



*Research and Innovation  
for the Oil and Gas Industry*

**SINTEF** is the largest independent research institute in Scandinavia. We have 2,100 employees from more than 70 countries, with international top-level expertise in science and technology, medicine and the social sciences. SINTEF is an independent, non-profit organisation that re-invests its earnings in new research, scientific equipment and expertise.


We create value through knowledge generation, research and innovation, and develop solutions that are adopted by industry and society.

We support ongoing development of some 2,000 Norwegian and international companies via our research and development activities.

The SINTEF Group comprises the SINTEF foundation and the four limited companies MARINTEK, SINTEF Energy Research, SINTEF Petroleum Research and SINTEF Fisheries and Aquaculture.

SINTEF works in close partnership with leading universities, other research institutes and industry.

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# CO<sub>2</sub> Capture and Storage (CCS)

Carbon capture and storage (CCS) provides a bridge to a sustainable energy system by minimizing the emissions of carbon dioxide CO<sub>2</sub> from burning the fossil fuels that is still necessary in the world's present energy climate. SINTEF is recognized as a key global player in the CCS research arena. We operate two centers of excellence in CCS: the BIGCCS international CCS research center and the NORDICCS CCS competence center. With our strategic university partner the Norwegian University of Science and Technology (NTNU), we have an annual CCS research and development turnover of over €20 million.

## Focus areas

- CO<sub>2</sub> capture: environmentally friendly absorbent systems; degradation persistent sorbent systems; industrial-scale membranes; and combustion technologies.
- Transport: safe and cost-effective solutions; thermodynamics; multiphase flow of mixtures of CO<sub>2</sub>; fracture propagation in pipelines; and verified calculation tools.
- Long-term, large-scale storage: capacity estimation; well and caprock integrity; monitoring methods; remediation; and CO<sub>2</sub> for enhanced oil recovery
- CO<sub>2</sub> value chain: analysis of potential and viability; capacity and time window matching; infrastructure and logistics; macro and business economics; and legal issues.



Photo: Thor Nielsen/SINTEF

Tiller CCS capture laboratory.

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# Drilling and wells

SINTEF has a strong position in researching and developing drilling equipment and applications. We specialize in advanced drilling models for use in real-time simulators and systems, drilling technologies and advanced materials. Our holistic and integrated approach focuses on better decision support through advanced mathematical models combined with modern visualization techniques. Our laboratory testing equipment is developed for small- and full-scale testing, and uses top-level instrumentation.

## Focus areas

- Development and testing of components and structures
- Drilling dynamics and mechanics
- Dynamic well control simulations
- Fatigue and degradation
- Fracturing interpretation and modeling
- Hard rock drilling
- High-performing materials
- Instrumentation and sensors for downhole monitoring of oil and gas wells
- Mud loss analysis
- Pore pressure and wellbore stability analysis
- Real-time decision support and control
- Solids production and chalk liquefaction
- Training simulator for drilling and well operations
- Volumetric sand production analysis
- Wear and corrosion
- Well integrity
- Well test interpretation



Photo: Thor Nilsen/SINTEF

**Developing drilling tools for hard rocks.**

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# Environmental technology

SINTEF offers environmental services based on its experience of modeling, testing of oils in its laboratories and large-scale facilities, and numerous real-time oil spill studies and analyses. Our main goal is to develop and strengthen Norwegian and international oil spill contingency plans through experimental research and field activities, and conducting applied biological and chemical research on environmental processes. Our decision support tools are licensed to all areas of worldwide offshore oil and gas activities.

SINTEF has a strong position in developing and tailoring energy-efficient technologies for offshore applications and has worked in close collaboration with the Norwegian and international offshore industries for many years, particularly through the EFFORT project.

## Focus areas

- Analysis and classification of oil pollution
- Control systems for efficient offshore energy utilization
- Energy-efficient supply of power from shore to offshore platforms
- Energy efficient technologies for oil and gas production (offshore platforms and floating production, storage and offloading facilities, ships, subsea equipment and operational procedures)
- Environmental monitoring and modeling
- Natural working fluids such as CO<sub>2</sub> and hydrocarbons for power production
- Oil chemistry
- Response technologies
- Subsea oil and gas release



Photo: SINTEF

Remote sensing systems that can detect and map oil in ice covered waters.

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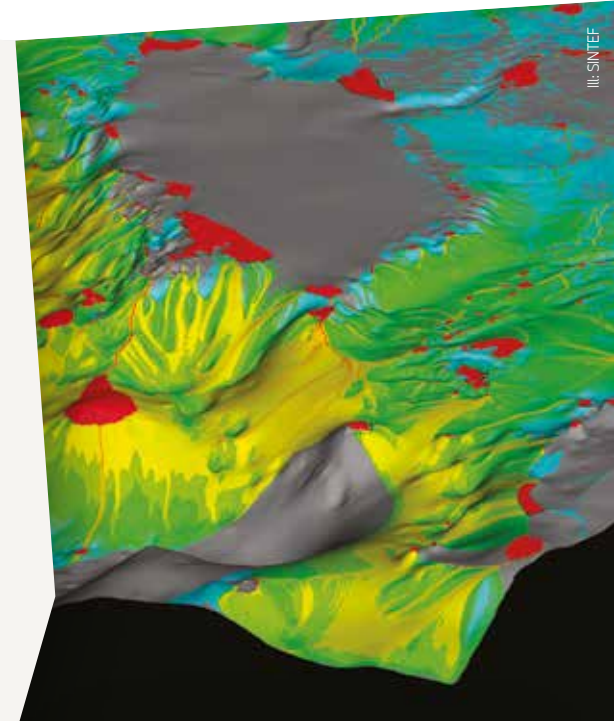
# Exploration technology

Hydrocarbon exploration relies on the ability to detect and quantify the amount of oil and gas in the subsurface properly. The geological structure and the corresponding petrophysical parameters of rocks are determined using sophisticated geophysical techniques. SINTEF develops and applies such methods for individual datasets as well as for the integration of various types of data, for example, seismic and electromagnetic. In order to reduce exploration risk further, geophysical methods can be used in an integrated workflow with rock physics and basin modeling.

Basin modeling, or petroleum system modeling, is applicable during all stages of exploration, from frontier basins to well-explored areas. SINTEF implements and applies methods and software for predicting hydrocarbon phases and volumes before drilling, including all the key elements of geological risk in exploration. We cover the entire petroleum system from source rock deposition and to the hydrocarbon accumulation in a trap.

## Focus areas

- Geophysical imaging
- Hydrocarbon migration modeling: new approaches
- Integration of different data types and models
- Overpressure modeling and prediction
- Palaeo-water reconstruction and modeling
- Rock physics modeling
- Seal capacity evaluation
- Source rock modeling
- Uncertainties in exploration workflows



Applying geological, geophysical expertise and developing our in-house software we can model all elements of a petroleum prospect (from source rock, expulsion, migration, and trap, seal or cap rock).

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# Flow assurance

SINTEF's multi-technology basis has made flow assurance a key subject in many technological areas. With our industry partners, we develop breakthrough technology solutions for the production and processing sectors, including the oil production, metallurgical, hydrocarbon processing, chemical and petrochemical industries.

We have acquired data from more than 14,000 high-quality multiphase flow experiments in our flow loops. Our large-scale flow facility has been crucial as the experimental basis for our widely recognized expertise in subsea multiphase flow assurance.

The electrical heating system for hydrate and wax remediation, DEH, is proved feasible as a flow assurance tool. The DEH technology has been utilized in offshore fields since the year 2000, and is a fully qualified technology used up to 42 kilometer tie-backs and operated both in intermittent and continuous operation.

## Focus areas

- Advanced, multiphase flow simulator development
- Coating technology
- Direct electrical heating of pipelines
- Gas hydrate management in pipelines and processes
- Industrial-scale multiphase flow experiments and studies at pressures as high as 1000 bar
- New subsea flow concepts
- Oil-water chemistry
- Separation technologies
- Wax technology



Photo: SINTEF/Thor Nilsen

The multiphase flow laboratory (in Trondheim, Norway).

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# Gas technology

Environmentally friendly utilization of natural gas and coal is becoming increasingly important. SINTEF focuses on gas resources and covers field development, transport and the processing required for commercial products. We have more than 30 years of experience gained through cooperation with the industry in the exploration and production of hydrocarbons in the North Sea and elsewhere.

## Focus areas

- Gas engines and turbines, combustion modeling and experimental facilities.
- Gas liquefaction and distribution (liquefied natural gas, liquid CO<sub>2</sub> and liquid hydrogen).
- Hydrogen production, storage and liquefaction, and combustion and fuel cell applications.
- Natural gas separation, including sweetening, processing and conversion to products.
- Use of natural gas in advanced metallurgical processes.
- Value-chain analysis, including transport infrastructure and techno-economic optimization.



Photo: Steinar Helge Hansen

Melkøya LNG plant with CO<sub>2</sub> separation.

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# Integrated operations

SINTEF is a leading provider of philosophies, strategies and methods for integrated operations (IO) in the oil and gas industry. The IO concept aims to enhance the development and operation of new and existing fields while optimizing the utilization of experienced, competent personnel and ensuring their safety. Increased value is possible by facilitating better and faster decisions through collaboration and information sharing and fully addressing the potential and requirements of the people, technology and organizations involved.

In a broader context, we are working with our partners in the Center for Integrated Operations in the Petroleum Industry at NTNU to maximize integration along the exploration and production value chain through reservoir, well engineering, subsea and surface facilities in order to optimize production and overall recovery.

## Focus areas

- Advanced drilling simulation and diagnostics
- Condition-based predictive maintenance
- Integrated planning and logistics
- IO compliance, work processes, systems and philosophies



Photo: MARINTEK

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# Improved and enhanced oil recovery

SINTEF puts strong emphasis on research into improved and enhanced oil recovery (IOR and EOR): about 700 SINTEF people work in oil and gas research, 300 of them on topics relevant to increasing oil recovery.

We have expertise in developing and using modeling and simulation tools at all scales and offer numerous laboratory facilities within a range of areas.

## Focus areas

- Bio-related EOR
- CO<sub>2</sub> for EOR
- Compaction drive analysis
- Drilling and well construction
- Environmental impacts, oil spills and degradation
- Geophysical reservoir monitoring
- Integrated operation and remote control
- Mechanisms for EOR
- Polymer-based EOR
- Reservoir geomechanics
- Reservoir simulation
- Reservoir characterization and monitoring
- Reservoir steering and production optimization
- Subsea power supply
- Well instrumentation



Photo: SINTEF/Tr. Nilsen

High pressure cell for measuring interfacial tension.

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# Maintenance, ageing and life extension

SINTEF develops innovative technology for systems that can support short- and long-term decision making for integrity management and the optimized life extension of production facilities. Our research and development work helps to improve efficiency and confidence in safe life extension processes, thereby reducing costs while realizing increased production.

We have extensive experience in corrosion protection, environmentally assisted corrosion cracking and tribology. We also have a seawater laboratory for long-term testing in natural seawater. Combining this with advanced techniques for metallographic and surface characterization enables us to perform most types of corrosion testing.

## Focus areas

- Aggregation and visualization
- Cathodic protection and hydrogen embrittlement
- Corrosion testing
- Decision processes for life extension
- Fatigue and fracture testing and modeling
- Material degradation and lifetime assessment
- Organic coatings, metallic and metallic-ceramic coatings
- Risks and resilience
- Smart data
- Stainless steel, high-alloy materials, aluminium and magnesium
- Thermal spraying of wear-resistant coatings
- Wear and corrosion in offshore components



Photo: STATOIL/Harald Pettersen

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# Marine operations

For more than 30 years, SINTEF has studied, tested and validated different types of marine operations. We have worked with all types of marine operations involving offshore vessels and fixed and floating structures worldwide.

SINTEF runs some of the world's leading laboratory facilities in the field of technology development for the oil and gas sector. We have combined our laboratory experience with the development of associated numerical tools and software, many of which are in daily use around the world by operators and supply industry companies.

## Focus areas

- Feasibility studies on vessels and structures
- Lift operations
- Marine communication
- Motions characteristics of floating facilities and vessels
- Pipeline installation
- Ship-to-ship cargo transfer operations
- Validation studies for field-specific solutions



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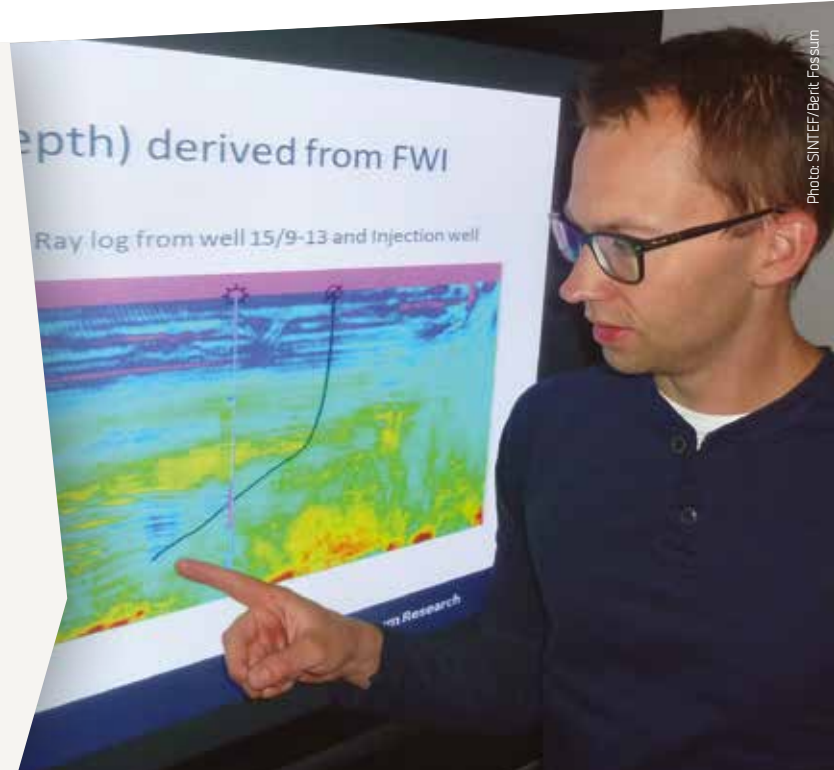
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# Reservoir characterization and monitoring

Successful characterization and monitoring of the subsurface depends on advanced data acquisition and processing, and geophysical methods. The ultimate goal of these techniques is to image the properties of the reservoir and provide essential information for oil and gas applications ranging from exploration and enhanced oil recovery to CO<sub>2</sub> storage. Being able to estimate the associated uncertainties is crucial for the correct interpretation of the resultant images and reliable economic and environmental assessments.

## Focus areas

- Accurate high-resolution imaging and monitoring
- Estimation of uncertainties in imaging
- Instrumentation
- Integration (joint inversion) of multiple datasets
- Multidisciplinary integration: geophysics, rock physics, reservoir modeling, basin modeling, etc.
- Quantification of the amounts of hydrocarbon or CO<sub>2</sub> in a reservoir
- Seismic and electromagnetic data for CO<sub>2</sub> monitoring
- Seismic while drilling



**Model of a gas plume as obtained from full waveform inversion for seismic data from Sleipner gas field.**

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# Risers and pipelines

We develop advanced numerical and experimental methods for the structural analysis and integrity assessment of risers, umbilicals, power cables and pipelines. Our technology is based on a combination of theoretical knowledge, extensive use of laboratory facilities and cross-disciplinary engineering expertise.

## Focus areas

- Arctic materials: steel, polymers, composites and aluminum
- Engineering critical assessment analysis of pipelines (DNV standard DNV-OS-F101)
- Fracture modeling and leak-before-break analysis of pipelines and risers
- Full-scale and component qualification testing for fatigue, fracture and corrosion
- Hyperbaric welding of subsea pipelines
- Integrity assessment for life extension of pipelines, risers, mooring systems and platforms
- Multi-scale modeling of materials
- Simulation of pipe laying, free-span assessment, upheaval buckling and snaking, trawl board impacts and on-bottom stability
- Static and dynamic analysis of risers, including vortex-induced vibration and fatigue assessment of complex cross-sections
- Through-process modeling of welding



Photo: SINTEF/Thor Nielsen

**SmartPipe – a system for online monitoring of offshore pipelines and risers.**

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# Large scale validation laboratories

The development of the Norwegian Continental Shelf, with its challenging and harsh conditions, has placed tough requirements on the various concepts used in exploration and production, including gravity-based offshore structures, floating production units and complete subsea and subsea-to-shore solutions.

To develop and qualify these solutions, SINTEF combines knowledge of hydrodynamics, flow technology, materials and structural integrity. An important factor in such work is the ability to test and verify solutions for the future in its modern large-scale laboratories. SINTEF runs some of the world's leading laboratory facilities. We have combined our laboratory experience with the development of associated numerical tools and software, many of which are in daily use around the world by operators and supply industry companies.

## Focus areas

- CCS
- Environmental laboratories (SeaLab)
- Materials and structural testing and qualification
- Multiphase flow
- Ocean basin and towing tank technology
- Smart grids
- Subsea power supply



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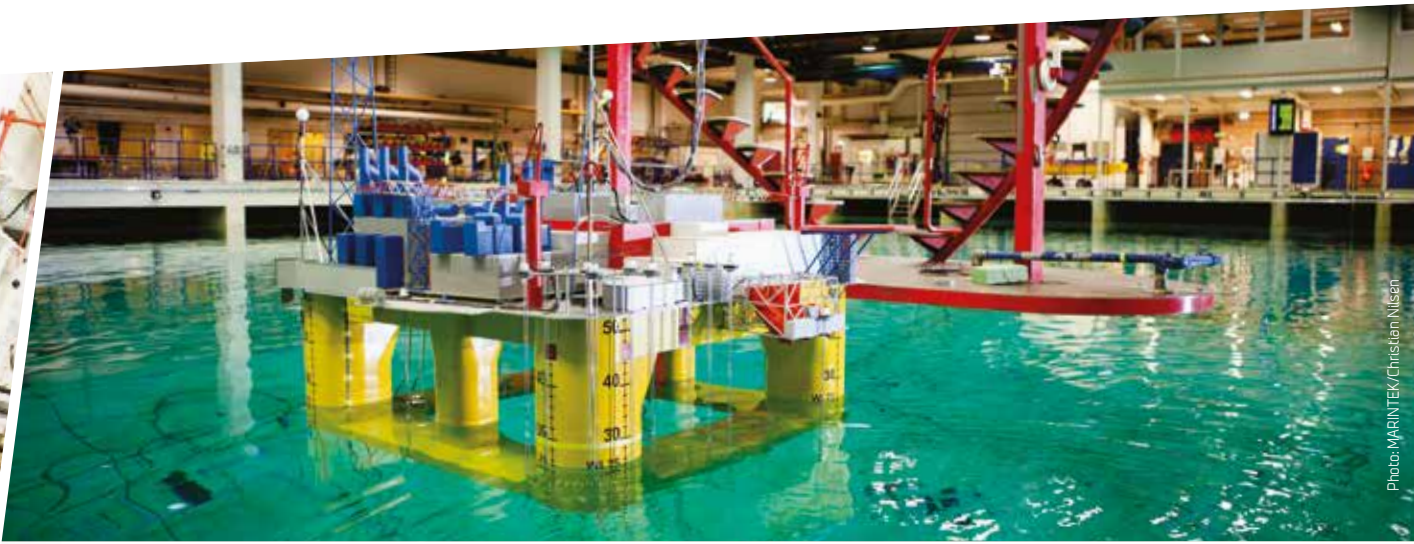


Photo: MARINTEK/Christian Nilsen



Photo: Adresseavisen/Steinar Fugelsøy

# Subsea power supply

The subsea production, processing and transport of oil and gas require a reliable power supply. In cooperation with oil companies and vendors, SINTEF is closing the technology gaps relating to deep and ultra-deep waters, higher power requirements and longer step-outs. We have extensive facilities for combined high-voltage and high-pressure testing of equipment and materials.

## Focus areas

- Aging and failure mechanisms for subsea electrical insulation materials and systems.
- Electrical heating of pipelines
- New or improved liquid and solid-state insulating materials.
- Power system simulation methods and calculation tools.
- Pressure-tolerant power electronics
- Subsea and offshore power grids
- Test and qualification methods for subsea high-voltage equipment.



Photo: SINTEF/Mette Kjelstad

Development of pressure tolerant power electronics in our laboratory.





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