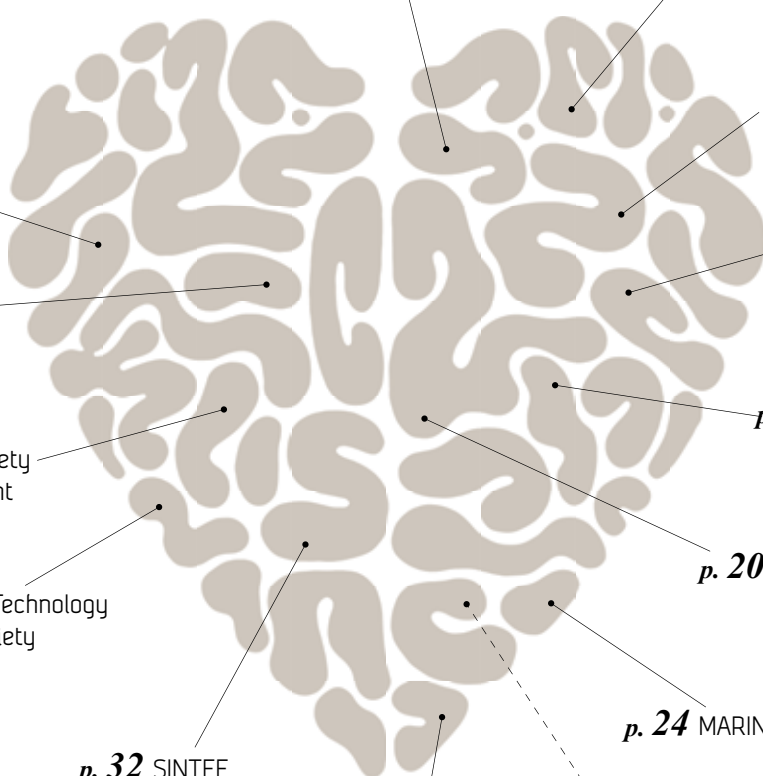




Technology for a better society
2010

Every day, our 2100 staff are working towards fulfilling our vision of "Technology for a Better Society".

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Annual Report

Annual report of SINTEF's board of directors, accounts and
HSE figures can be found at: www.sintef.com/2010-en

Glimpses of SINTEF's year

- ▶ HRH Crown Prince Haakon opened SINTEF's new facility for carbon capture and storage near Trondheim. The plant is one of the most advanced in the world, and will help to lower the cost of capturing CO₂, a greenhouse gas.
- ▶ Oslo was selected as the European Union's pilot city for hydrogen-fuelled cars, with SINTEF as an important contributor.
- ▶ SINTEF assisted BP and the US authorities after the Deepwater Horizon disaster in the Gulf of Mexico by modelling and testing the spread of oil, its behaviour and degradation in the water, and the effect of chemicals that dissolve oil in seawater.
- ▶ We hosted the International Conference of the Society for Medical Innovation and Technology, at which 300 of the most prominent surgeons, engineers and medical technology scientists in the world presented recent advances in their fields.
- ▶ IRIS, the University of Stavanger, NTNU and SINTEF set up a research centre for enhanced oil recovery and improved safety on the Norwegian continental shelf. The centre was subsequently selected as a Centre for Research-led Innovation by the Research Council of Norway.
- ▶ SINTEF ICT was awarded an environmental prize worth NOK 250,000 for the development of X-ray technology that separates valuable metals from electronic waste.
- ▶ SINTEF was awarded funding by the European Science Foundation for a project in synthetic biology that will help to bring the world bioenergy without using food as raw materials.
- ▶ The pilot study report on the Ocean Space Centre, a future centre of research and knowledge about the oceans, was submitted to the Minister of Trade and Industry.
- ▶ SINTEF celebrated 60 years as a centre of research in the service of society.

The Age of Knowledge

Our age is characterised by clear global challenges; basic problems such as climate, food insecurity, clean water, energy, health and work. These are what we often call the “great challenges”.

Photo: Geir Mogen



At the same time, a new geopolitical reality is emerging, with an open global economy and a trend towards a better economic balance among different regions and nations. “New” great powers such as China, India and Brazil are emerging. Hundreds of millions of people have seen their standard of living rising, although many others do not have their basic physical needs covered. According to the United Nations, about a billion people on the Earth are hungry, and this number has risen in the course of the past few years.

Our shared task is to develop sustainable solutions for the future in a number of essential areas. The concept of “sustainability” includes care of the environment, social responsibility and good steering of industry and society.

We are living in an age of knowledge and technology. An ever-rising level of knowledge and changing scientific understanding mean that the future holds great potential. Formerly distinct disciplines are becoming ever more closely linked, and new knowledge is being generated at the interfaces of different areas of knowledge such as the natural sciences and engineering, medicine and technology. Interactions between the social sciences and technology are of vital importance, and we need greater insight into the relationships that exist between technology, people, culture and society.

The development of new solutions also demands interactions between what we might call experience-based and research-based knowledge. Innovation and new solutions often emerge in the context of close interplay of education, research, the public sector and industry.

Throughout its 60-year history, SINTEF has operated within the framework of this model. Our research generates knowledge that is made available to everyone at the same time as we develop concrete solutions and technology that belong to the companies that invest in research. Nowadays, this is called “open innovation”.

In this publication about SINTEF in 2010, we present our organisation and bring you some good stories that demonstrate the breadth and practical value of our research. This year, the full version of our Annual Report has been published on the Internet, at www.sintef.com/2010-en

Unni Steinsmo
President of SINTEF

This is SINTEF

SINTEF is the largest independent research organisation in Scandinavia. We create value through knowledge generation, research and innovation, and develop technological solutions that are brought into practical use.

SINTEF is a broadly based, multidisciplinary research concern that possesses international top-level expertise in technology, medicine and the social sciences, and our aim is to become the most renowned contract research institution in Europe.

SINTEF is an independent, non-commercial organisation. The profits of our contract research projects are invested in new research, scientific equipment and competence development. In the course of the past five years, we have invested NOK 500 million of our own funds in laboratories and scientific equipment.

The SINTEF Group comprises the SINTEF Foundation, four limited companies and SINTEF Holding.

Key figures

SINTEF employs 2100 staff who come from 67 different countries.

Our turnover in 2010 was NOK 2.8 billion, more than 90% of which was won in open competition for contracts for industry and the public sector and project grants from the Research Council of Norway. Every year we perform more than 7000 research projects for some 2000 clients. Basic grants from the Research Council make up around seven percent of our turnover.

SINTEF also acts as an incubator for new industrial companies. In 2010, we were involved in the commercialisation of eight different SINTEF tech-

nologies, through licensing agreements and the establishment of new companies.

Partners in cooperation

SINTEF operates in partnership with the Norwegian University of Science and Technology (NTNU) in Trondheim, and collaborates with the University of Oslo. NTNU personnel work on SINTEF projects, while many SINTEF staff teach at NTNU. Our collaboration involves the extensive joint use of laboratories and equipment, and more than 500 people are employed by both NTNU and SINTEF. We also collaborate with other leading research organisations in Norway and abroad.

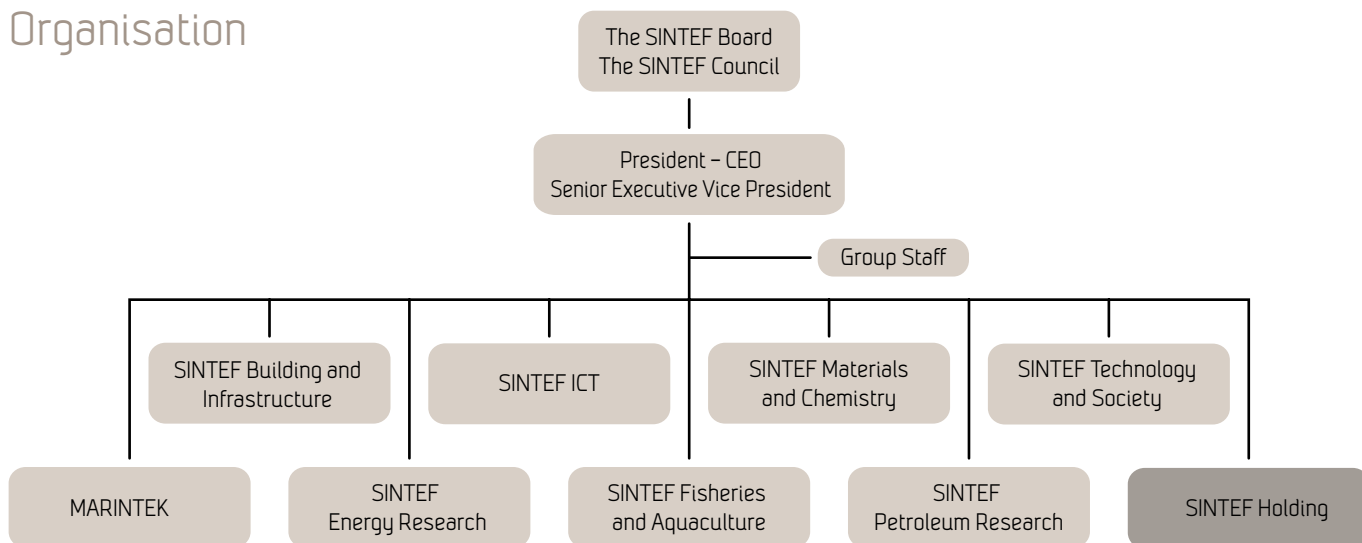
International activity

SINTEF has clients in about 60 different countries. In 2010, 16 percent of our turnover was derived from international contracts.

About 40 percent of our international turnover comes from the EU's research programmes, in which SINTEF is a leading participant. European Union projects are given high priority, because we believe that it is important to participate in multinational knowledge-generation efforts, and because such projects give us access to interesting networks.

Our ambition is to grow in the international R & D market, and for this reason, we are investing in areas in which we are particularly strong: oil and gas, energy and the environment, materials technology, maritime and biomarine technology, ICT, building research and medical technology. We maintain an international presence via our own subsidiary companies or laboratories in the USA, Brazil and Denmark.

Organisation



SINTEF Building and Infrastructure



Photo: Benedikte Skarvik

Senior technician Øystein Holmberget tests window air- and rain-tightness.

SINTEF Building and Infrastructure offers top-level expertise in disciplines ranging from architecture and building physics to management, operation and maintenance of buildings, geotechnology, roads, water and other types of infrastructure.

Important projects and events:

Attractive concrete buildings and structures: The Norwegian concrete sector developed a unique range of expertise in the 1980s and 90s. Many people feared that this would disappear when the era of the Condeep platforms passed, but in fact, SFI COIN, which is led by SINTEF, is developing new types of concrete, construction techniques and building technologies. A study has shown that every krone invested in R & D on concrete between 1980 and 2000 returned NOK 19 to industry and society!

More environmentally friendly construction: GLITNE, a project owned by the architecture firm Snøhetta AS and led by SINTEF Building Research, focuses on how environmentally efficient buildings can be made more competitive. One proposal is a model of extended producer responsibility that aims to encourage more environmentally friendly construction practices. Greenhouse gas accounting for a building case showed that the load on the climate due to materials production is greater than had been expected.

Underground exports: 25 years have passed since SINTEF opened its Department of Geology and Rock Technology. During the past few years, this group has greatly extended its international activity, which now ranges from major underground projects in the high-density environments of Hong Kong and Singapore to subsea road tunnels in the Faeroes, Åland and the Shetland Isles.



Photo: Mikkel Ehem Maxness

*Executive Vice President Hanne Rønneberg
wants to bring new climate knowledge
to the construction industry.*

What is the most important societal challenge facing the Institute's sector of industry?

I could make a whole list of equally important points. Some of SINTEF Building Research's projects were launched with the aim of solving some of the biggest challenges facing society today. On the one hand, we need to provide solutions that will reduce greenhouse gas emissions, at the same time as we develop technologies and strategies for adapting the built environment to the climate changes that the United Nations International Panel on Climate Change say are already inevitable.

How have you grasped this double challenge?

Just over ten years ago, one of our predecessor institutes, the Norwegian Building Research Institute, launched the Climate 2000 programme, which became one of the largest research programmes in the construction industry in the following decade. In this programme, we have continued the development of climate-influenced structures and components, which will help to make future buildings more capable of withstanding climatic impacts. The programme has also led to improved methods of incorporating adaptations to local geographical conditions when the climatic screen of buildings is being designed – roofs and terraces, external walls and foundations. A lot of people in the building industry looked askance at us when we started all this in 2000; climate change as a consequence of global warming was not on the agenda of the construction sector then. We don't meet such reactions today!

SINTEF and NTNU were also among the first to start research on low-energy buildings, and this has developed into a major effort on passive house solutions. We were represented on the expert committee that submitted the report entitled "Making buildings energy-efficient" to the Minister of Local Government in autumn 2010. The many years of competence development at SINTEF/NTNU that lie behind this effort have led

to us being awarded the status of Research Centre for Environmentally Friendly Energy, for zero-emissions buildings (ZEB).

What would you do first if you were Minister of Local Government, and thus responsible for housing and building, for a day?

I would ensure that SINTEF Building Research was given funding that would enable us to add our knowledge of climate adaptation and energy efficiency improvements to our Building Research series of publications. Everyone agrees that it is vitally important to provide the construction industry with up-to-date data in these fields. This is not a trivial task. The factors that I have already mentioned mean that we need to update 200 of the directions in the Building Research series, which is the construction industry's source of knowledge and quality norms.

We also need a few tens of million kroner for an aggressive research and innovation strategy for the construction industry. We are all ready here to roll up our sleeves!

*Number of employees: 227
Proportion of academic staff
with doctorates: 27%
Total number of publications: 1145
Gross turnover: MNOK 274
www.sintef.com/building*

Weapon against the weather

*Her doctorate was on climate changes in times past:
now she wants to help us get through the next one.*

Text: Svein Tonseth

German-born **Kristina Heilemann** (pictured) will never forget the late summer of 2002, when the weather gods dropped millions of tons of rain on Central Europe. The long waterway of the River Elbe burst its banks, and thousands of Kristina's countrymen had to be evacuated.

"The towns on the banks of the river were completely unprepared for the nightmare," she remembers.

The experience makes the SINTEF scientist all the more keen on the results of a pioneering project that she and ten colleagues from a number of Norwegian research groups – plus another German scientist – have been carrying out for the Research Council of Norway.

The project has been developing risk and vulnerability analysis tools that focus in particular on natural disasters caused by climate change.

"This is the first step towards a widely available tool that will help local authorities adapt to a changing climate," is how Kristina sums up the project.

"Now we are continuing this task for the European Union. Our aim is to enable local authorities to focus on effective measures that they can put into effect in advance to reduce the damage done by heavy rainfall events, combinations of spring tides and storms, as well as the longer-term threat of a rise in sea level. We are talking here of everything from drawing up contingency plans to improving drainage systems.

As a researcher, Kristina's perspective concentrates on what the future might bring. When she took her doctorate, however, she looked for the most part into the past. The topic she chose for her PhD has given her a unique insight into the climatic history of Europe since the last Ice Age until the present. Kristina is a geologist, and she has used subsea sediment deposition processes to reconstruct changes in the climate.

She has long since taken the step from detailed basic science to applied research. She came to Norway as research manager in the Department of Coastal and Harbour Technology at SINTEF Building Research in 2007.

Double challenge • For the past three years Kristina has been a member of an eleven-strong team in the multidisciplinary Research Council project called ADAPT (Adapting Community Risk and Vulnerability Analyses for Climate Change). SINTEF/NTNU had already developed a general method for local risk and vulnerability analyses. The Adapt CRVA team

have taken this model a step further by incorporating threats from a new, wetter climate, emphasising the importance of making local experience from previous flood events easily available to present and future planners.

"We are collaborating with Trondheim City Council in mapping the potential consequences of extreme weather conditions for the city's water supply and run-off systems. Our analyses have given us a preliminary overview of the weaknesses in the present system. However, future analytical tools will need to be capable of supplying more detailed results than this, our first version. But if systems of this sort are to be of practical value for the authorities in small communities, they will have to be kept simple to use," she says.

This is the double challenge that this SINTEF scientist and her colleagues from eight countries have accepted in the European Union's project FloodProBe – Technologies for the Cost-effective Flood Protection of the Built Environment.

Kristina's scientific hobby-horse is that future risk-analysis tools in the field of flooding need to show users whether floodwaters can put several social functions out of operation simultaneously.

Power-cuts? • "One of the most important aspects that will need to be flagged is the possibility of floodwaters interfering with electricity supply or destroying vital transport routes. Could a flood isolate the local hospital or police station? Or a kindergarten? When we are thinking of contingency plans that need to be drawn up in advance, it is vital that the model should clarify such things," says Kristina.

At Norway's Directorate for Civil Protection and Emergency Planning (DSB), information consultant Guro Andersen says that the Directorate has recently drawn up an Internet-based guide to climate adaptation for Norwegian local authorities.

"Is it important for local authorities to have a standardised risk and vulnerability tool for climate change?"

"Yes, it is important to have a standardised tool, but it also needs to be flexible, since the challenges will differ from one community to another. And it must also allow for local knowledge to be brought into the process," Andersen concludes.



SINTEF Energy Research



Senior scientist Mario Ditaranto works on carbon capture and storage.

SINTEF Energy Research studies indoor climate and energy consumption in buildings, gas technology, combustion, bioenergy, CO₂ capture and transport, environmental impacts, refrigeration technology, and thermal food processing.

Important projects and events:

Barrier technology for high-tension cables: Many years of leading-edge research and collaboration with Norwegian industry have given us knowledge and technology that limit "water trees" caused by humidity. Cables that are less vulnerable to water penetration have a significantly longer life-cycle. Our research can also have environmental benefits, as lead cable seals can be replaced with lighter and cheaper polyester materials, particularly when offshore wind-farms are being connected up.

Risk control: We are at the international leading edge in the field of controlling risk in electricity grids. New analytical methods based on information about the technical condition of the grid puts us in a better position to design goal-oriented operation and maintenance measures. The categories of consequences in the risk assessment include personal safety, environmental impacts, economics, delivery quality and reputation. Analyses carried out in grid operating companies have shown that we can reduce both maintenance costs and operating risks at the same time.

Improving energy efficiency: Norwegian land-based industry aims to save more than 16 TWh a year by 2020. The potential for energy-saving is also large in the offshore sector, and our research is aimed at developing energy-efficient, cost-effective technology. Energy21 has suggested that the savings made here could be turned into goods manufacture worth NOK 40 billion a year.



Photo: Eng, Karin Skimo

*President Inge Gran
is a burning advocate of energy not being used.*

What is the most important societal challenge facing the Institute's sector of industry?

Supplying energy that does not affect the climate is the biggest global challenge facing us today. But guaranteeing a secure, stable energy supply is also important. Our society is driven by energy, which is also a critical resource; just try to imagine a modern society without electricity. Elected politicians would not survive for long in a society that could not be sure of its energy supply.

What are you doing to meet these challenges?

We are working in several different areas, but we have prioritised our efforts on renewable sources of energy, in line with the Norwegian authorities' own priorities. In that connection, I would emphasise that Norway's national Climate Agreement is very special, indeed quite unique in a global context.

If we are talking about specific projects, I might mention our role as leader of four national Research Centres for Environmentally Friendly Energy (FMEs). These centres deal with wind, water, bioenergy and last but not least, CO₂ capture and storage. Each FME is an eight-year research project worth in the order of NOK 250 – 500 million, which is not exactly small change. But the most important aspect may be that these projects are industry-driven, as this demonstrates that our long-term efforts where we collaborate with industry and the energy sector have been successful. These centres represent major Norwegian mobilisations in the right direction.

Besides, I have a motto, which is that the best kilowatt hours are those that aren't used. Our efforts to develop energy-efficiency technologies for the grid and for industry itself are vital to the struggle to ensure that we have sufficient energy.

Is it possible to save our way out of the energy crisis?

Well, there is at least a lot that we can do. Energy21, the national strategy for research, development, demonstration and commercialisation of energy technologies, estimates that Norwegian land-based industry could reduce its energy consumption by as much as 20 percent. To do so will require a real joint effort: knowledge generation, industrial cooperation and political will are all essential. If our efforts are successful, the energy that we make available can be used for new value creation.

There is a good example of how energy use can be made more efficient in Jæren: a plant that distributes waste heat from four manufacturing companies to a heat pump is now supplying remote and greenhouse heating to a local gardening company. In return, the companies that supply the heat get cooling water that reduces their own energy consumption. There is no doubt that improving energy efficiency is often the cheapest and most environmentally friendly way of making more energy available.

Number of employees: 214

Proportion of academic

staff with doctorates: 47%

Total number of publications: 276

Gross turnover: MNOK 401

www.sintef.com/energy

Smarter grids for everyone

A little box in your fuse box can reduce your consumption of expensive polluting electricity and the need for more power lines.

Text: Svein Tønseth

The box has received several advance prizes, one of them in Steinkjer, with the scientists sitting in the front row and five thousand "on-stage" electricity customers who will act as the vanguard for the rest of us. Before the end of 2016, if everything goes according to the plans of the authorities, all Norwegians will all have this device in their houses; a new electricity meter, with a lot of ICT already baked into it.

These meters offer two-way communication, which will enable the power company to disconnect your water heater and underfloor heating when general consumption is high (if you agree). This simply postpones heating. The system has already been trialled in many other places. The Steinkjer meters will take hourly or quarter-hourly readings, which means that the accounting system will "see" every kilowatt hour that you use, with its current price. Today's meters show only total consumption and calculate the average price of each kilowatt.

Money in the piggy bank • If you move some of your electricity consumption away from times when the electricity system is most heavily loaded, you are putting money in society's piggy bank, say the scientists.

"Shifting consumption around in the course of the day will reduce the use of expensive, polluting methods of generating electricity and reduce the need for investment in the distribution network. Hourly measurements will also give consumers the discount that they deserve when they don't use electricity during peak hours. But the amount of money involved is not enough to be a driving force. For society to benefit from this, it is vital for the authorities – either via methods of charging for electricity or direct support – to help to compensate people who are willing to adapt," says senior scientist Kjell Sand.

National arena • This SINTEF scientist leads the scientific side of the pilot project in Steinkjer, which is being run on behalf of the "Norwegian Smartgrid Centre", a national arena for a smarter electric power system, which has participants from the research and education sectors, electricity companies and industry. Sand explains that Smartgrid is the name of the environmentally friendly and robust electric power system of the future, and that the meters à la Steinkjer are key components of this vision.

Over a cup of coffee, Sand talks about the surge in demand that takes place when everyone gets up and makes – you guessed it – their coffee at the same time.

"Modern society has dimensioned its power-generating capacity and

distribution grid to meet peak-hour demand. If Europe continues in this direction in this age of renewables, the electricity generating companies will need to have fossil-fuelled power stations for reserve capacity in the morning. Because no-one can be sure that wind turbines will turn fast enough or if the sun will shine strongly enough on our solar panels just when they are needed."

But can't Europe base itself on a little bit of morning fossil-fuelled electricity?

"Yes, but in that case, we need new technology that can rapidly turn electricity generation in these power stations up and down. We believe that it will be cheaper instead to develop technology that adapts consumption to available capacity. That's what SmartGrid is all about," explains Sand.

Freeing up capacity • According to Kjell Sand, if everyone in Norway postponed heating their water and their floors until after the morning rush, generating capacity equivalent to that of a large Norwegian power station would be saved.

But can Norwegian consumer behaviour actually reduce the need for fossil-fuelled power stations on the Continent?

"Yes. Europe wants to use Norwegian hydropower during the morning peak. If Norwegian households could move some of their electricity consumption away from these hours, it would clear the way for a power exchange of this sort."

Would the price of this be that we would have to shower in cold water and pad around on ice-cold floors?

"No. The temperature in the hot-water tank and in our floors sinks too slowly for us to notice brief power-outs. Experiments have also shown that remote disconnection makes people so conscious of what they pay for electricity that they are not only willing to postpone parts of their electricity usage, but also actually reduce it. In Steinkjer, we will probably also trial add-on devices that are stuck into wall-sockets and communicate for example with specially equipped panel heaters so that people can also have them switched off automatically when the price of electricity is high, if they wish."

According to Kjell Sand, the pilot city of Steinkjer will be an important display window for SmartGrid technology.

"At the same time, we will be gathering valuable information about the wishes and experiences of our users. The future of the SmartGrid concept will be determined by the success of the pilot projects!"



SINTEF Fisheries and Aquaculture



Apprentice Mathias Onsøien works with start-feeding of cod at SINTEF SeaLab.

SINTEF Fisheries and Aquaculture is Europe's leading centre of technological research for the fishing and aquaculture industries. We perform technological research and development along the entire marine value chain. Our most important clients come from the Norwegian fishing and aquaculture sector.

Important projects and events:

HSE in the fishing fleet: We are helping to make fishing boats safer, and thus more attractive, work-places; an important aspect where recruitment to the industry is concerned. Because on the Norwegian coast, the offshore industry is a tough competitor for other branches in the struggle for sufficient manpower.

Thinking kelp: If you think "green", kelp may be the answer. We are now cultivating these familiar growths in underwater "research plantations". Part

of the thinking behind this is to turn kelp into a raw material for a new generation of sustainable biofuels that will not lay claim to good agricultural soil or freshwater resources. Cultivated kelp can also be turned into food and chemicals, and it can be used in fjord improvement projects where "wild" kelp has been exterminated.

Create: This is one of our national centres for research-led innovation (SFIs), and it will lay the foundations for the next generation of aquaculture activity, including installations that will be located in more open waters and/or further out to sea. The centre does research on sea-cage design, fish-farm operation, fish behaviour and logistics.

Efficient, humane slaughter: We have helped to ensure that Norway has the world's first salmon slaughter plant with automatic bleeding based on machine vision and robot technology. Such advances offer more rational operation, ensure that the fish are well treated and improve the quality of the end-product.



President Karl A. Almås believes that the sea holds the key to solving the global food crisis.

What is the most important societal challenge facing the Institute's sector?

Developing technology and expertise that will enable the world to increase its outtake of food from the sea efficiently and sustainably. This is how Norway can help to deal with the global food crisis.

Although this country is responsible for only three percent of the world's catches of wild fish and farmed fish products, it operates a first-class supply industry. Via the solutions that this industry offers the world, our research can contribute to a growth in seafood production that will make a real difference on a global scale.

What are you doing to meet these challenges?

We have flagged five areas where our results will make a difference for society:

We will make it possible to double Norwegian aquaculture production by 2020. Our contribution here will cover both the knowledge that is needed to build and operate fish-farms in more open waters and research on what we call "multitrophic" aquaculture; fish, crustaceans and kelp that either directly or indirectly utilise fish feed together, as well as knowledge that will improve management of areas that are already used by aquaculture. At the same time, we will help to double the profitability of the Norwegian fishing industry. Our efforts here will cover helping to make the fishing fleet's energy consumption more efficient, providing solutions that will ensure that catches are of the right species and size, and the development of monitoring technologies that will reduce or prevent overfishing.

With our help, Norway will also have the world's most modern fish-processing in 2020. This notion covers every aspect from the arrival of the farmed fish at the slaughtering station to total utilisation of the raw material, in addition to the development of value-added products such as marine oils for the health-food market. We will also help to ensure that Norway

develops a new biomarine industry which by 2020 will increase its annual turnover from its current level of NOK 3 – 4 billion to 10 billion. Topics in this area include kelp and seaweed cultivation for bioenergy generation and human consumption, plus bioprospecting, i.e. the hunt for organisms that are capable of producing antibiotics, for example.

Our fifth area of concentration will be helping the supply industry throughout its entire range of activities.

How is it possible to double aquaculture production in an industry with environmental problems?

The aquaculture industry will manage to solve its problems of fish-lice and escapes, just as it has already solved previous crises of health and antibiotics consumption. If we take the recent escape at the Island of Hitra as an example, it shows that even greater efforts are needed, not only to reduce the chances of such events taking place at all, but also to deal with their consequence if they do happen. Today, these problems overshadow the fact that there is currently no more efficient way of producing protein than giving feed to a fish; because fish don't use energy to stand on all four legs or to maintain a temperature of 37 degrees."

Number of employees: 114
Proportion of academic staff with doctorates: 37%
Total number of publications: 108
Gross turnover: MNOK 152
www.sintef.com/fish

A win-win situation

The Barents Sea in 2010: below decks in a modern factory trawler two men smile happily on behalf of the climate and the fishing industry.

Text: Svein Tønseth

The calendar says that it is November, but the darkness of winter has already fallen over the Hopen Deep, where the trawler "Atlantic Star" is plunging through the waves off Bear Island.

Below decks are two SINTEF scientists, and in front of them lies clear evidence that it will be possible to combine the separation of small cod during trawling in the far north with a long wished-for cut in the trawler fleet's fuel consumption and greenhouse gas emissions.

Eduardo Grimaldo (pictured) from Peru and Spaniard **Manu Sistiaga** are far from their native countries. The trawler lies in the middle of the nursery grounds of the Lofoten cod stock. On board the vessel, the two scientists count and measure the cod that come in from the catch bins.

Floating trawl • What is special here is that the cod are being taken by a midwater trawl, i.e. one that is towed far above the seabed. This type of gear has been forbidden in north Norwegian waters for the past 30 years, in order to conserve the small cod that will become the parents of future year classes. This meant that special permission was required for this research cruise.

The size of fish retained by the trawl cod-end is basically determined by the dimensions of the net mesh. But higher up in the water column, the density of the fish may be much higher than at greater depths, and then the catch can quickly fill the net. When that happens, it can be difficult for small fish to escape through the mesh. When the ban came into force, other sorting mechanisms did not exist.

Since then, however, things have developed rapidly, both at management level and in terms of technology – the field of the two scientists on board the "Atlantic Star". On the Hopen Deep, they are using sorting equipment that functions perfectly well.

"Recent developments, including our own findings, suggest that it should soon be possible to permit use of the mid-water trawl again in the north," says Eduardo Grimaldo once he is back on dry land.

Efficient sorting • "For 30 years now, everyone who has been going after cod in northern waters has been obliged to use bottom trawls. Friction with the seabed makes such trawls energy-intensive. In order to improve energy efficiency and minimise negative effects on the seabed flora and fauna, the trawler industry and the politicians want a midwater trawl that can catch fish without effects on the seabed.

During the research cruise, Manu and Eduardo demonstrate that a midwater trawl fitted with easily deployed systems for sorting fish by size

can efficiently separate out smaller fish. Two systems are being trialled. Both produce catches in which fish below the minimum permitted size make up less than two percent of the catch, in areas where the proportion until now has been as high as 32 percent.

At the same time, towing resistance is reduced, because the trawl does not impact the bottom. The experience gained in the course of two cruises indicates fuel savings of at least 20 – 30 percent per kilo of catch compared to bottom trawling. This implies a major reduction in greenhouse gas emissions from the ship's engines. Three benefits at once! What is the secret?

Soft panels • In bottom trawling, the fish pass along a metal grid at the opening of the cod-end, where the grid openings are large enough to enable undersized fish to escape. Instead of this solution, Eduardo and Manu have gone in for "soft panels" in the net-wall, with flexible meshes of the appropriate size; "Exit Windows", as they are called.

The two scientists based their choice on the fact that sorting grids appear to lose their ability to selectively retain fish at the high fish densities that build up in the net when midwater trawls are used. They also believe that it is not good on health and safety grounds to drag heavy metal grids up on deck.

"If small fish are to survive the sorting process, they have to get out of the trawl as quickly as possible, and preferably while the trawl is being towed and not on the surface, where the pressure is different, and there is a danger of stress, crush injuries and scale loss. We are going to check carefully where sorting actually takes place, and we are very hopeful that it is while the net is still being towed. This is because with the midwater trawl, everything happens so quickly that the fish are lively and have not lost any of their ability to swim. During bottom trawling with grids, we know that sorting takes place near the seabed, and that almost all small cod survive escaping. It has also been shown that such "Exit Windows" sort just as well as grids on the bottom," says Eduardo.

Can the sorting success of the "Exit Windows" lead to the ban on midwater trawls in northern waters being reconsidered? Senior consultant Robert Misund in the Norwegian Directorate of Fisheries answers:

"These scientists are smart people, whom we support and with whom we have a long history of cooperation. But before your question can be answered, we will need evidence about the phase of the trawling operation when the sorting takes place, in order to know more about the survival of the fish that are sorted out through mesh panels. The use of midwater trawls in northern waters also requires solutions that will ensure that catches do not become so big that they cannot be handled."



The photo was set up and shot according to SINTEF's HSE regulations.

SINTEF ICT

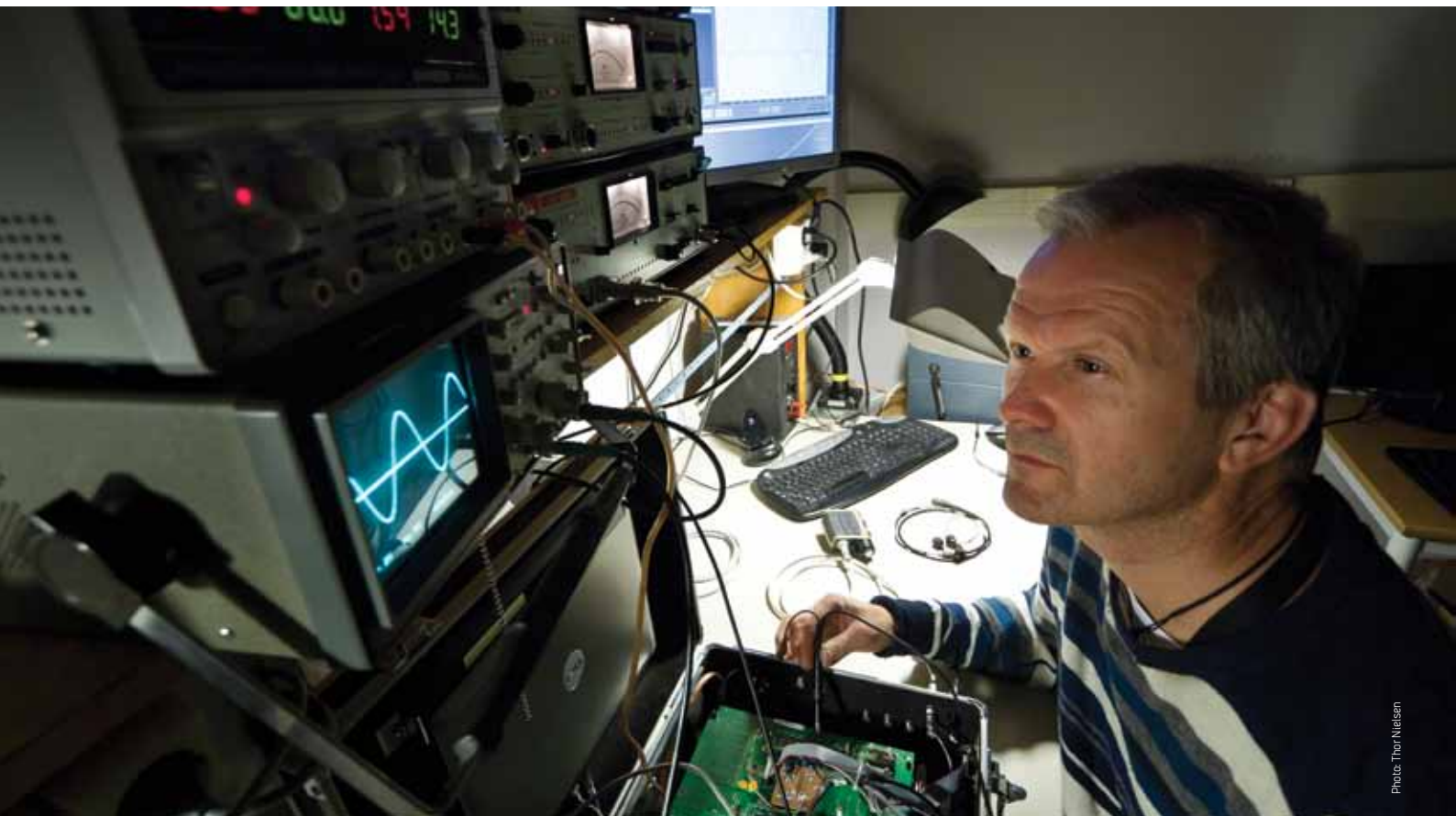


Photo: Thor Nielsen

Researcher Olav Kvaløy in the Acoustics Laboratory.

SINTEF ICT provides research-based expertise and technology in the fields of micro- and sensor systems, monitoring and communication systems, and information systems and calculation-oriented software.

Important projects and events:

EE waste: We have been awarded the Elretur Environmental Prize of NOK 250,000 for the recovery of scarce metals. Elretur is a nation-wide return company that collects, recycles and handles electrical and electronic waste products in an environmentally friendly manner.

Strategic cooperation: Telenor and SINTEF have signed an agreement regarding strategic collaboration in the fields of M2M (Man-Machine Communication), Future Internet, Information Security and Power-efficient Solu-

tions. The agreement means that SINTEF will be Telenor's executive R & D partner in these areas.

Electronic transport: As project manager of the "Internet of Energy for Electric Mobility" consortium, we are helping to develop tomorrow's transport systems. Our main goal in this respect is to save energy and reduce emissions from mobile units that are connected to intelligent energy networks (SmartGrid). One of our areas of focus is electric vehicle requirements for distributed charging capacity.

The Internet of Things: We lead the cluster that is coordinating the European Union's projects on the "Internet of Things", i.e. technology that will be able to do everything from checking whether you have switched off the stove in your holiday cabin (and then actually switching it off) to helping hospitals to trace instruments and see whether they are in use.



Photo: Mikkel Ebrein Maxness

Executive Vice President Aage Thunem thinks that we need to become better at handling and recycling electronic waste.

What is the most important societal challenge facing the Institute's sector?

The global challenges are our challenges. Information and communication technology is making valuable contributions to how we deal with the challenges of the climate, energy and food supply. In many cases, ICT will be essential if we are to deal with these cost-effectively.

Many aspects of modern society are based on extensive use of information technology, and ICT is part of the critical infrastructure of today, because it touches on everything from banking and finance to energy distribution, communications and welfare services. For this reason, the Internet of the future is one of our areas of special interest: basic technologies such as Net-based systems, services and not least, security and vulnerability aspects of Internet use are important topics in our work.

A particular challenge for our discipline involves the environmental problems created by the use of electronics, in the form of the waste products generated by all the electronic products we use today, not least as individual consumers. In our view, there is a great need to "green" the ICT industry via the implementation of good environmental measures.

What are you doing to meet these challenges?

We are working on projects related precisely to recycling rare, valuable metals from the electronics sector. Moreover, ICT is a key technology in terms of taking up all the major societal challenges. Medical technology and welfare technology are examples of fields that have been built up around ICT, and we are working on a number of projects in these areas. Technology from our micro- and nanolaboratory is playing a core role in the development of new medical technology.

One important area of effort for us is the development of "SmartGrids", which are an Internet-based combination of ICT and the joint control of the energy supply by electricity generators, distributors and users. The aim

here is to be able to steer and monitor energy supply and consumption for the individual consumer and company, as well as for the supplier, in a more efficient way.

Information security is another important area of activity for us, and we are working on the distribution and gathering of information via the Internet. Our aim here is to secure personal information and data against theft, for both companies and individuals.

Who are your biggest clients?

"We have no large, dominant individual clients apart from the Research Council of Norway and the European Union, which certainly do finance a large number of projects. A group of companies from the ICT sector and suppliers to the petroleum industry appear regularly on our client list. We use our European Union projects to develop our own strategic competence and technology in such areas as the Internet of the future, information systems, welfare technology, and sensor and measurement systems. All this takes place in close collaboration with industry and other European research institutions.

Number of employees: 280

Proportion of academic

staff with doctorates: 45%

Total number of publications: 614

Gross turnover: MNOK 356

www.sintef.com/ict

An eye for detail

*Contract: to make the smallest autofocus lens in the world.
Challenge: To make it inexpensive. Timetable: Before our competitors.
Status: Mission accomplished.*

Text: Christina Benjaminsen

"The clue is a gel," says research scientist **Dag Wang** (photo). "And a piezoelectric material."

"Piezoelectric???"

"Yes; it means that the material can change its physical shape when we apply an electric current."

"How exciting!"

"We make use of a technique with PZT devices based on MEMS, which also makes them cheap to produce."

"Stop there! Can we just begin at the beginning?"

Of course Dag Wang can do just that; he is one of the inventors of what is currently competing to be the world's leading technology for autofocus lenses for smart phones. The lens measures no more than 3 x 3 mm, but it can focus sharply to infinity. The technology is now ready to be commercialised by the Norwegian company PoLight, which specialises in optical solutions for high-technology communication units.

Brain-storming • The story behind the technology began about six years ago behind the glass walls of MiNaLab in Oslo, when five scientists met for a workshop in the "Micro" meeting room on the fifth floor. On the agenda was a brain-storming session with the aim of thinking up new, energy-saving solution that could give small optical systems autofocus capability. The walls were soon covered in yellow "sticky notes", and the big whiteboard was full of sketches and mathematical formulæ.

"One important requirement was that it should be possible to adjust the lens for just what should be in sharp focus. To do this, we usually need to move individual lens elements, which requires energy. The optimal solution would therefore be to be able to modify the curvature of the lens itself, just as our eyes do," explains Wang.

What the scientists needed, then, was something that resembled a soft, flexible lens, and a material that could imitate the muscle that controls the shape of the lens in our eye.

The idea of creating a autofocus lens based on principles found in nature soon set the ideas flowing. The result was a sketch of an optical "sandwich" that consisted of superfine glass plates, a polymer, a gel-like material and a flexible metal alloy, all in mini-format.

Hunt for electrical materials • A few hours later, a rough sketch of the new lens-to-be was ready. The piezoelectric material that the scientists needed would have to be developed to order. If they could manage to get a ring of this material to expand and contract using hardly any energy, and at the same time, place a gel-based lens in the centre of the ring, there would be a good chance of success.

After at least a year of internal development, the prototype was operational.

In 2006, the research team signed a project contract with PoLight in Horten. This small company had long been working on optical systems, and it saw the potential for bringing this technology to the mobile phone market.

Playing with the big boys • Today, four years later and after investing almost NOK 100 million in development, PoLight's people have just come home from the world's biggest mobile telephony trade fair; the Mobile World Congress in Barcelona, where the company demonstrated the new camera lens, which they had already integrated into a mobile phone, to a group of specially invited technology companies. Manufacturers such as Apple, Nokia, LG and Sony Ericsson are now on the list of interested companies.

"We attracted a lot of attention because of the image quality that our lens offers. Now we are in discussion with several major mobile phone companies and their suppliers, and I hope that we will land a contract in the course of the year. It is particularly gratifying for a small company like us to be taken seriously by these big companies. It demonstrates the power of cooperation between research and industry," says PoLight's managing director Jon Ulvensøen.

While PoLight is negotiating with major industrial companies, Dag Wang and his colleagues in SINTEF just keep on working, because they believe that their little lens will find applications far beyond making high-quality MMS's for mobile phone users. The most interesting applications in the future will be machine vision in bottle-return systems and similar installations, and in tiny cameras that can be used inside our bodies.



Photo: Geli Magen

MARINTEK



Photo: Thor Nielsen

Thoralf Hamstad, M.Sc., carrying out trials in the Ship Model Tank.

MARINTEK performs research and development for industry and the public sector. We create new technologies in the fields of floating petroleum production, subsea pipelines for oil and gas transportation, renewable energy from the oceans, vessel development, the shipbuilding and maritime equipment industries, shipping and logistics.

Important products and events:

The EU Flagship project: The EU-supported Flagship project aims to improve the safety, environmental profile and competitiveness of European shipping. We have been responsible for the technical coordination of the project, and have evaluated new business models, energy efficiency, responding to on-board alarms and dealing with accidents at sea and ashore. The results are of great importance for European

maritime research policy and product development.

Specialised well-maintenance vessel: We have carried out a series of studies aimed at developing a specialised well-maintenance vessel. The objective has been to combine the motion characteristics of rigs in extreme sea-states with the mobility of normal vessels. Our results combine numerical analyses with a wide range of model trials in our Ocean Basin.

Tidal turbine: Tidal turbines operate in demanding environments, with large variations in the speed and direction of ocean currents. Statkraft has developed a new tidal turbine in close collaboration with researchers in Trondheim, in which we have been responsible for special instrumentation and a rig for testing tidal turbines in waves. Our research has produced results that have improved our understanding of the technology involved, as well as a more robust and stable design.



Photo: Eng, Kvern, Skimo

President Oddvar Inge Eide

wants to encourage more environmentally friendly shipping.

What is the most important societal challenge facing MARINTEK?

In our view, the major challenge facing society today is the scarcity of energy and food, in addition to climate change.

Oil and gas will be important components of our energy supply for many years to come, as resources are recovered from ever deeper waters and in the Arctic. This situation demands new solutions. We also need to learn to exploit the renewable energy that is available at sea – via offshore wind turbines, wave-power systems and tidal power schemes.

Climate and environmental challenges also make demands of a more environmentally friendly shipping industry. We need to develop more energy-efficient hulls, and propeller systems will also have to undergo further development. We will also have to reduce emissions of NO_x and CO₂.

What are you doing to meet this challenge?

We have been working for a long time on solutions to encourage more environmentally friendly shipping. One example of this is technology that enables us to use LNG instead of bunkers oil or diesel fuel in main propulsion machinery. This technology is already in operation, in ferries that are operating in waters around Trondheim and Western Norway, for example. In 2010, we also performed a number of tests in the Ship Model Tank aimed at verifying energy-saving hull designs and propeller systems.

We have also been working for many years on exploiting renewable energy from the sea, and we participate in one of the Research Council of Norway's research centres for environmentally friendly energy (FMIs); Novitech, which concentrates on offshore wind turbines. In this project, we have just developed an analytical software package for optimising offshore wind turbine design and mooring systems. In 2010, we also tested a tidal turbine that is capable of operating in heavy waves.

Operations at great depths and in the Arctic make new demands, which we are trying to satisfy by generating new knowledge and ensuring that technological solutions are safe and cost-effective.

Deep-water operations demand to an ever greater extent that we combine testing and simulations in order to be able to develop and verify good development solutions. For this reason, an important core area of MARINTEK's efforts in 2010 has been continued development of numerical methods for estimating hydrodynamic loads.

The Arctic also place particularly high demands on vessel design, operations and personnel.

How can good ship design improve working conditions and benefit the environment?

Working conditions in the Barents Sea can be extreme, and the motions of vessels and platforms so great that ongoing operations have to be broken off. Much of our research is therefore aimed at adapting vessel size to the wave regime at a given location of operations. However, the operational envelope is also being expanded with the result that operators can avoid expensive periods of downtime.

Since subsea installation sites may lie far from their onshore base, vessel design is also important for fuel consumption and the amounts of greenhouse gases and particles emitted during operations.

Number of employees: 200

Proportion of academic

staff with doctorates: 36%

Total number of publications: 297

Gross turnover: MNOK 297

www.sintef.com/marintek

The ice-breaker

The temperature is minus 20°C. The wind is gusting at storm strength and the vessel is icing up. But on deck, the crew carry on working; the harsh conditions don't stop them.

Text: Åse Dragland

"We have tested the new vessel with such a scenario in mind," claims **Tor Einar Berg** (pictured), "and we believe that its main dimensions can be adapted to both the wave regime and the climate so that its operational limits can be stretched."

Berg is talking about the new vessel that is being specially designed to operate in fields east of Svalbard, where oil companies wish to inspect and carry out repairs on future subsea installations. The vessel will therefore be equipped with a 7.7 x 7.7 m moonpool through which installation modules can be deployed and hauled up again. There will also be more such moonpools further forward for operating remotely operated vehicles (ROVs).

For weeks now, the scientists have been testing propulsion, resistance and the sea-keeping abilities of the vessel in MARINTEK's towing tank and ocean basin, and they have evaluated a number of criteria and limiting values on the basis of the tasks that the vessel is being designed to perform.

Weather and sea-states in the Barents Sea are different from those in other parts of the sea around Norway. The waves are both lower and shorter, and the weather changes more rapidly – particularly in connection with polar lows.

"If the motions of the vessel are too severe, equipment cannot be set out, and operations have to be broken off. This means that we need to adapt the dimension of the vessel to the wave conditions where it will be operating, which will enable us to extend the operational envelope," says Berg.

Propeller knives • The most north-easterly part of the Barents Sea has seasonal ice cover. The current maintenance philosophy is that all equipment maintenance offshore should be carried out in the summer season, when the sea is ice-free. However, unexpected faults can occur at any time, so companies must also be able to work during the months

that the sea is covered by ice. Having to shut down a production system because of broken equipment and then wait several months for access to it is extremely expensive.

For this reason, the new vessel must be capable of operating in first-year ice. It is being designed to be able to turn round and force its way stern-first through the ice. Its propellers are then reversed, so that the heavy "head-box" fittings in which they are mounted act as ice-knives. The head-box units are designed to withstand ice and ice-loads, but they must not become so bulbous that they slow down the vessel.

Yellow hull in the Ocean Basin • Berg glances down on the yellow scale model bobbing in MARINTEK's huge Ocean Basin.

"This is the fellow that helped us to optimise the design."

Since there may be a long distance between the onshore base and the subsea installation site, vessel design is also important for fuel consumption and the amounts of greenhouse gases and particles emitted. Heavy fuel oil will be banned from the Arctic, and marine diesel fuel emits particles that settle on the ice, where they absorb more solar radiation and make the ice melt more rapidly. This is something that we do not want to happen in the Arctic, so liquid natural gas (LNG) is a potential alternative fuel.

"The vessel is being designed to produce as few emissions as possible," says Berg.

Now the model and its test result are being packed up to be sent to Aker Arctic Technology in Helsinki for ice tests that may reveal a need for changes in the hull form. More work is also due to be done on the superstructure and the location of the helideck.

Behind the three-year project, besides SINTEF, are Statoil, NTNU, Aker Arctic Technology and VTT (these last two from Finland), and the ship design company STX OSV. The project is partly financed by the Research Council of Norway.



SINTEF Materials and Chemistry



Photo: Thor Nilsen

Engineer Kai Vernstad analyses the amine content of chemicals used in CO₂ capture.

SINTEF Materials and Chemistry is a contract research institute that offers a high level of expert knowledge in materials technology, applied chemistry and applied biology. Our main areas of research are Materials and energy, Oil and gas, Biotechnology, and Bioscience.

Important projects and events:

LEDA multiphase transport: In 2010, the LEDA Flow Multiphase simulator was declared to be at commercial level by our external partners. LEDA is developing a next-generation simulator to calculate and visualise multiphase transport of oil, gas and water. Among other things, LEDA will be able to identify the problems that might arise when pipelines are laid out at great depths, over long distances and in rugged terrain.

Carbon capture and storage (CCS): This is a major area of effort for us, and together with NTNU, SINTEF is the largest participant in the European Union in this field. In 2010, we opened the CO₂ laboratory at Tiller near Trondheim, where we have gathered much of our CCS research under one roof. The laboratory provides a link between small- and large-scale test facilities. Our SOLVit project is developing next-generation amine-based chemicals for scrubbing CO₂ from flue-gases, in collaboration with Aker Clean Carbon.

Oil-spill protection technology: We have built up significant expertise in the field of marine environmental technology since the Bravo disaster in 1977. In 2010, we helped BP in the Gulf of Mexico in a number of areas ranging from modelling oil dispersal, through the use of dispersants, to the behaviour and breakdown of oil in water. This work is continuing in 2011.



Executive Vice President Torstein Haarberg wants to create robust, sustainable energy systems for the future.

What is the most important societal challenge facing SINTEF Materials and Chemistry?

Creating robust, sustainable energy systems for the future through renewable sources such as solar energy, offshore wind and geothermal heat. We must also do all we can to capture and store the greenhouse gas CO₂ that is produced by electricity generation and other industries.

How are you dealing with this challenge?

In the field of solar energy and solar cell technology, we are positioning and equipping ourselves at the part of the value chain that brings us from the raw material to complete silicon wafers. In Norway, we have had a silicon industry for a long time, and many years of research have given us broadly-based expertise in producing metallic silicon.

We are carrying out laboratory trials to identify other methods of producing cheap, sufficiently pure silicon to use in solar cells. Last year, SINTEF Materials and Chemistry focused on setting up a new solar laboratory that includes kilns for baking various types of silicon cast, which are then cut up into thin wafers. The casting method itself can become a refining process, in which we remove contaminants during casting itself. This also helps to reduce the price.

In the area of offshore wind-power generation, we also need to reduce costs in order to become competitive, and here we are working on the materials side of things. A floating deep-water wind turbine requires quite a different design from that of a land-based unit. The design of rotor blades and control systems presents a number of challenges. Reducing the weight of the rotor, gearbox and generator is a vital part of keeping costs down. These turbines need to be light, while the materials of the rotor blades must be so strong that they can tolerate wind forces with a mass of up to one hundred tonnes. Since access to these turbines for repairs and maintenance will be difficult, they will have to operate as indepen-

dently as possible, which means that the materials need to be virtually maintenance-free.

In CCS, there is a need to reduce the energy costs of the capture process. In our CO₂ laboratory at Tiller, we are trying to identify non-hazardous chemicals (amines) for use in the scrubbing process. We are also developing membranes for CO₂ separation, and we have already identified efficient membranes that we will scale up for use in full-scale systems.

SINTEF and NTNU are involved in 14 European Union CCS projects worth a total of more than €400 million.

How did you succeed in positioning yourselves so well?

Our good position is due to the fact that we have continuously developed our competence in this field. In 2008, a Norwegian R & D programme worth NOK 300 million was launched, and this is due to continue until 2016. SINTEF Materials and Chemistry plays a major role in this programme. Now that we have built a NOK 42 million laboratory that offers unique pilot-scale test facilities, we are in a strong position in the European context.

Number of employees: 393

Proportion of academic

staff with doctorates: 67%

Total number of publications: 718

Gross turnover: MNOK 600

www.sintef.com/mc

Ready to slaughter bacteria

Robots and screening technology will fix malicious bacteria that entrench themselves in our bodies.

Text: Åse Dragland

This is the challenge: **Håvard Sletta** (photo) holds up an illustration taken from the New York Times that shows two contrasting curves in black and white. The falling curve shows the number of new antibiotics that have been approved for sale in the USA in the past 30 years, while the steep curve opposite illustrates the explosive growth in resistant bacteria found in American hospitals between 1999 and 2006.

Sletta runs his finger through his hair: "This is hard reality. Infections caused by antibiotic-resistant bacteria are a growing problem all over the world. Every year, two million Americans get bacterial infections while they are in hospital. These infections are becoming more and more difficult to treat because bacteria are becoming increasingly resistant. Norwegian figures from 2008 show that 5.8 percent of Norwegians who had surgery that year, were infected as a result of the procedure. This is a figure that surgeon **Camilla Muller** (photo) at St. Olav's Hospital in Trondheim wants to reduce. Unfortunately, "last-ditch antibiotics" are now being used more and more as a matter of routine, and the major pharmaceutical companies are not particularly willing to invest in the development of new antibiotics.

The micro enemy • This is why the Sandvika company AlgiPharma is turning on the ultimate enemy: pathological resistant bacteria that pack themselves within protective layers called biofilms. When bacteria entrench themselves in such micro-communities, they can protect themselves against external threats such as antibiotics. Like tiny isolated flat-dwellers, they sit inside secure walls and have even fixed up a network of channels that supply them with nutrients.

With the aid of scientists in Cardiff, SINTEF and NTNU, AlgiPharma AS wants to find out if there is any benefit to be gained from using an alginate polysaccharide (OligoG): can this manage to dissolve biofilms and potentiate antibiotic activity?

SINTEF has been brought into the project to find out what OligoG acts on, and to help the company to understand how it works. With the aid of

laboratory robots and screening technology, the SINTEF scientists are in the midst of large-scale mapping of the algal derivative.

"Bacteria like to attach themselves to surfaces, and biofilms are a common form of growth. There are many types of biofilm, such as the coating that we brush off our teeth every day, not to mention the beneficial biofilms that are used in water purification systems," says Sletta.

"It is easy to do away with bacteria that float freely in liquid media, but those that grow close together and form colonies are more difficult to get rid of. Chronic biofilms establish themselves in wounds, lungs (for example in cystic fibrosis patients), in the urinary tract and on prostheses installed within the body.

Attempted murder in the laboratory • In order to perform the mapping, the Trondheim scientists receive packages of obstinate bacteria from Cardiff.

"These are bacteria that are difficult to kill with normal types of antibiotic," comments Sletta. The bacteria are placed on A5-sized, 384-well trays, to which the alginate extract and antibiotics are added in carefully calculated doses of different strengths in each well.

The pipetting robots are used to set up the experiments, and the robot arm with its little pipettes rapidly places the doses in the correct order and in rising concentrations along the rows of wells. The scientists recently performed 80,000 tests of this sort in the course of a week.

Håvard Sletta shows us a picture of a finished well-tray, in which a violent green on the left of the upper row shades into a lighter colour on the right, showing how the additives have done their work.

AlgiPharma has already tested its product on human beings, and in due course the company will start trialling it on cystic fibrosis patients. "At the moment, we are working on applications to the Research Council of Norway and the European Union for funds to take this to the next stage," says Sletta. "We simply have to win this fight!"



SINTEF Petroleum Research



Photo: Thor Nelsen

Research scientist Marita Wolden in the multiphase laboratory at Tiller.

SINTEF Petroleum Research concentrates on improving the profitable, environmentally friendly and safe mapping and recovery of national and international petroleum resources.

Important projects and events:

The LEDA simulation software was commercialised: LEDA is a new-generation tool that simulates the transport of oil, gas, water, chemical additives and possibly sand from oil wells – in a single pipeline; multiphase flow, as it is known. Among its other advantages, LEDA can simulate potential flow problems when the product stream is carried at great depths, over long distances and in rugged terrain.

CO₂ Field Lab: This project aims to improve our understanding, and thus the safety, of CO₂ storage by generating better knowledge of how CO₂ migration in geological formations can be monitored. Last year, we carried out a large-scale mapping exercise of our field laboratory at Svelvik.

Better modelling of hydrocarbon leaks from reservoirs: The project entitled "Top seal integrity and leakage, with relevance for explosion risk in the Barents Sea", was launched with financial support from the Research Council of Norway. This is a strategic institute programme that aims to improve safety in the petroleum industry through a better understanding of the properties of reservoir ceiling rock formations.



Photo: Geir Mogen

President May Britt Myhr believes that research on petroleum and renewable energy should go hand in hand.

What is the most important societal challenge facing your discipline today?

To obtain sufficient energy for the world, safely and with as little impact on the environment as possible. Unfortunately, all efficient forms of energy involve risk. We have recently been forcibly reminded of this, first with the Macondo disaster in the Gulf of Mexico and then the meltdown at the Fukushima nuclear power plant in Japan. It will be an enormous global challenge to produce enough energy for the world while reducing the risk of accidents.

What is SINTEF doing in this respect?

We are contributing vital research on both renewable energy sources and the petroleum sector. Both areas are of great importance, and we should not forget that both oil and gas will be among the most important sources of energy for decades to come. Norway is the third biggest exporter of gas in the world, and the fifth biggest exporter of oil; we are also an important exporter of technology and knowledge. This is because our responsible way of producing oil on the Norwegian continental shelf is something that others wish to learn from. Since the disaster in the Gulf of Mexico there has been a great deal of demand for Norwegian expertise, as we have realised very clearly here in SINTEF. Even so, there are several areas where there is still plenty of room for improvement.

Norway is also a world leader where recovery rates from reservoirs are concerned – although about 50 percent is still left behind when wells are abandoned – even on the Norwegian shelf. Generating knowledge and technology that will raise recovery rates is therefore a high priority.

This effort has been concretised by the establishment of a new centre that is doing research on enhanced recovery and improved safety during

drilling and well-treatment operations. The centre opened last August, and it is operated by IRIS, SINTEF, NTNU and the University of Stavanger. The Research Council of Norway and a number of oil companies support the centre financially.

Why do we need to recover oil now, rather than leave it there for future generations?

When an oil-field is abandoned and its infrastructure is removed, it is difficult and expensive to return to it later to recover the rest of the oil that we know is lying in its depths, which is why we need to make recovery rates as high as possible. This is economically profitable, environmentally sound and politically uncontroversial. Many parts of the Norwegian shelf are now regarded as mature, and in only a few years their installations will start to be dismantled, so it is time to get technological developments moving, so that we can take as much oil as possible out of the reservoirs before they are abandoned.

Number of employees: 119

Proportion of academic

staff with doctorates: 64%

Total number of publications: 151

Gross turnover: MNOK 207

www.sintef.com/petroleum

The last oil

*Some people learn from other people's mistakes:
Inge Carlsen is one of them.*

Text: Christina Benjaminsen

At 05.45 a.m. on Thursday April 20, 2010, the following email was sent from the Deepwater Horizon drilling rig to BP's office in Houston: "We have completed the job and it went well."

Just a few hours later, the situation was turned on its head. An explosion on the 33,000 tonne rig on the Macondo field in the Gulf of Mexico had cost 11 human lives. All the safety barriers in the exploration well 1500 metres below the surface and a further 4500 below the seabed had failed. During the next 89 days some five million barrels of reddish-brown oil flowed up from the depths. A disbelieving world watched the worst oil-spill in the history of the USA on its TV screens.

Nine months after the disaster, special consultant **Inge Manfred Carlsen** (pictured) from SINTEF Petroleum Research sits bent over a huge pile of papers. Among them is the Obama Report, written by the commission that has examined the disaster down to the last detail at the request of the President.

The experts' expert • Carlsen is an expert on well integrity and drilling safety: in other words, on just about everything that can go wrong with an oil-well. As a member of a broadly-based team of scientists from several SINTEF departments, he is currently analysing what happened on the Deepwater Horizon platform.

"Our job is to learn from the Macondo disaster on behalf of the Norwegian Petroleum Safety Authority, and the goal is to be able to deal with risk on board Norwegian petroleum installations. The most important questions are: How could this possibly happen? Could it happen again? How can we reduce the likelihood of such a disaster taking place on the Norwegian shelf?"

But then, Carlsen and his colleagues can all point to long experience in dealing with technological challenges in the offshore industry. They have supplied new solutions for safer, cleaner and more efficient hydrocarbon production; some of these have led to spin-offs in petroleum technology, safety and environmental technology.

Deeper and more difficult • Just now, risk assessment and well

safety projects are in greatest demand as far as these scientists are concerned. All over the world, the most easily accessible oil-fields are nearing full depletion, and more and more offshore activity is taking place far out to sea and in very deep waters. Industry is exploring deeper, more complex geological formations, where temperatures and pressures are higher. This is more demanding, and can also be more hazardous.

"Efficiency requirements are rising, and the limits of what is technologically possible are being stretched. At the same time, this needs to be balanced against stricter environmental requirements. We have specialised in helping our clients to predict what could happen during such specialised and highly demanding well operations," says Carlsen.

Recreating reality • Among the tools currently under development for Statoil is a training simulator for well drilling. The simulator consists of a number of computer models that can analyse everything from pressure conditions and rock mechanics effects to how the drill string is behaving. It will enable various drilling scenarios to be recreated down to the smallest detail.

The simulator will be very useful: drilling an exploratory well can cost as much as NOK 1.5 billion. The daily rate for hire of an advanced offshore platform can be \$500,000 or more, equivalent to NOK 3 – 4 million. When we count in other essential services, the price can easily double. In other words, in this sector, exploring and failing is expensive.

SINTEF Petroleum Research's client list includes oil companies from all over the world, not least because this sector has turned its attention to the resources that lie in the sensitive arctic region. This will involve dealing with extreme climatic challenges on top of a number of other complicating factors such as darkness and long distances from land.

"There is no doubt that we live in a society whose most important source of energy is fossil fuel, as it will be for several years to come. Our job is to provide the knowhow that can optimise drilling and production. The Deepwater Horizon disaster has been an important lesson for the offshore sector, and it will change many of our assumptions, not to mention how we work in the future," says Carlsen.



SINTEF Technology and Society



Photo: Thor Nielsen

Image-guided surgery: SINTEF scientists have helped to develop the technology involved.

SINTEF Technology and Society is a multidisciplinary research institute that operates in the fields of industrial technology and the social sciences. We offer solutions to problems of health, care services and welfare, dignified working conditions, a sustainable working life, and climate and the environment.

Important projects and events:

The European Union's Mediate project: has raised awareness throughout Europe about the need for accessible transport systems for handicapped persons.

SINTEF's prize for excellence in research: The Prize was awarded to Terje Andreas Eikemo for his studies of social health inequalities in Europe.

This research provided new insight into how health is influenced by educational level, occupation and income. Eikemo studied in particular the "Scandinavian model", which offers everyone identical health services, and its effects on our perception of our own health.

We have established nanomedicine as a strategic effort for the SINTEF Group: The aim of the four-year special effort is to further develop interdisciplinary research in medical technology in Trondheim, and create an international leading-edge research group in this area.

Study of living conditions: We have carried out a national survey of the living conditions of handicapped persons in Lesotho in Southern Africa. This is the seventh country in the region in which we have performed such studies in cooperation with local user organisations.



Photo: Mikkel Ehem Maxness

*Executive Vice President Tonje Hamar
wants to give social research a more prominent
place in technology projects.*

What is the most important societal challenge facing your discipline today?

The whole of our division deals with important social challenges, so there is no lack of major tasks that need to be taken up. One challenge that affects all of us is to ensure that the range of health and welfare services for everyone is not compromised in the future. This is particularly relevant just now because of the large rise in the number of elderly people that we know will be with us in just a few years. This will mean that more people will be needing care, while there will be fewer of us capable of providing it. Health and welfare are also linked to our overall life situation, not least to how we perceive our working life, which many people believe is becoming harder. Creating the right conditions for helping employees and looking out for the rights, obligations and dignity at work of the individual are obvious challenges. Nor can we avoid the social challenges that climate change is facing us with. Its consequences are affecting individuals, organisations and society, and all these aspects need to be seen as a whole.

What is SINTEF doing to deal with these challenges?

First and foremost, we are making serious efforts to be even more professionally competent. Our ambition is to be among the best at international level. We are also actively working towards integrating social science into the national technology projects that are dealing with these problems.

I would also like to mention the excellent, relevant European Union projects that we have launched in the fields of ultrasonics and image-guided treatments. These have contributed to the SINTEF Group's efforts in nanomedicine and micro- and nanotechnology for medical applications. If we succeed in these fields, we will make important contributions to the diagnosis and treatment of serious illnesses.

We have also carried out large-scale studies of the relationship between health and unemployment and between health and social and political transformations in Europe, and we are an active contributor to research on poverty and health in low-income countries. This has given us important knowledge about how health inequality can be reduced.

We have also participated in studies of various models of health services financing in Scandinavia. This has made valuable contributions to the debate about costs and efficiency in the availability of health services. Another area of effort that is also linked with quality of life is our work on road safety and elderly drivers. Technology that will help them to keep their driving licences for as long as possible is an important part of our research.

Our multidisciplinary approach helps us to create wealth and encourage learning across boundaries.

How many of these projects are financed by your own funds?

Every project is unique, and we therefore invest in them all. Our most important resources are our colleagues and the knowledge that they put into our projects. If we are talking about our own financial resources, we use our basic grants to build up long-term competence. This is in areas in which there is a need for new knowledge but where the market is not yet mature, such as our work in the field of advanced clothing for extreme conditions and image-guided surgery.

Our basic grant comes to around ten percent of our total turnover, so most of our projects are financed by external sources in the public and private sectors, the Research Council of Norway and the European Union.

*Number of employees: 270
Proportion of academic
staff with doctorates: 35%
Total number of publications: 492
Gross turnover: MNOK 332
www.sintef.com/tse*

The hunt for the X-factor

Gudrun Rudningen is trying to capture the volatile concept of creativity.

Text: Christina Benjaminsen

They sit in the big hall in rows, like an orchestra. The level of sound is surprisingly low, and only the selective use of colour in the interior contrasts with the polished grey concrete floor. The work zone of Snøhetta's 80 architects is divided by low shelves that house work-lamps and small white sculptures. Three-dimensional models of ideas and buildings made of plaster, cardboard and metal. The range of these small figures is evidence of what the company is best known for; creative problem-solving.

It is precisely the constant demand that each and every task should be solved in a completely new way that has brought Snøhetta into the Idea Work project – together with SINTEF and a handful of other companies.

"The aim of the project is to identify the aspects that come to the fore when creativity is at its best, so that we can push the factors that drive our ability to think afresh and develop ideas," says researcher **Gudrun Rudningen** (photo).

Rudningen is a visual anthropologist, and is on a hunt for what are called drivers of creativity; factors that are in operation when idea development produces particularly good results. This has given Snøhetta and four other Norwegian companies an innovative "pull".

Architects and objects of research • Creativity is a success factor, but it is a concept that can be difficult to capture and define. This is why the anthropologist is trying to develop a language and encourage a consciousness of what motivates idea generation. Idea Work deals with understanding and professionalising creative problem-solving, both at the stage of concept development and later, when ideas are brought into use.

"When we heard about the project, we had already put together a working group that was going to develop our own creativity," says architect Frank Dennis Kristiansen. Idea Work turned out to suit Snøhetta perfectly; we very often compete for contracts, and time is always short in the concept development phase."

The result was that the architects in Shed no. 39 on Vippetangen Pier in Oslo became guinea-pigs for every minute of their working days for four months. Hours of video recordings and interviews have since been

studied, analysed and structured by the SINTEF scientists, who finally concretised their results in a set of 13 defined creativity drivers, which were formulated as a little pack of cards decorated with attractive images and clear descriptions of the drivers. If all goes according to plan, the cards will be turned into a little book.

"These cards are a specific tool that we can use when we get stuck. For example, they can help us to assemble an even better team. The drivers have made us more conscious during the ideas phase – we now know better what works and what doesn't," says Kristiansen.

Hard work • Not all of the companies that are participating in the project are working on topics that are related to the classical perception of creativity. A law firm, a bank, an oil exploration group and a company that trades in CO₂ quotas are also participants. For the Idea Work researchers are challenging the myths that claim that creativity is a matter of guided processes and that professional creativity is possessed exclusively by certain professions and domains of thought.

But does a formula for what triggers concept development actually exist? No, says the researcher; there is no single type of practice that functions at all times and in all settings. What drives creativity in one place may not function somewhere else. Good ideas are based on solid professional expertise and hard work.

All the same, some common factors do exist among successful groups that are innovative and create value. No fewer than 12 of the 13 drivers that the project identified at Snøhetta are also in operation in all the other companies. These include the ability to perceive the major lines of a problem, to be able to produce a prototype of the idea at an early stage, to have a source of opposition to the idea, to be working in an informal atmosphere that has space for laughter and playfulness, and to be able to swim against the current.

Idea Work is led by SINTEF, but it is a collaborative project that involves researchers from the USA, the UK and Australia. The project has been running for three and a half years and is financially supported by the Research Council of Norway.



The lady's not for turning

On her bookshelf stands an angel wearing a princess's crown, a hint that HSE director Bente Wiggen has few problems about setting high goals – at several levels.

Text: Christina Benjaminsen

"Just a few years ago, Health, Safety and the Environment was mostly a matter of keeping something big and heavy from landing on your head or your toes – basically, the physical environment. Nowadays, HSE is quite a different matter; it is a major discipline that ranges from dealing with psychosocial conditions to handling chemicals." So says HSE director **Bente Wiggen** (pictured) of the SINTEF Group's Division of Information and Communications Technology: SINTEF ICT.

The walls of her office boast a fine display of framed certificates as witness that both safety and quality are taken seriously here. The enthusiastic lady originally trained as a chemical process engineer, but as early as 1987 she was made work safety representative with her then employer, AS Rockwool, and acquired a taste for HSE as a profession.

Now, yet another certificate is due to be hung on the wall. SINTEF ICT's Department of Microsystems and Nanotechnology has just been certified according to the environmental control standard ISO-14001. The vibration-free laboratory is a world leader in the development and small-scale production of advanced sensors. In this clean-room laboratory, even a speck of dust is regarded as something huge.

But what on earth is ISO-14001?

"Briefly, it is a certificate that gives us good help in systematising our efforts regarding environmental challenges and setting goals for improvement for ourselves. It is a standard of requirements, but at the same time it is a useful tool that helps us to keep our own house in order. One of its elements involves mapping all the environmental aspects of our organisation."

All? Really?

"Yes, all of them," smiles Bente Wiggen. But of course we select the most important when we are dealing with the results of the survey.

With its 284 employees and sharing quarters with several departments of NTNU and the University of Oslo, communication and collaboration are important keywords for SINTEF's HSE efforts.

"To have clear agreements regarding responsibility and a good dialogue with our partners is therefore just as important as dealing with chemicals and equipment that need special treatment," believes Wiggen. "In the laboratories for which we have main responsibility, we need to set HSE standards, even where NTNU staff or students use the facilities," she says as she accompanies us into ICT's robot laboratory at Gløshaugen in Trondheim, where trials of a remote control system for an offshore platform are in full swing. The enormous robot is powered by several electric motors, and it can perform complex operations with a number of tools. It is also equipped with a crane that lifts heavy loads as if they were milk cartons. Taking up an area of six by eight metres, the robot is made as secure as a caged lion, because if something were to go wrong, it could crush just about anything that got in its way. This is why it is guarded by access control measures and a twelve-point set of safety instructions. Moreover, no-one can touch its controls without the appropriate training.

"It is obvious that there is a danger of being crushed by such a colossus, which is why we are extremely strict about routines. The robot is equipped with dead-man's controls and safety routines that make it impossible to use it when there are people within the limits of its movement envelope," explains Wiggen.

HSE is largely a matter of creating the right attitudes, so she is pleased that the subject is an item on the agenda of every single meeting at SINTEF. This makes for a good arena for discussions and exchanges of experience related to HSE challenges.

So she doesn't feel that she is alone in tackling this important job:

"In SINTEF, HSE is a responsibility of line management. Besides, it is always permitted to think for oneself. If you are out doing fieldwork or working somewhere other than where you are used to being, only you yourself can take the right decisions," says SINTEF's head of HSE.

"But of course, this means that good attitudes have to be an integral part of your thinking."



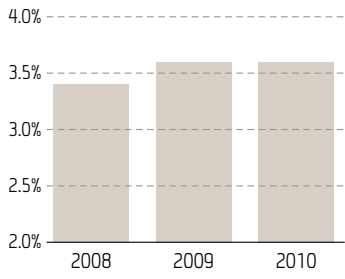
Photo: Geir Mogen

Sick-leave

SINTEF is making systematic efforts to reduce sick-leave and exclusion via health-improvement and preventive measures. In 2010, sick-leave added up to 3.6% of net working hours.

Sick-leave

(Percentage of total working hours, excluding vacations and overtime)

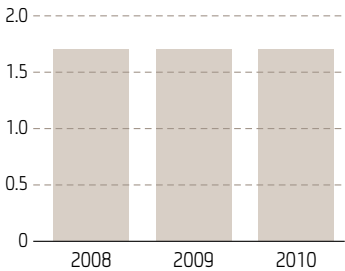


Personnel injuries

SINTEF's aim is that its activities will not produce any injuries

Frequency of injuries leading to sick-leave

(H1-value. Number of injuries leading to sick-leave, per million hours worked)



Our complete HSE accounts can be found at www.sintef.com/hse2010

SINTEF in Society

*SINTEF intends to realise its vision of “Technology for a better society”.
Every day, we attempt to solve some of the biggest challenges facing society.*

SINTEF is a private, independent, non-commercial research organisation constituted in the form of a socially beneficial research foundation with subsidiary companies. The statutes of both the Foundation and its subsidiaries state that the aim of SINTEF is to contribute to the development of society via research, and that financial gain is not an objective.

Our core activity is contract research for clients in industry and the public sector. No-one may take out dividends or in any other way benefit from profits made by SINTEF. Any financial profit from our activities is invested in laboratories, scientific equipment, competence development and self-financed research.

SINTEF's activities benefit society in the form of new knowledge and concrete solutions. Our aim is to develop solutions to major social tasks in the fields of climate, energy, clean water, food and efficient organisation of the public sector, but we also provide concrete improvements for industry, which contribute to greater value adding and more efficient and environmentally friendly production.

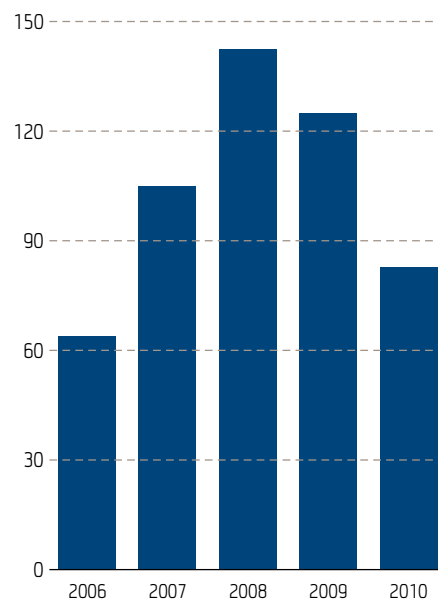
Investments in scientific equipment

Our ability to invest in new knowledge and improved laboratory facilities is an important part of our duty to society. For this reason, it is important that we make a financial profit that can be invested in new research. This provides value to society as a whole, because SINTEF's laboratories and research are a core part of the Norwegian research system.

In the course of the past five years, SINTEF has invested MNOK 519 in laboratories, buildings and scientific equipment. Our largest recent investments have been at Tiller in Trondheim,

in the upgrading of the Multiphase Laboratory and the construction of a new laboratory for CO₂ capture and storage, which was opened by HRH Crown Prince Haakon in April 2010.

Investments (mnok)



In 2010, SINTEF invested MNOK 83 in scientific equipment, buildings and other equipment.

Self-financed research

SINTEF finances its own efforts in certain areas of research. Prioritised multidisciplinary efforts financed by the Group are called Group Efforts.

These efforts emerge from high-quality scientific groups and their aim is the creation of value and commercial yield. Group Efforts are required to be carried out in cross-disciplinary cooperation among several divisions of the Group.

Financing is on a shared basis, with SINTEF itself paying 50 percent, the institutes involved 25 percent, and the individual group the final 25 percent.

In 2010, SINTEF invested MNOK 14.5 in Group Efforts. It also carried out self-financed research at divisional level. In 2010, research projects were carried out in bioscience, software, hydrodynamics, medical technology, x-ray technology and ocean monitoring.

Scientific publishing

It is important that most of our results should be published. Publishing tests the quality of our research, and it is through publication that our research can be of the most importance for societal development.

Much of SINTEF's contract research is confidential in the sense that its results belong to the client. We often agree with the client that some or all of the results can be published. Where publicly-financed research is concerned, there are regulations and expectations that research results will as far as possible be made generally available.

The results of our research find their way to society via a number of different channels, such as academic journals, databases and more popular media.

We stress that our published results should be easily accessible. Open results are collected in a database of publications, which is accessible via the Internet and in national research databases.

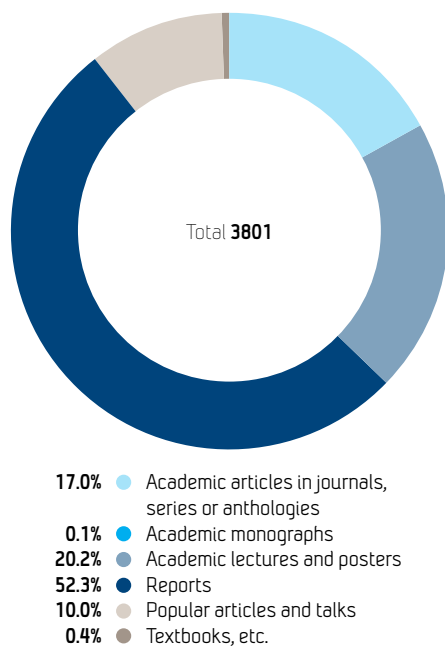
Popular science publishing

Besides its publications in academic journals, SINTEF believes that one of its duties is to convey information at a popular level to industry,

the media, the general public and the authorities. SINTEF scientists are often consulted by the media as experts and as sources of knowledge and research results. In 2010, SINTEF's research and its academic staff were cited in about 8900 articles in Norwegian media and some 700 articles published in international media.

Publications

(including popular dissemination)



In 2010, SINTEF produced 3801 publications, of which 651 were in recognised peer-reviewed academic journals. This is equivalent to 0.53 academic publications per researcher year. This figure has risen in recent years.

We publish the popular science magazine Gemini in collaboration with NTNU. The Norwegian edition of Gemini has a circulation of 90,000, and the English edition, 10,000. In 2010, there were four issues of Gemini in Norwegian and two in English.

SINTEF Building and Infrastructure's knowledge system is very active in the information dissemination field, particularly vis-à-vis the construction industry. It operates its own publishing

company, Internet bookshop and certification activity, and publishes the "Byggforsk" series on the Internet.

Ethics in SINTEF

SINTEF maintains a high standard of ethics throughout its range of activities. Our efforts in this field are based on our vision of "Technology for a Better Society" and our core values of honesty, generosity, courage and solidarity.

Principles and regulations

We base our ethical standards on general moral concepts and four basic moral principles:

- Principle of human dignity
- Precautionary principle
- Principle of justice
- Principle of utility

Our attitude to ethics in SINTEF has three facets: research ethics, business ethics and interpersonal relations. SINTEF has adopted a basic set of values and a set of ethical rules that apply to all its employees.

Our research ethics are based on the regulations of the national ethics committee, principles promoted by the European Group on Ethics in Science and New Technologies (EGE) and international conventions such as the Vancouver Convention.

SINTEF is a member of Transparency International and has adopted the UN's Global Compact, which involves certain obligations and the submission of status reports regarding basic principles of human rights, standards of working life, the environment and anti-corruption measures. These principles provide guidelines for SINTEF's ethical measures in the fields of commercial operations and interpersonal relationships.

SINTEF employees are members of several national research ethics committees.

Organisation of ethical efforts

In SINTEF, ethics are a management responsibility that also involves all our employees, which

means that everyone has a personal responsibility to behave ethically and in line with existing regulations and guidelines. In order to support our efforts in this field, SINTEF has appointed an ethics council and an ethics representative.

The ethics council has been established by the Board of the the SINTEF Group, and provides advice to management and staff in questions of ethics. The council has six members and includes managers and staff representatives. In 2010, the council held three meetings.

The ethics representative supports our staff in ethical questions and functions as an adviser and discussion partner for the whole organisation. The ethics representative is under an obligation to respect the confidentiality of information received. The representative participates in a range of meetings at management level and divisional gatherings, as well as in several external arrangements. The ethics representative also acts as a channel for employees who wish to raise ethical problems or warn of conditions that might be in conflict with the law or ethical standards. This system means that SINTEF complies with the Work Environment Act's requirements regarding an internal notification channel.

Demands made of suppliers and clients

SINTEF evaluates all its suppliers, who are required to provide information regarding their policy and performance in HSE, ethics, the physical environment and quality. The evaluation is performed when new contracts are signed and contracts with current suppliers are revised.

Many of our clients maintain high standards in the fields of HSE, ethics, the environment and quality, and make specific demands of SINTEF. We lay great emphasis on being able to meet their requirements, and to document our own standards through good quality systems. Clients who do not make specific demands of us as suppliers are requested to sign up to SINTEF's business ethics standards. SINTEF has adopted a resolution regarding business ethics and social responsibility that applies to all contracts as they are signed.

UN Global Compact

SINTEF has signed up to the UN's Global Compact, which is the major world-wide initiative to promote social responsibility in industry.

This obliges us to operate in accordance with the following nine principles in the fields of human rights, standards of working life, the environment and anti-corruption measures:

- Support and respect the protection of internationally recognised human rights
- Ensure that we do not contribute to breaches of human rights
- Maintain the freedom to organise and ensure that the right to collective bargaining is respected in practice
- Ensure that all forms of forced labour are abolished
- Ensure that child labour is really abolished
- Ensure that discrimination in the workplace is abolished
- Support a precautionary approach to environmental challenges
- Encourage the development and spread of environmentally friendly technology
- Combat all forms of corruption, including blackmail and bribery.

Membership of the Global Compact means that we are required to make the above principles an integral part of our everyday operations, that we encourage social responsibility among our clients, suppliers and the general public, and that we submit an annual report regarding our status vis-à-vis the principles. In 2010, SINTEF submitted its first Communication on Progress.

Environmental policy

Our research is our most important response to environmental challenges. In many areas, our research groups are at the international leading edge, for example in the fields of renewable energy, carbon capture and storage, energy efficiency, materials science and oil-spill contingency planning.

As far as our own activities are concerned, SINTEF has adopted an environmental policy and an

action plan that apply to the whole organisation.

On the background of our vision of "Technology for a better society", SINTEF will take sustainable development into account in all aspects of its activities. The concept involves good corporate governance, social responsibility and respect for the environment.

SINTEF's environmental policy is intended to ensure that both our research and how we operate our own business reflect consideration for the physical environment. It will also ensure that our own environmental performance is continually being improved.

We make the following commitments:

- to satisfy legal environmental requirements.
- that we will strive to establish national and international R & D programmes that have the objective of developing environmentally friendly technology.
- that we will stress environmental problems in our investments in knowledge generation and laboratories.
- that we will reduce our emissions of greenhouse gases and consumption of energy, and as far as possible reduce hazardous emissions to the soil, the atmosphere and water in the course of our own activities.
- that we will disseminate our knowledge and provide premises for social debate and the design of national and international environmental policy.

Action Plan for 2008 – 2010:

We will implement environmental steering in accordance with the ISO 14001 environmental standard.

This means that we will:

- set environmental requirements of our suppliers.
- reduce energy consumption in our buildings.
- deal with our waste so as to reduce it in quantity, encourage sorting at source, and ensure that it is recycled and responsibly disposed of.
- critically examine our travel habits in order to make travel more environmentally friendly.

- invest in technology that enables us to travel less.
- profile the CO₂ cost of air travel and invest at least the same amount in the development of new environmental technology.

In 2010, we analysed all relevant environmental aspects of the Group's activities, prioritised the most important of these and established environmental plans. These cover such aspects as the use of chemicals, treatment of waste and process emissions, energy consumption and travel.

SINTEF had no accidents that led to damage to the physical environment in 2010.

Equal opportunity

SINTEF's ethical regulations state that everyone in SINTEF is equally valuable. No discrimination of any sort is tolerated, whether on the grounds of race, gender, religion, sexual orientation or age.

Gender balance

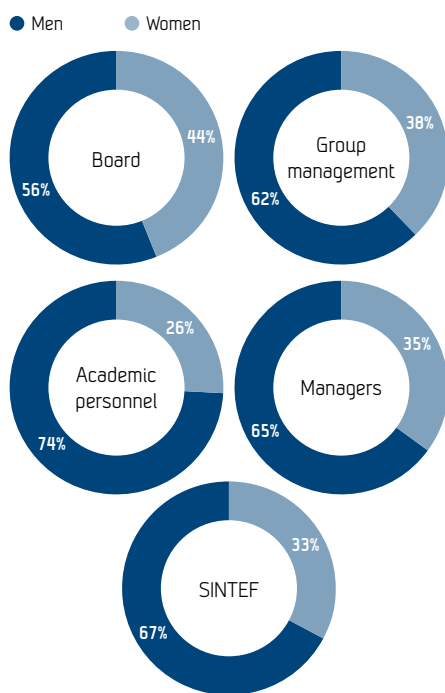
One of our aims is to increase the number of women in research and administrative positions. This means that SINTEF strives to recruit women and to develop female managers from our own ranks. Follow-up of equal opportunities is a responsibility of management, and is in the hands of each individual line manager.

Our personnel policy states that we wish to recruit more female researchers and managers in order to increase diversity of experience, approaches and perspectives. Since 1992, it has been an aim of SINTEF that the proportion of female research staff should correspond to the proportion of women in relevant academic institutions, and that the proportion of female managers should correspond to the proportion of women among researchers and engineers.

The proportion of women among our academic staff has risen from 15 percent in 1992 to 26 percent in 2010, while the proportion of female managers has risen from 3 percent to 35 percent.

As a point of departure, SINTEF does not appoint personnel to part-time positions, but we are open to the possibility of allocating such positions to employees who take the initiative to ask for them. Eighty percent of our employees are in full-time positions. Twenty-seven percent of our female employees, and 17 percent of male staff currently work part-time. One reason for part-time employment is that our staff are taking advantage of the opportunity to wind down their working week with the company negotiated pension agreement.

Equal opportunity in SINTEF



SINTEF makes little use of temporary appointments. At the turn of the year, we had 42 temporary employees (3 percent), of whom 15 were women and 27 men.

SINTEF's 2010 work environment survey revealed no significant differences in how women and men experience their work situation. We will continue to implement goal-oriented measures to ensure that SINTEF is an attractive work-place for women.

SINTEF's absentee statistics indicated that sick-

leave among women was 5.1 percent, and 2.6 among men. Female Engineers and Researchers in SINTEF (KIFS) was established in 1988 as a forum and project under Group management. In the course of the more than 20 years since then, KIFS has been an important co-player in efforts to attain the goals of our development plan to "recruit female colleagues to key positions i SINTEF." In the course of the years, KIFS has studied a number of relevant topics, including salary differentials and the use of leave of absence, and has organised study days and meetings.

KIFS will continue to work on relevant gender-related problems, and it hopes to continue its lively discussions that go beyond mere figures.

In 2008, KIFS initiated a study of the relationship between gender and salary in SINTEF. The study revealed a salary differential of four percent in favour of men, and that this varied between types of position and departments. Catching up on seniority following leaves of absence was a major causal factor in this connection.

On the background of the study, Group management decided that such inequalities would be eliminated in the forthcoming salary negotiations, that procedures would be established for modifying salaries following leaves of absence in order to ensure that seniority in salary levels would not be permanently lost, and that efforts to recruit more female managers would be intensified.

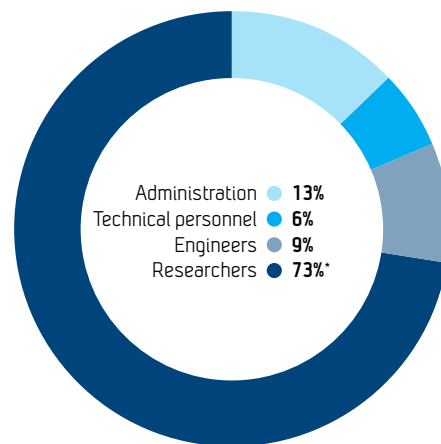
This has been followed up in subsequent salary negotiations, and since 2008, women have received higher increases in salary than men. SINTEF intends that this will continue to be followed up until the skew in salary levels has been eliminated.

Colleagues from other countries

SINTEF employs a large number of people who come from outside Norway. On December 31, 2010, we had 322 employees from a total of 67 different nations with non-Norwegian language and cultural backgrounds.

This means that we are an international insti-

Employees (not including SINTEF Holding)



*Of whom 46% hold doctorates

tute and an attractive work-place for high-quality research staff from all over the world. These colleagues bring with them valuable scientific and cultural competence that is of major, and positive, importance for our organisation.

In order to ensure that staff from other countries are well looked after, SINTEF has set up an integration programme for new appointees from other countries and their families. The programme offers ex-pat services, free Norwegian classes as well as English teaching in the SINTEF School. Diversity management is one of the topics of the SINTEF School's management development programme. The Work Environment Survey has documented that colleagues from other countries are very happy at SINTEF.

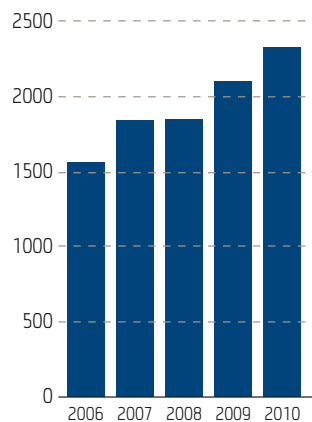
Staff with special needs

SINTEF makes serious efforts to meet the requirements of its employees who have special needs for work-place adaptations. The SINTEF Foundation is an Inclusive Working Life (IA) company. Via our IA objectives, we have committed ourselves to adapt work-places for such of our staff as already have or who develop disabilities. We cooperate with the Norwegian Labour and Welfare Administration in these efforts, and we utilise available public-sector support schemes. Another IA aim is that we should focus on competence when recruiting new colleagues, rather than on their limitations due to disabilities.

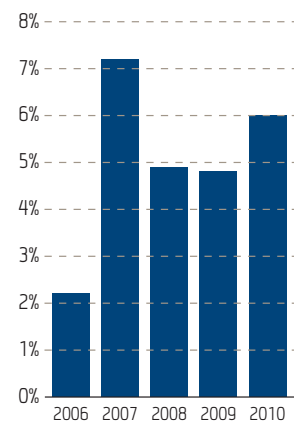
Key financial figures

MNOK	2006	2007	2008	2009	2010
Result					
Gross operating income	1 959	2 271	2 592	2 754	2 813
Net operating income	1 566	1 846	2 100	2 232	2 325
Operating result	35	133	103	107	139
Result before tax	88	223	145	139	170
Balance					
Fixed assets	510	654	719	788	1 134
Current assets	1 426	1 599	1 821	1 966	2 124
Sum assets	1 936	2 253	2 540	2 754	3 258
Equity capital	988	1 259	1 397	1 526	2 056
Liabilities	948	994	1 144	1 228	1 202
Sum equity and liabilities	1 936	2 253	2 540	2 754	3 258
Profitability					
Operating margin %	2.2	7.2	4.9	4.8	6.0
Total profitability %	5.2	11.3	6.5	5.7	6.1
Profitability of equity capital %	9.3	19.9	10.9	9.5	9.5
Liquidity					
Net cash flow from operational activities	179	300	89	325	317
Degree of liquidity	1.6	1.7	1.7	1.7	1.9
Solidity					
Equity capital %	51	56	55	55	63
Operating working capital	397	508	616	763	928

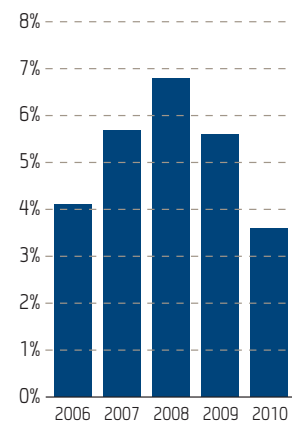
Net operating income (MNOK)



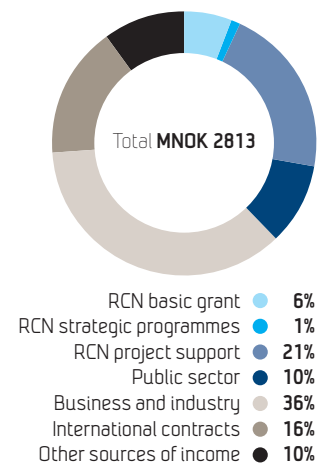
Net operating margin (%)



Investments (% of net operating income)



Sources of finance (% of gross operating income)



The Annual Report of the Board, accounts and HSE figures
are available at: www.sintef.com/2010-en



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