training is a significant component of *LowEmission*. 19 PhDs/Postdocs will be completed at NTNU and over 30 MSc candidates will be educated through the Centre. This gives recruitment possibilities for *LowEmission* partners.

An individual research plan is developed for each PhD student and Postdoc, based on the research needs of the Centre. The research deals with fundamental and basic-oriented topics underpinning and expanding the *LowEmission* knowledge base. To ensure that all the work in the Centre is directed towards the common objectives, the PhD/ Postdoc programme is an integral part of the research tasks. All PhD students, Postdocs, and their supervisors take an active part in the annual *LowEmission* meetings and seminars.

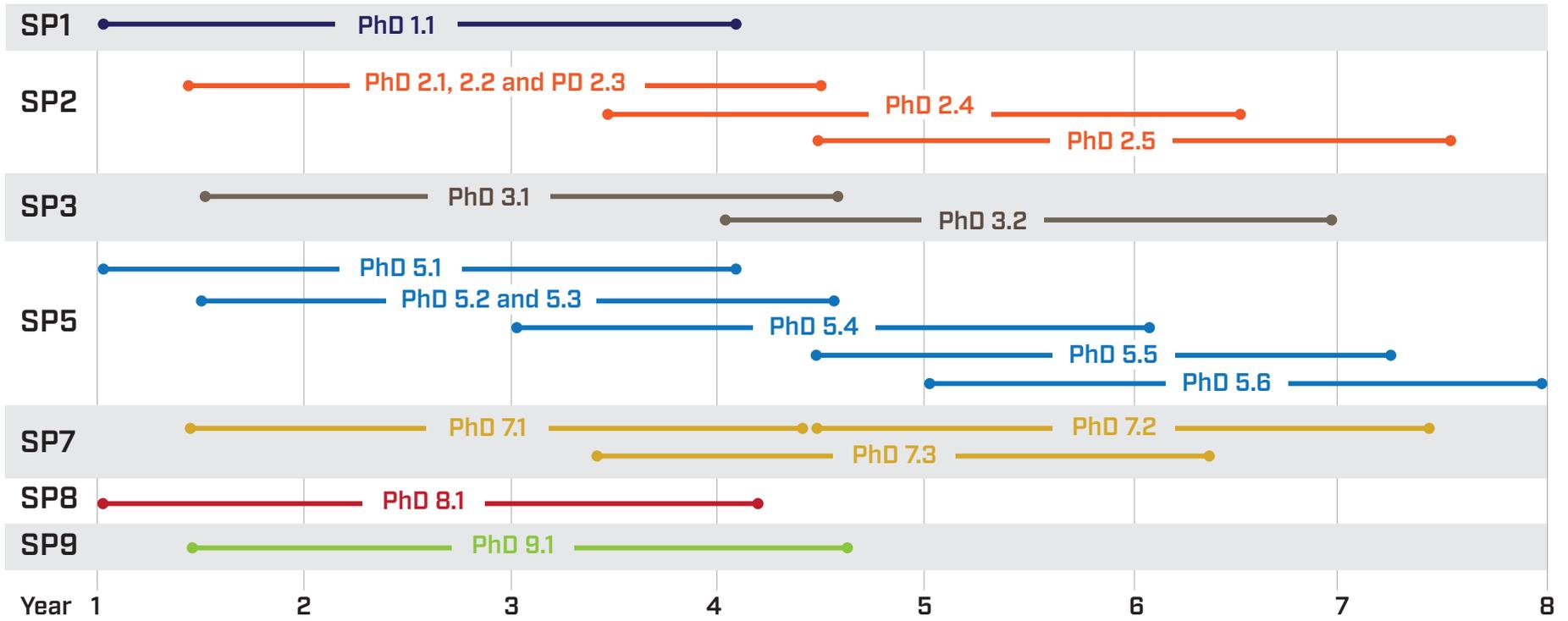
To emphasize the importance of the educational programme, one of the first things undertaken in 2019, was the launching of an advertising campaign directed at recruiting PhDs and Postdocs. The response was very positive, and the first highly qualified candidates will start during the spring of 2020. Altogether, 11 candidates will start their projects in 2020.

Efforts will be made to involve candidates in the daily life of the Centre and its research activities as much as possible. They will be given visibility at the annual Consortium Day, and we plan to organize candidate seminars together with the industry partners. Also, a joint annual candidate seminar will be held jointly between all the PETROSENTERS.

## Gender equality

All partners of *LowEmission* recognize the importance of gender aspects, and this focus is emphasized at all levels of the Consortium. The Centre encourages all partners to collectively achieve the EU target of recruiting at least 40% female staff in scientific positions.

The academic partners encourage female applicants through open announcements, thus striving for gender balance when employing PhD candidates and Postdocs. NTNU has developed a plan for equal opportunities and recruitment of women to the university and encourages female professorships through mentor programmes and skill development. The goal by 2020 is that 50% of new employees in academic positions are women.



LowEmission education program.

# Recognitions and visibility

## Opening of the LowEmission Research Centre

On Friday June 14<sup>th</sup> the LowEmission Centre was officially opened by the Minister of Petroleum and Energy, Mr. Kjell-Børge Freiberg, at Gløshaugen, Trondheim. In his opening address, the Minister said that: *"This will be our new national team for low-emission technology in the petroleum industry. I have great expectations for the work that is now starting. Collaboration will be an important key to success. We need high scientific quality, but also industry partners who are willing to test the technology and put it to use. Therefore, it is gratifying that so many from the industry are interested in playing an active role in this centre"*.

## Nomination for "Green Initiator of the Year"

During the first year of operation LowEmission was nominated for the 2019 Rystad Energy's Gullkronen award. The purpose of Gullkronen is to recognize companies, teams, or people who have shown outstanding achievements on the Norwegian Continental Shelf during the previous year. Nine prizes were awarded on January 28, 2020 in Oslo – four for E&P achievements, three for the oil service sector, a Green Award and an "Honour Award". The Low Emission Centre was nominated in the category "Green Initiator

of the Year". Even though we did not win, being nominated was a great honour and inspiration.



*Commitment all the way to the top both at SINTEF and NTNU – from left: Inge R. Gran, President SINTEF Energy Research, Marit Mazzetti, Acting Centre Director and Centre Manager, Minister of Petroleum and Energy, Mr. Kjell-Børge Freiberg, Johan Hustad, Director NTNU Energy and Alexandra Bech Gjørsv, CEO SINTEF.*



*Not disappointed, only extremely proud to have been nominated - LowEmission's Stefania Osk Gardarsdottir, Ragnhild Skorpa, and Milan Stanko at the Gullkronen award ceremony.*

**Gullkronen** is an award founded and organized by Rystad Energy. The ambition of is to recognize achievements made by companies involved in the Norwegian oil and gas business in the previous year. The idea is to present and honour high performances and to share this in an informal and celebratory manner. Rystad Energy consultants and analysts and external industry experts are selected for various categories within the E&P and oil service industry. There are four E&P awards: Explorer of the Year, Business Developer of the Year, Project Developer of the Year and Field Operator of the Year. Within the oil service category, the New Venture of the Year, Globetrotter of the Year and Business Success of the Year are chosen. Finally, there is the Green Initiator of the Year and the Honour Award.



#1

### Other highlights/Invited keynotes

In its first year of operation, the *LowEmission* Centre has been active in communicating the Centre activities and the importance of developing and implementing low-emission technologies in various forums.

A few examples of 2019 communication highlights:



#2

**#1** Centre Manager and Acting Director Marit J. Mazzetti presented *LowEmission* at the Energy Change conference 2019 in Stjørdal.

**#2** Alexandra Bech Gjørnv, President and CEO of SINTEF presented the *LowEmission* Centre at the OG21 Forum as a prime example of how to mobilize R&D for change, to help industry tackle their challenges while contributing to a better society.

# Communication

Communication has been an important part of the *LowEmission* work in 2019 and will continue to be. For internal communication, striving for an active dialogue between the research and industry partners is of great importance and will ensure that the Centre activities continue to tackle challenges with high industry-relevance.

With *LowEmission* being a Centre for knowledge transfer between industry, academia, scientists and the broader public, external communication activities such as taking part in meetings and workshops with parties from the oil and gas industry as well as taking part in public events and debates as a factual voice is of great importance.

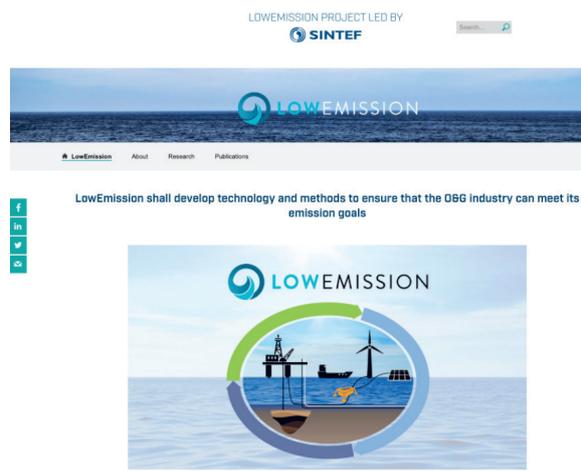
The Centre has been and will continue to be visible through platforms like TV, newspapers, national radio, magazines and social medias.

Although the Centre was officially opened just last year, the Centre has had good developments whilst laying the groundwork for future external communications and marketing efforts. Highlights include general positive reception for the official opening of the Centre, a fair amount

of media coverage and an overall great reach on the official Centre opening video that was posted in social media channels.

## Web

The *LowEmission* webpage provides information about the Centre, its research and other activities like events and conferences.



## Newsletter

A holiday greeting was sent out to partners by Acting Centre Director Marit Mazzetti. More info on newsletters will follow in 2020.

## Twitter

The *LowEmission* Twitter account (@*LowEmissionNCS*) is used to share news about Centre activities, popular science publications like videos, posts on #SINTEFBlog and conference news. The target groups of the account are consortium members, potential partners, researchers, policy makers (domestic and international) and the “interested public”. The account was started in 2019 and quickly made relevant followers. The account is very active and will continue to be throughout the Centre's life.

In 2019, *LowEmission* had:



148

followers



3800

Twitter views

The most popular tweet of 2019 was the first post on the account, in October. The first post contained a link to the project page on [sintef.no/en](http://sintef.no/en).

The tweet had:

- 1431 views
- 10 engagements (i.e. retweets, likes, etc.)
- 34 clicks



## Media

LowEmission has had a decent amount of media coverage in 2019, with 15 media contributions and 9 presentations registered in Cristin. Here are some examples:

## 1: Teknisk Ukeblad

### Vil ha gassturbinene offshore over på hydrogen eller ammoniakk

Kommer som neste steg på det nasjonale lavutslippssenteret. Men først skal utslippene ned på eksisterende turbiner.



Oljebransjens klimagassutslipp skal nedover. Nå jobbes det med å få på plass løsninger som gjør at man kan kjøre gassturbiner på hydrogen eller ammoniakk. (Foto: Erlend Tangeraaas Lygre)

## 2: Gemini.no



I 2016 utgjorde utslippene fra petroleumsvirksomheten om lag en fjerdedel av de samlede norske klimagassutslippene. Kutt i denne sektoren vil derfor ha stor betydning for de samlede norske utslippene. Foto: Thinkstock

**Stor interesse for forskningscenteret  
LowEmission**

## Blog

The Centre published one blogpost on the SINTEFBlog in 2019. This blogpost contained information about the Centre and the official opening of the Centre, where the Minister of Petroleum and Energy, Mr. Kjell-Børge Freiberg attended. The blogpost has had a total of 296

#ENERGY / #INDUSTRY / ENERGY EFFICIENCY / ENERGY SYSTEMS / GAS TECHNOLOGY / RENEWABLE ENERGY / WIND POWER

### Happy occasion at SINTEF & NTNU – Opening of the LowE-mission Research Centre

Coauthors: Ragnhild Skorpa and Stefania Gardarsdottir, SINTEF On Friday June 14th the Research Centre LowEmission was officially opened by the Minister of Petroleum...

readers as of 17.02.2020, and serves as a good starting point for future posts from the centre.

The Centre also had a very successful video linked to the blog post, with over 10.000 views and an estimated reach of over 25.000 on SINTEF Energy Research's Facebook channel.



# Appendices

## STATEMENT OF ACCOUNTS

(All figures in 1000 NOK)

As an option the funding and cost for each partner may be presented and also how funding and cost is allocated to the subprojects in the centre.

### Funding

	Amount	In kind	Sum
The Research Council	10026		10026
The Host Institution (SINTEF Energi)		540	540
<b>Research Partners</b>			
NTNU		25	25
SINTEF AS		469	469
SINTEF Ocean		128	128
<b>Enterprise partners</b>			
Operators	9355		9355
Vendors		3617	3617
<b>Public partners</b>			
<b>Sum</b>	<b>19381</b>	<b>4778</b>	<b>24159</b>
<b>Costs</b>			
The Host Institution (SINTEF Energi)	10446		10446
Research Partners	10096		10096
Enterprise partners		3617	3617
<b>Sum</b>			<b>24159</b>

## PUBLICATIONS

Here are all *LowEmission* publications from 2019.

### Presentations

From: 2019 To: 2019 Main category: Conference lecture and academic presentation All publishing channels

- Barnett, Alejandro Oyarce.**  
Fuel Cells for offshore installations. *LowEmission* Consortium day - Breakout session 1; 2019-12-05 - 2019-12-05. SINTEF
- Gruber, Andrea.**  
Carbon-free firing of gas turbines for clean and efficient power generation off-shore. *LowEmission* Consortium day - Breakout session 1; 2019-12-05 - 2019-12-05. NTNU
- Lesaint, Cedric Michel.**  
Material characterization of aged wet-design cable. *LowEmission* Consortium day - Breakout session 1; 2019-12-05 - 2019-12-05. ENERGISINT
- Mazzetti, Marit Jagtoyen.**  
Develop Low Emission Technology to ensure the O&G industry can meet its emission goals. Industritopp-lederkonferansen (vendors); 2019-05-16 - 2019-05-16. ENERGISINT
- Mazzetti, Marit Jagtoyen.**  
*LowEmission* - Meeting Industry's Emission Reduction Goals. NOROG Toppledørmøte (operators); 2019-05-23 - 2019-05-23. ENERGISINT
- Mazzetti, Marit Jagtoyen.**  
*LowEmission* - Moving towards zero emission oil and gas production. Energy Change 2019 - Stjørdalen;

2019-10-24 - 2019-10-24. ENERGISINT

- Mazzetti, Marit Jagtoyen.**  
*LowEmission* - Moving towards zero emission oil and gas production. Offshore miljøforum; 2019-11-21 - 2019-11-21. ENERGISINT
- Mazzetti, Marit Jagtoyen.**  
*LowEmission* - Moving towards zero emission oil and gas production. TNO workshop on the Nexus of Oil and Gas and Renewables; 2019-11-14 - 2019-11-14. ENERGISINT
- Reyes-Lúa, Adriana.**  
Offshore Gas Turbines: Operation practice and typical transients. *LowEmission* Consortium day - Breakout session 1; 2019-12-05 - 2019-12-05. ENERGISINT

### Report/thesis

From: 2019 To: 2019 Main category:

Report/thesis All publishing channels

- Deng, Han; Skaugen, Geir.**  
Deliverable Report: DSP1\_2019\_4 - Working fluid screening and analysis. : SINTEF Energy Research 2019 18 s. ENERGISINT

### Media contribution

From: 2019 To: 2019 Main category:

Media contribution All publishing channels

- Mazzetti, Marit Jagtoyen.**  
- Dette blir vårt nye landslag for lavutslippsteknologi i petroleumsindustrien. enerwe.no [Business/trade/industry journal] 2019-06-14. ENERGISINT

2. **Mazzetti, Marit Jagtoyen.**  
Hun leder jobben med å gjøre norsk oljeproduksjon utslippsfri. Stavanger Aftenblad [Newspaper] 2019-09-28. ENERGISINT
3. **Mazzetti, Marit Jagtoyen.**  
Hun leder jobben med å gjøre norsk sokkel utslippsfri. Bergens Tidene Facebook [Internet] 2019-10-02  
ENERGISINT
4. **Mazzetti, Marit Jagtoyen.**  
Stor bransjeinteresse for forskningssenteret *LowEmission*. ntb.no [Internet] 2019-06-14  
ENERGISINT
5. **Mazzetti, Marit Jagtoyen.**  
Stor bransjeinteresse for forskningssenteret *LowEmission*. Metal Supply [Internet] 2019-06-14  
ENERGISINT
6. **Mazzetti, Marit Jagtoyen.**  
Stor interesse for forskningssenteret *LowEmission*. gemini.no [Business/trade/industry journal] 2019-06-14. ENERGISINT
7. **Mazzetti, Marit Jagtoyen.**  
VIL FJERNE CO FRA OFFSHORE. TU [Business/trade/industry journal] 2019-06-25. ENERGISINT
8. **Mazzetti, Marit Jagtoyen.**  
Vil ha gassturbinene offshore over på hydrogen eller ammoniakk. TU [Business/trade/industry journal] 2019-08-26. ENERGISINT
9. **Mazzetti, Marit Jagtoyen.**  
Vil kutte alle utslipp på norsk sokkel innen 2035. nrk.no [Newspaper] 2019-11-26. ENERGISINT
10. **Mazzetti, Marit Jagtoyen.**  
Åpnet forskningssenter som skal gjøre nors sokkel grønnere. Ingeniørens stemme [Business/trade/industry journal] 2019-06-15. ENERGISINT
11. **Mazzetti, Marit Jagtoyen; Tande, John Olav Giæver.**  
Hun leder jobben med å gjøre norsk oljeproduksjon utslippsfri. Stavanger Aftenblad [Newspaper] 2019-09-28. ENERGISINT
12. **NRK, P1; Mazzetti, Marit Jagtoyen.**  
NRK Radio - Nyhetsoppdrag: <https://radio.nrk.no/serie/dagsnytt/NPUB07323519/26-11-2019>. NRK [Radio] 2019-11-26. ENERGISINT
13. **Skarsaune, Erlend; Mazzetti, Marit Jagtoyen.**  
Hun leder jobben med å gjøre norsk oljeproduksjon utslippsfri. <https://sysla.no/a/50k0kE> [Business/trade/industry journal] 2019-10-02. ENERGISINT
14. **Skarsaune, Erlend; Mazzetti, Marit Jagtoyen.**  
Hun leder jobben med å gjøre norsk oljeproduksjon utslippsfri. aftenbladet.no [Internet] 2019-09-28  
ENERGISINT
15. **Taraldsen, Lars; Mazzetti, Marit Jagtoyen.**  
Vil ha gassturbinene offshore over på hydrogen eller ammoniakk. tu.no [Business/trade/industry journal] 2019-08-26. ENERGISINT

#### Multimedia products

From: 2019 To: 2019 sub-category: Multimedia product  
All publishing channels

1. **Mazzetti, Marit Jagtoyen.**  
*LowEmission* åpning. SINTEF Energi 2019  
ENERGISINT
2. **Mazzetti, Marit Jagtoyen.**  
Nyhetsmorgen. NRK Radio 2019. ENERGISINT
3. **Mazzetti, Marit Jagtoyen.**  
*LowEmission* | Forventinger til senteret. SINTEF Energi 2019. ENERGISINT

#### Blogs and information material

From: 2019 To: 2019 Main category: Information material(s)  
All publishing channels

1. **Mazzetti, Marit Jagtoyen.**  
www.lowemission.no - nettsiden. ENERGISINT
2. **Mazzetti, Marit Jagtoyen; Skorpa, Ragnhild; Gardarsdottir, Stefania Osk.**  
Happy occasion at SINTEF & NTNU – Opening of the *LowEmission* Research Centre. ENERGISINT SINTEF

## Management

Last name	First name	Position	Main research area	Institution	SP
Dawson	James	Professor	Fluid mechanics and Combustion	NTNU	
Gardarsdottir	Stefania	Research Scientist	Techno-economic process analysis	SINTEF Energy Research	
Johansen	Jon Magne	Senior Business Developer	Business development	SINTEF Energy Research	
Mazzetti	Marit J	Senior Research Scientist	Low-emission power generation offshore	SINTEF Energy Research	
Pettersen	Jan Petter	Asset Manager Blane	Field development	Repsol Norge AS	
Skorpa	Ragnhild	Research Scientist	Well integrity	SINTEF Industry	
Torsæter	Malin	Research Manager	Formation physics	SINTEF Industry	
Ødegård	Anders	Senior Project Manager	Fuel cells and hydrogen	SINTEF Industry	
Nonås	Lars Magne	Senior Research Scientist	Optimization of offshore logistics	SINTEF Ocean	
Aalberg	Ann Karin Jullumstrø	Project Coordinator	Accounting and central operations	SINTEF Energy Research	

## SP Leaders

Last name	First name	Position	Main research area	Institution	SP
Rohde	Daniel	Research Scientist	Dynamic simulations	SINTEF Energy Research	1
Worth	Nicholas	Associate professor	Turbulence, combustion, experimental methods	NTNU	2
Hestad	Øystein	Research Manager	Transmission technology	SINTEF Energy Research	3
Ødegård	Anders	Senior Project Manager	Hydrogen, fuel cells	SINTEF Industry	4
Svensen	Harald	Research Scientist	Energy systems, renewable integration	SINTEF Energy Research	5
Skorpa	Ragnhild	Research Scientist	Well integrity	SINTEF Industry	6
Bergmo	Per Eirik	Research Scientist	Reservoir technology, drainage	SINTEF Industry	7
Schümann	Heiner	Research Scientist	Process modelling and concept testing	SINTEF Industry	8
Nybø	Roar	Senior Business Developer	Well drilling, machine learning	SINTEF Industry	9

## Key Researchers

Last name	First name	Position	Main research area	Institution	SP
Rohde	Daniel	Research Scientist	Dynamic simulations	SINTEF Energy Research	1
Skaugen	Geir	Senior Research Scientist	Heat exchangers; Optimization	SINTEF Energy Research	1
Mocholí Montañés	Rubén	Research Scientist	Dynamic simulations	SINTEF Energy Research	1
Deng	Han	Research Scientist	Heat exchangers; Optimization	SINTEF Energy Research	1
Gruber	Andrea	Senior Research Scientist	Combustion, numerical modelling	SINTEF Energy Research	2
Ditaranto	Mario	Senior Research Scientist	Combustion, experimental methods	SINTEF Energy Research	2
Barlow	Rob	Senior Research Scientist	Combustion, experimental methods	Sandia National Labs	2
Løvås	Terese	Professor	Combustion, chemical kinetics	NTNU	2
Worth	Nicholas	Associate professor	Turbulence, combustion, experimental methods	NTNU	2
Moeck	Jonas	Associate Professor	Combustion, theoretical and experimental methods	NTNU	2
Hvidsten	Sverre	Senior Research Scientist	Transmission technology	SINTEF Energy Research	3
Ve	Torbjørn A.	Research Scientist	Transmission technology	SINTEF Energy Research	3
Lesaint	Cedric	Research Scientist	Transmission technology	SINTEF Energy Research	3
Sæternes	Hans Helmer	Research Scientist	Transmission technology	SINTEF Energy Research	3
Hestad	Øystein	Research Manager	Transmission technology	SINTEF Energy Research	3
Hølto	Jorunn	Research Scientist	Transmission technology	SINTEF Energy Research	3
Straus	Julian	Research Scientist	Environmental impact of offshore electrification	SINTEF Energy Research	3
Riboldi	Luca	Research Scientist	Environmental impact of offshore electrification	SINTEF Energy Research	3
Svendsen	Harald	Research Scientist	Grid planning	SINTEF Energy Research	3
Perez-Valdes	Gerardo A	Research Scientist	Grid planning	SINTEF Industry	3
Oyarce	Alejandro	Senior Research Scientist	Hydrogen, fuel cells	SINTEF Industry	4, 9
Polfus	Jonathan	Senior Research Scientist	High temperature fuel cells	SINTEF Industry	4
Vøllestad	Einar	Research Scientist	High temperature fuel cells	SINTEF Industry	4
Ødegård	Anders	Senior Project Manager	Hydrogen, fuel cells	SINTEF Industry	4
Holdyk	Andrzej	Research Scientist	Electrical system stability	SINTEF Energy Research	5
Nørstebo	Vibeke	Research Manager	System optimisation	SINTEF Industry	5
Flatberg	Truls	Senior Research Scientist	System optimisation	SINTEF Industry	5
Knudsen	Brage	Research Scientist	Control systems, gas	SINTEF Energy Research	5
Nesheim	Dag Atle	Research Scientist	Data mangement	SINTEF Ocean	5
Svendsen	Harald	Research Scientist	Energy systems, renewable integration	SINTEF Energy Research	5
Tedeschi	Elisabetta	Professor	Electrical system control and stability	NTNU	5

Last name	First name	Position	Main research area	Institution	SP
Gardarsdottir	Stefania	Research Scientist	Techno-economic process analysis	SINTEF Energy Research	6
Skorpa	Ragnhild	Research Scientist	Well integrity	SINTEF Industry	6
Lund	Bjørnar	Senior Research Scientist	Drilling and well integrity	SINTEF Industry	6
Mazzetti	Marit J.	Senior Research Scientist	Low-emission power generation offshore	SINTEF Energy Research	6
Hestad	Øystein	Research Manager	Offshore electrification	SINTEF Energy Research	6
Svendsen	Harald	Research Scientist	Integration of renewable energy in offshore systems	SINTEF Energy Research	6
Nonås	Lars Magne	Senior Research Scientist	Optimization of offshore logistics	SINTEF Ocean	6
Bergmo	Per	Research Scientist	Energy efficient drainage	SINTEF Industry	6
Schümann	Heiner	Research Scientist	Energy efficient processing	SINTEF Industry	6
Lothe	Ane	Research Manager	Energy efficient drainage	SINTEF Industry	6
Grimstad	Alv-Arne	Senior Research Scientist	Reservoir technology, drainage	SINTEF Industry	7
Holt	Torleif	Senior Research Scientist	Process technology, reservoir technology	SINTEF Industry	7, 8
Barrabino	Albert	Research Scientist	Process technology/chemistry	SINTEF Industry	7
Bergmo	Per	Research Scientist	Reservoir technology, drainage	SINTEF Industry	7
Berg	Carl Fredrik	Associate Professor	Reservoir technology, drainage	NTNU	7
Angga	I Gusti Agung Gede	PhD student	Reservoir drainage, optimisation	NTNU	7
Schümann	Heiner	Research Scientist	Process modelling and concept testing	SINTEF Industry	8
Holt	Torleif	Senior Research Scientist	Process modelling and energy analysis	SINTEF Industry	8
Barrabino	Albert	Research Scientist	Process modelling and energy analysis	SINTEF Industry	8
Franklin Krause	Daniel	Senior Engineer	Field measurements, fugitive methane emissions	SINTEF Ocean	9
Føre	Maria	Research Scientist	Shuttle tanker VOC and methane emissions	SINTEF Ocean	9
Oyarce	Alejandro	Senior Research Scientist	Hydrogen, fuel cells	SINTEF Industry	4, 9
Flatberg	Truls	Senior Research Scientist	Optimization, decision support systems	SINTEF Industry	9
Gribkovskaia	Victoria	Research Scientist	Optimization, logistics, offshore transport	SINTEF Ocean	9
Kisialiou	Yauheni	Research Scientist	Operations research	SINTEF Ocean	9
Halvorsen	Elin E. H.	Research Scientist	Operations research	SINTEF Ocean	9
Nonås	Lars Magne	Senior research Scientist	Operations research	SINTEF Ocean	9
Fagerholt	Kjetil	Professor	Operations research	NTNU	9
Norlund	Ellen K.	Principal consultant supply chain	Operations research	Equinor	9
Nybø	Roar	Senior Business Developer	Well drilling, machine learning	SINTEF Industry	9

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