SINTEF

Research and innovation for the oil and gas industry

SINTEF has been a key research partner ever since oil and gas exploitation began on the Norwegian shelf 50 years ago. We have expertise across the entire value chain, from exploration to production and the storage of CO_2.

SINTEF is the largest independent research institute in Scandinavia.

We have 2,000 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 and innovation through knowledge generation and development of technological solutions that are brought into practical use.

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 Fishieries and Aquaculture.

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

Carbon dioxide capture, transport and storage (CCS)

The CO_2-laboratory at Tiller. Photo: SINTEF/Thor Nielsen

Carbon dioxide capture, transport and storage (CCS) is key for meeting global climate targets providing a lower cost and more rapid transition to a sustainable global economy. SINTEF is recognized as a key global player in the CCS research arena. We operate centers of excellence in CCS: the BIGCCS international CCS research center (2008 to present) and from 2016/17 the Norwegian CCS Research Centre (NCCS). We operate on a global scale with strong interactions with the Zero Emission Technology and Innovation Platform (ZEP), the European Energy Research Alliance (EERA) and the European Carbon Dioxide Capture and Storage Research Infrastructure (ECCSEL). Our customers are typically oil and gas companies, utilities, industrial processing companies, vendors and governmental bodies. 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.

KEY RESEARCH AREAS

- CO_2 capture: environmentally friendly absorbent systems; degradation persistent sorbent systems; industrial-scale membranes; gas sweetening, post-combustion, oxyfuel and pre-combustion technologies.
- Transport: safe and cost-effective solutions; thermodynamics; multiphase flow of mixtures of CO_2; fracture propagation in pipelines; and verified calculation tools.
- Long-term, large-scale storage: capacity estimation; well and caprock integrity; monitoring methods; remediation; and CO_2 for enhanced oil recovery.
- CO_2 value chain: analysis of potential and viability; capacity and time window matching; infrastructure and logistics; macro and business economics; hydrogen/CCS economy and legal issues.

www.sintef.no/CCS

Drilling and well technology

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.

KEY RESEARCH 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
- Geo-steering for optimal well placement
- 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

Developing drilling tools for hard rocks. Photo: SINTEF/Thor Nielsen

www.sintef.no/drillwell

Energy efficiency

SINTEF has a strong position in developing and tailoring energy-efficient technologies for oil and gas production, processing and transport and has worked in close collaboration with the Norwegian and international offshore industries for many years. SINTEF's research groups are international leaders within the development of industrial processing knowledge, heat pumping and power cycles based on natural working fluids. Through the ongoing KPN projects COMPACTS, COPRO, HEAT-UP and FME HighEFF (2016-2022) SINTEF is currently developing technologies for more energy efficient production and processing on platforms. Flow assurance has been important for energy efficient transport and has been the focus of projects FACE and Smooth pipe.

The Oceberg field centre. Photo: Statoil/Harald Pettersen

KEY RESEARCH AREAS

- Energy efficient technologies and operational procedures for oil and gas production on offshore platforms and floating production, storage and offloading facilities, ships & subsea equipment.
- Integrated energy supply to production and processing (heat and power).
- Waste heat utilization- compact, light-weight and efficient bottoming cycles, capture, reutilization and conversion of waste heat to power.
- Novel concepts and geometries of heat recovery equipment, Heat exchangers, Heat Pumps.
- Cost optimal heat-to-power conversion from low (LT) to medium (MT) temperature heat sources.
- Natural working fluids such as CO_2 and hydrocarbons for power production.
- Novel component design and optimization of compressors, expanders, ejectors.
- Novel concepts for integration of energy flow in well stream and power production.
- Energy-efficient long distance supply of power from shore to offshore platforms.
- Heat production , waste heat upgrading & power distribution for electrified platforms.
- Control systems for efficient offshore energy utilization.

www.sintef.no/energy-efficiency

Environmental services and research

SINTEF offers environmental services based on experimental research in laboratories and large-scale facilities, and experience from numerous real-time oil spill studies and analyses. Our main goals are to develop knowledge and technologies to minimize impacts and environmental risks related to regular releases of produced water and drilling discharges and of accidental oil spills. Supported by experimental research and field studies within applied biology and chemistry SINTEF has developed decision support tools (OSCAR & DREAM) that are licensed worldwide to areas with offshore oil and gas activities.

KEY RESEARCH AREAS

- Oil spill characterisation and fluid chemistry
- Oil spill fate and behaviour on sea, in ice, on shorelines and in sediments
- Fate, behaviour and mitigation of subsea oil and gas releases
- Environmental effects of pollutants on marine organisms
- Environmental risks related to discharges of oil and chemicals
- Oil spill response technologies
- Environmental monitoring, modeling and decision support

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

www.sintef.no/climate

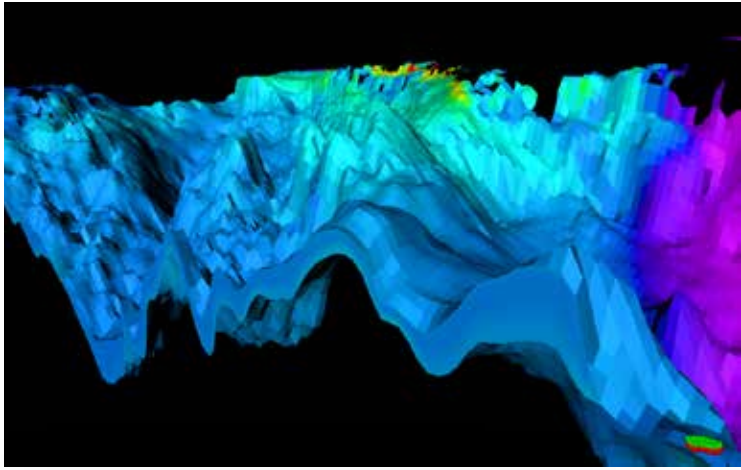
Exploration technology

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 a range of different on datasets (e.g., for example integrating seismic and electromagnetic).

For basin modelling, SINTEF implements and applies methods and software that covers the entire work flow from paleo-water depth modelling, source rock deposition to the hydrocarbon accumulation in traps. In order to reduce uncertainty exploration risk further, geophysical methods can be used in an integrated workflow with rock physics and basin modelingmodelling.

KEY RESEARCH AREAS

- High-resolution geophysical imaging
- Paleo-waterdepth modeling
- Source rock modeling
- Overpressure modeling and prediction
- Seal capacity evaluation
- Hydrocarbon migration modeling: new approaches
- Quantitative imaging and interpretation methods
- Uncertainties in exploration workflows



Applying geological, geophysical expertise and developing our in-house developed software we can model all elements of a petroleum prospect. Example: source-rock modeling using OF-Mod. Illustration: SINTEF

www.sintef.no/exploration

Gas technology

Environmentally friendly utilization of natural gas and coal is becoming increasingly important. SINTEF focuses on natural 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. The use of natural gas as substitute of coal and coke in metallurgical processes is of increasing importance in order to decrease CO_2 emissions.

The use of hydrogen as energy carrier is currently receiving considerable attention. Decarbonisation of hydrocarbons in terms of conversion to hydrogen allows for application of centralized and efficient CCS technologies. SINTEF has vast experience in hydrogen technologies, ranging from production, via storage and distribution to end use in turbines, fuel cells and metallurgical processes. Over the last decades, SINTEF has become one of Europe's leading research institutes within hydrogen technologies with a significant portfolio of EU funded projects carried out in close cooperation with international industry partners. Advanced laboratories have been established at SINTEF pursuing open access policy to ensure efficient use of infrastructure facilities.

KEY RESEARCH AREAS

- Gas engines and turbines, combustion modelling and experimental facilities.
- Gas liquefaction and distribution (liquefied natural gas, liquid CO_2 and liquid hydrogen).
- Hydrogen production, storage and liquefaction, combustion and fuel cell applications.
- Hydrogen gas purification for transportation (fuel cell) applications using Pd-membranes.
- Natural gas separation, including sweetening, processing and conversion to products.
- Use of natural gas and hydrogen replacing carbon in advanced metallurgical processes.
- Value-chain analysis, including transport infrastructure and techno-economic optimization.

www.sintef.no/gastech

Melkøya LNG plant with CO_2 separation. Photo: Statoil/Helge Hansen

Improved oil recovery (IOR/EOR)

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 applying experimental methods as well as modelling and simulation tools to study processes from pore to reservoir scale. We offer services within a wide range of areas relevant to oil recovery.

KEY RESEARCH AREAS

- Water based EOR methods (low salinity, surfactants, polymers, microbial, nanofluids, water diversion by gels).
- Gas based EOR methods (HC gas, CO_2, mobility control including foam).
- Oil recovery from paleo residual oil zones.
- Reservoir stimulation by hydraulic fracturing.
- Reservoir characterization, modelling and simulation.
- Geophysical reservoir surveillance and interpretation (time laps seismic, CSEM, rock physics, joint inversion).
- Advanced drilling and wells.
- Production and subsea installations (seabed and downhole separation, artificial lifts, hydrate management).
- Extended field lifetime (material performance and degradation, production management during late phases of production).

High pressure cell for measuring interfacial tension. Photo: SINTEF/Thor Nielsen

www.sintef.no/improved-recovery

Information and communication technologies

Information- and communication technologies are rapidly evolving and have become and integrated part of our daily lives both at work and at home. New businesses and concepts thrive on the presence of the internet and cloud based services everywhere, and the trends are pointing towards an era of a digitized society where all things that we interact with are connected to the internet.

The advent of an ever-increasing number of small and energy efficient sensors combined with new, powerful and energy efficient communication technologies has made it possible to realize dedicated sensor networks that gives businesses increased insight and knowledge to develop both new and improved products and services. Smart data is the new gold and in the oil & gas sector, it has become important for businesses to find or realize information and communication technologies that can provide the right data for improved future operations.

SINTEF offers services based on their long experience in developing information and communication technologies for offshore and subsea applications.

KEY RESEARCH AREAS

- Big Data
- Internet of Things
- Cyber Security
- Subsea modems and underwater communication/ sensor networks
- Wireless instrumentation
- Embedded systems for safety-critical applications
- Instrumentation for harsh environments
- Robotics and autonomous systems (UAV & drones)
- Microsystems and sensors
- Optical instrumentation
- Solutions for ensured safety and security
- Risk assessment
- Reservoir simulation
- Modeling and simulation of porous media processes

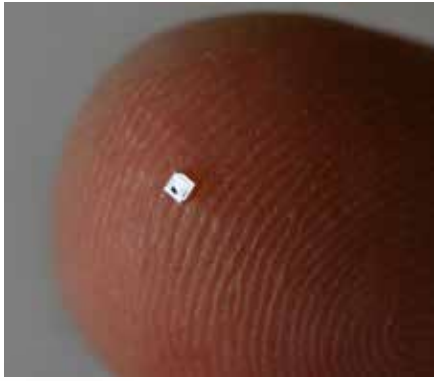


Photo: SINTEF

www.sintef.no/ict

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.

KEY RESEARCH AREAS

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

Photo: MARINTEK

www.iocenter.no

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.

KEY RESEARCH 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

Marine operations and floating production

Photo: Charles Hodge Photography

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.

KEY RESEARCH 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

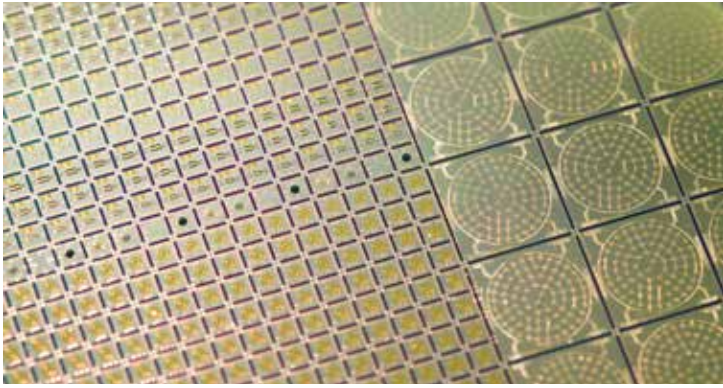
www.sintef.no/ocean-space

Materials and Nanotechnology

Correct application of the right materials in offshore components and structures is often decisive for safe, environmentally sound and cost effective oil and gas operations. The application of nanotechnology allows for new material solutions related to most aspects of the business. SINTEF has a strong position in tailoring and qualifying materials technology for use in the oil and gas sector, and has access to advanced laboratories for development, characterisation and testing of materials and components (including sensors).

KEY RESEARCH AREAS

- Experimental and computational integrity assessment and extended lifetime of offshore components and structures, including development of standards and guidelines for safe implementation.
- Fatigue, wear, corrosion and other degradation mechanisms of materials including hydrogen embrittlement and their interaction.
- Joining technology including welding and joining of dissimilar materials.
- Damage assessment of materials and components.
- High performance materials for demanding conditions e.g. rock drilling components and materials for use in arctic regions
- New or improved liquid and solid-state materials for subsea electrical insulation.
- Polymer and nanotechnology based EOR.
- Trace materials for reservoir characterization and monitoring.
- Organic, metallic, ceramic and hybrid coatings, including coatings for flow- ensurance and –enhancement and anti-icing properties.
- Chemical characterization of reservoir fluids and production chemicals.
- Development, prototyping and small and medium size production of sensors for flow assurance, condition monitoring, exploration, and gas detection.
- Nanotechnology safety for health and environment.



www.sintef.no/materials-nano

Risers and pipelines

Photo: SINTEF/Thor Nielsen

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.

KEY RESEARCH 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.

www.sintef.no/ogtransport

Subsea processing and transport technologies

Technologies for subsea solutions will be of key importance for cost efficient development of future oil and gas fields. A large share of new discoveries are likely to be subsea developments with tiebacks to existing infrastructures. In addition, low pressure or mature reservoirs with complex surface chemistry and harsh environments result in challenges within flow assurance, and production monitoring and processing that must be solved.

In cooperation with oil companies and vendors, SINTEFs multi-technology knowledge base develop breakthrough technological solutions for subsea production and processing. We have developed and tested technologies e.g. to remediate industrial flow assurance problems and to provide solutions for subsea power supply. Our research and development activities are supported by our comprehensive large scale laboratory facilities: Multiphase flow laboratory, subsea power laboratory, laboratory for mechanical testing of flexible pipes, umbilicals and cables, and underwater robotic laboratory.

KEY RESEARCH AREAS

- Advanced multiphase flow simulations and experiments.
- Flow assurance technologies (Gas hydrate management, viscous oils, wax, sand, direct electrical heating of pipelines).
- Complex oil–water chemistry.
- Ultra-high resolution mass spectrometry.
- Subsea processing.
- Subsea technology validation.
- Materials and coating technology for subsea applications.
- Monitoring and sensor technology to ensure a high level of security in subsea developments.
- Subsea power supply solutions and offshore power grids.

The Multiphase flow laboratroy at Tiller.
Photo: SINTEF/Thor Nielsen

www.sintef.no/subsea
www.sintef.no/ogtransport

Technologies for the Arctic

Photo: SINTEF/Nils Røkke

SINTEF researchers have been operating in the Barents Sea and in Svalbard for four decades, and are accustomed to the demanding conditions. We have spearheaded the development of Arctic technologies in a number of fields.

KEY RESEARCH AREAS

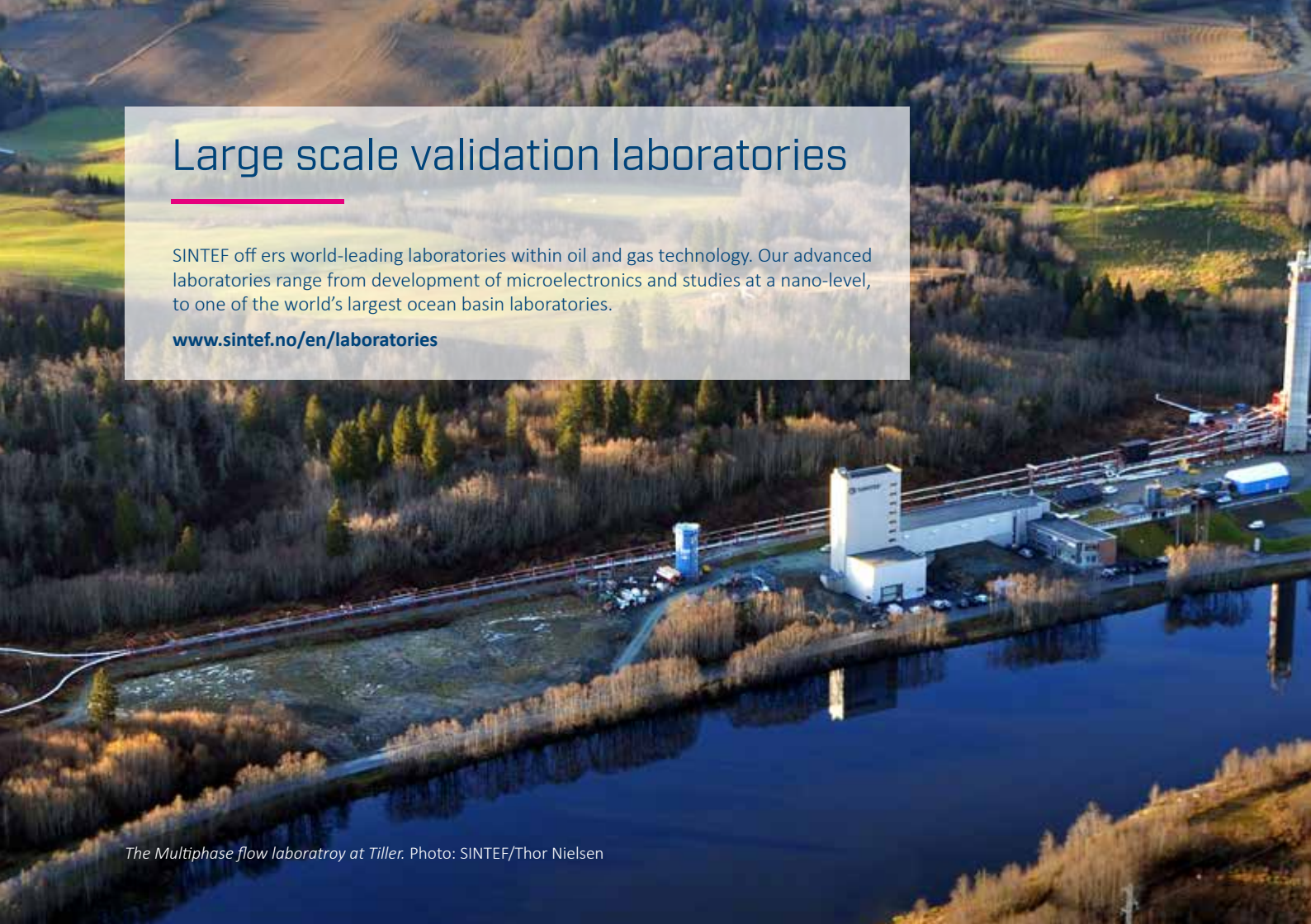
- Technologies for constructions and operations in ice and permafrost.
- Oil spills in ice – contingency and response, fate and effects.
- Communication and navigation systems and system performance under Arctic conditions.
- Cold exposure effect on physical and cognitive performance, development of smart clothing for work in cold environments.

www.sintef.no/high-north

Large scale validation laboratories

SINTEF off ers world-leading laboratories within oil and gas technology. Our advanced laboratories range from development of microelectronics and studies at a nano-level, to one of the world's largest ocean basin laboratories.

www.sintef.no/en/laboratories



The Multiphase flow laboratroy at Tiller. Photo: SINTEF/Thor Nielsen

Technology for a better society

www.**sintef.com**