NTVA Review 2011

NORWEGIAN ACADEMY OF TECHNOLOGICAL SCIENCES

NTVA **IN BRIEF**

The Norwegian Academy of Technological Sciences (NTVA) is an independent organization founded in 1955. NTVA is a member of the International Council of Academies of Engineering (CAETS) and of the European Council of Applied Sciences and Engineering (Euro-CASE).

The objectives of NTVA are:

- to promote research, education and development of technology and natural sciences
- to stimulate international cooperation within these fields
- to promote the understanding of technology and natural sciences among the authorities and the public to the benefit of Norwegian society and industrial development in Norway.

NTVA is an organization whose members are distinguished scientists and industrial leaders recruited from academic institutions and from industry in Norway and abroad. Individuals who have made significant contributions to the technological sciences or in related areas, or whose professional work has contributed significantly to the realization of advanced technology in practice, are eligible for membership. The total number of members is 522.

NTVA has an Industrial Council consisting of representatives of the top management of leading industrial companies and institutions in Norway. The purpose of the council is to support NTVA in fulfilling its missions, and to strengthen the relations between the academy and society. In 2011, the Council had 37 members

The main activities

NTVA had 32 arrangements in 2011. Five seminars and workshops were arranged in Trondheim or in Oslo. Two of these were on the occasion of the International Year of Chemistry in 2011. Regular meetings open to the public were held in Bergen (7), Oslo (6), Stavanger (6) and Trondheim (8). Some of the themes from these meetings are rendered in in this review.



Lerchendal gård

PUBLISHER

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Cover photo: Vscan, Pocket-sized ultrasound, Source: GE Healthcare

FOREWORD

Roy H. Gabrielsen
President

2011 was a turbulent year in Norway and many activities, including those of NTVA, were influenced by the July 22nd disaster. In 2010, NTVA started its work to establish a strategy for its work with energy. This is a among the most important topics to be solved for our society, and its solution rests profoundly on science and technology. The intention of the Academy is to highlight the importance of the energy question globally and even more so on the particular possibilities and responsibilities Norway has as a major producer of energy. This topic has, as expected, gained great interest inside the Academy; it is also obvious that this interest is shared by other actors, be it in our sister academies, in industry and in the political environment. This interest is enhanced by the relation between energy consumption and environmental issues. Due to the tragic event mentioned above and the necessary postponement of planned seminar activity concerning the topic of energy, the work with the energy strategy of NTVA continues into 2012.

The international cooperation of NTVA with academies and technology organizations abroad has been excellent. Thus, contacts within the CAETS and Euro-CASE have been maintained while previously established contacts with the Nordic and selected international technological academies have been developed further. It is the opinion of NTVA that contacts in fields of science are very important in building bridges among societies. For example our cooperation with the Chinese Academy of Engineering (CAE) continues to develop.

On the other hand, we recognize that the full potential for national cooperation with other Norwegian academies has not been utilized in full. NTVA has therefore taken initiatives for a close and long-term cooperation with The Norwegian Academy of Science and Letters (Det Norske Videnskaps-Akademi, DNVA). Our intention is to merge the best possible complementary national scientific and technological expertise to make the knowledge possessed by the academies' scientists available to society. Both academies would contribute to enhancing the focus on science, research and technology, promote scientifically based discussions in the media and also to increase the visibility of science in general. After two years, we can already see the results of this closer cooperation between the two largest academies in Norway.

Cooperation with industry is important for NTVA. We also hope that contacts with NTVA may be important for industry. The Academy realizes that although good relations between NTVA and industry already exist, this contact needs to be improved. Actions have been taken to achieve this. Clear responses and advice from the industry are crucial for us to better understand what our industry members expect from us. The Academy's members include scientists with the highest level of technological and strategic knowledge that presumably is valuable for industry. This was indeed demonstrated in the NTVA Technology Forum arranged in September 2011 with the theme "Innovation and Technological Research". There were several excellent presentations given by NTVA members and guests with deep knowledge and experience from research, technology, innovation and application of research results. The meeting was well attended, but these talks truly deserved an even larger audience – and it is the opinion of the President the knowledge and experience generously shared by the speakers would have been of great value for many more than those present at Lerchendal Gård this day in September 2011.

Oslo April 2012

KJELL H. BENDIKSEN
– NEW HONORARY MEMBER OF NTVA IN 2011

NTVA's honorary membership has been awarded to Kjell H. Bendiksen for his roles as researcher, administrator, disseminator of knowledge and active member of NTVA.

KJELL H. BENDIKSEN, born in 1947, received his cand. real. degree in nuclear physics from the Department of Physics, University of Oslo in 1973, and Dr. Sc. in hydrodynamics from the Department of Mathematics, University of Oslo, in 1983.

As a researcher, Kjell H. Bendiksen has been a key figure in both basic and technically applied research on multiphase flow in Norway. Bendiksen was the main actor behind the development of the simulation program OLGA, which has become the national and international standard for multiphase simulation in the process and petroleum industry. A range of major development projects and billions in income in Norway could not have taken place without the developmental work in which Kjell H. Bendiksen has played a central role. His list of publications in this area is extensive.

Kjell H. Bendiksen was the president of the Institute for Energy Technology (IFE) at Kjeller from 1995 to 2010. During recent years, IFE has focused on strengthening research – especially in the areas of solar cells, wind power, energy storage and handling of CO2. IFE's isotope laboratories control all of the radiopharmaceuticals used in Norwegian hospitals. The Halden Project now has 18 member countries and 100 member organizations including safety authorities from many countries. The project provides key information that is used in safety assessment and licensing.

As an active communicator of various aspects of energy needs and energy systems, Kjell H. Bendiksen has shared his knowledge with both authorities and the general public. He has served on many boards and councils, as well as on national and international technical and scientific committees. He has a strong scientific background with publications in many international journals and conferences, and his work is often cited.

Kjell H. Bendiksen has always responded positively to NTVA's requests for various forms of help and support. In this way, he has demonstrated his understanding of NTVA's contribution to recruitment, education, research and commercial development in science and technology.

Kjell Bendiksen, NTVA Technology Forum 2011

NTVA **SPECIAL AWARD 2011**

TO KJELL ARNE INGEBRIGTSEN, BJØRN ANGELSEN AND KJELL KRISTOFFERSEN

The award committee stated: "The committee recognizes Angelsen and Ingebrigtsen for their pioneering work in laying the technological and industrial foundation that has made Norway a frontrunner in the technological development and use of medical imaging. Kristoffersen has built upon this foundation and has played a key role in the development of medical ultrasound technology of high international ranking, as recently demonstrated by the instrument, Vscan." Vscan is the small mobile ultrasound machine developed by GE Vingmed Ultrasound in Horten, and that was awarded the "Engineering Achievement of the Year" in 2009 by Teknisk Ukeblad.

During the NTVA Technology Forum, the three were awarded diplomas illustrated by Håkon Bleken.

KJELL ARNE INGEBRIGTSEN, born in 1937, is a civil engineer with a background in communication technology and physical electronics, and received the degrees of lic. techn. and dr. techn. from NTH. Prior to 1985, his main activity comprised research and teaching at FFI, SINTEF and NTH. After 1985, Ingebrigtsen became a central figure, both as a researcher and administrator, in the development of Vingmed Sound for the commercialization of ultrasound imaging technology for diagnosis in medicine. From 1992 to 2000, he also held various positions of leadership working with strategy and market development in the international companies that Vingmed Sound had then become part of. Ingebrigtsen has made major contributions both as an academic and as a leader in the industrial development of ultrasound for heart diagnosis.

Vscan in office, Photo: GE Healthcare

Roy Helge Gabrielsen, President NTVA (from left), Kjell Kristoffersen, Bjørn Angelsen and Kjell Arne Ingebrigtsen

BJØRN ANGELSEN, born in 1946, is a civil engineer in physical electronics (1971) and received his degree dr. techn. (1977) from NTH. After completing his education as a civil engineer, he became part of the first research group that worked with measurements of circulation in the heart and in the circulatory system, first with mathematical models, and later with ultrasound on living people. It was in this field he received his doctoral degree from NTH. In 1982, together with heart specialist Liv Hatle, he co-authored a book about ultrasound in the diagnosis of the heart – a book that has been read throughout the world. He was awarded the prestigious "Ian Donald Medal for Technical Achievement within Ultrasound Technology" in 2006.

KJELL KRISTOFFERSEN, born in 1952, received his degrees in civil engineering and dr. techn. in technical cybernetics from NTH. As Chief Engineer, he is now one of the senior figures in GE Healthcare globally. He is also adjunct professor at the Department of Circulation and Medical Imaging, NTNU. He received the Edison prize for innovative technology in GE Healthcare in 2004. In 1998, he was given the responsibility to coordinate the international development of technology in GE Healthcare between GE in Milwaukee, Schenectady, Haifa and Horten, and later between GE and system developers in Europe, USA and Asia. He has played a central role in the development of Vscan, which was launched in 2009.

NTVA **TECHNOLOGY FORUM 2011**

INNOVATION AND TECHNICAL RESEARCH

Thursday 6 September – Lerchendal gård

Innovations are the most important elements in economic growth. During a financial crisis, such as we have been experiencing in recent years, innovation becomes constrained, and commercialization comes to a halt because of the lack of risk capital. The renewal of economic growth therefore demands the renewal and commercialization of innovation.

Technical research creates robust innovations. The knowledge that is achieved through research provides a lead over the competition, and inventions can be protected by patents. However, technical research does not automatically lead to innovation. A major portion of technical research is of a generic nature, and not aimed toward applications with a commercial value. In other cases, there may be a lack of both the initiative and the support to transform the results of research into a commercial product. The chance of succeeding is often so uncertain that it is not possible to raise capital, in spite of the knowledge that the profit can be great if the product is a success.

Universities are large and important arenas for technical research. During the past 10 years, Norwegian universities have established "Technical Transfer Offices" (TTO) to aid in the commercialization of research. The TTOs have

Adviser Roar Arntzen, St Olavs Hospital (left) and Unni Steinsmo, President and CEO SINTEF

Director Alf Bjørseth, Scatec

Rolf Skår, former Director, Norsk Romsenter

Bjørn Olstad, Director Microsoft Development Center Norway

a double purpose: One is to ensure that the university receives its share of the commercial value of the invention that has been achieved through research at the university. The other is to stimulate university researchers to focus on innovation in their work. Because the TTOs have not been functioning long, it is still too early to be able to evaluate the contributions they have made.

During Technology Forum 2011, NTVA focuses our attention on innovation from technical research, and especially on the contributions from our universities. The idea behind the choice of theme is that technical research in universities both can and should be contributing more towards creating innovations with commercial value than is the case today. Where do we find the greatest hindrances? Are they embedded in the culture of the university, in the instruments for commercialization (TTO) that are not good enough, or in the lack of capital?

In order to find possible answers to these questions, the seminar has been divided into three parts. The first part takes personal experiences as a point of departure to shed light on the underlying mechanisms and the measures that can be taken to stimulate innovation. This will include critical views of public and private initiatives. The second part is a presentation of some success stories. What has been decisive in their success? The final part comprises presentations from universities. How do they view their responsibility to society regarding innovation?

NTVA **TECHNOLOGY FORUM 2012**

NATURAL GAS AND NORWEGIAN INDUSTRY

Thursday 6 September – Lerchendal gård, Trondheim

Norway is significant as a producer of oil and gas. We have enough resources to be a stable supplier for a long time to come. We export nearly all natural gas that is recovered from the Norwegian continental shelf. Arguments against the exploitation of this resource in Norway have been tied to the price and emissions of CO_2. The focus of the seminar is on possible uses of natural gas in Norway for something other than as a source of energy.

Compared with the focus on upstream gas production, relatively little attention has been paid to gas downstream. It seems that, for Norway, natural gas is a problem that we must get rid of as quickly as possible by exporting it. Statoil is cultivating upstream activity increasingly more. Gassmaks is a program under the auspices of the Norwegian Research Council; its purpose is to increase the value added in the natural gas chain. This involves a strengthening of knowledge, industrial development and competitive international strength. This will contribute to increased value added for society through industrial refinement of natural gas in Norway.

A project that appears very promising regarding both industry and environment in Norway is "Ironman" at Tjeldbergodden. The plan is to transport iron ore from Kiruna via Narvik to Tjeldbergodden. Here, the iron is directly reduced with the aid of natural gas. Compared to the process in the carbon-based blast furnaces, the gas emissions are reduced by approximately 60 per cent. The gas pipeline that today goes to Tjeldbergodden has available capacity and the lot for the new ironworks is ready. The alternative for value added and 120 positions of employment in Norway might be to build the plant in England, Belgium or the Netherlands.

NANOTECHNOLOGY FOR RENEWABLE ENERGY MATERIALS

The Norwegian Academy of Technological Sciences (NTVA) in co-operation with Norwegian University of Science and Technology (NTNU) arranged a workshop in Trondheim, 31 August to 1 September, on Nanotechnology for (renewable) energy materials.

Aim of the workshop:

Significant improvements are expected in the production of energy in the coming years, in particular from renewable and environmentally friendly energy sources. Efficient and reliable energy transport and storage systems, highly efficient solar cells, and ability to harvest more energy from the environment are all among expected breakthroughs in the near future. Further developments of materials with tailor made properties directed toward these targets are needed for these advances. Tailor made materials at the nanoscale, applying various principles from nanotechnology, are expected to have great impact on the field of renewable energy. A series of recent developments highlights the potential of these strategies.

China is becoming world's most important research nation, especially in the field of renewable energy and nanotechnology. Norway is an energy nation and sets high priority in cooperation with China in the field of renewable energy.

With the support of the Norwegian Research Council via the RENERGI program, Norwegian Academy of Technological Science, NTNU NanoLab and NTNU Strategic Areas Materials, we are planning to hold the first Norway–China workshop on nanotechnology for (renewable) energy materials in Trondheim, Norway.

Photo: Hein Johnson

Professor Qiang YAO, Tsinghua University

In this workshop, we invite a group of experts in the thematic fields from Tsinghua University, China; National center for Nanoscience and Technology, China; BeijingUniversity of Science and Technology as well as the Norwegian University of Science and Technology (NTNU) and SINTEF to present their latest research. Getting acquainted with each other and seeking long term cooperation between China and Norway forms the motivation behind this key event. It aims to build a Chinese–Norwegian network, foster knowledge of nanotechnology and materials for energy applications, promote bilateral research projects, and increase international student recruitment.

NTVA **ENERGY STRATEGY 2012–2017**

In 2011, NTVA established a committee to develop NTVA's energy strategy for the period 2012 – 2017. The members of the committee are Roy H. Gabrielsen (NTVA's president and leader of the committee), Kjell H. Bendiksen (IFE/UiO), Hans H. Faanes (NTNU), Einar Hope (NHH), Erling Rytter (Statoil/NTNU), Knut Åm (IRIS), Sverre Aam (SINTEF). Hein Johnson (secretary general NTVA) is the committee's secretary.

The committee's work is founded on the following premises:

1 The need for energy on a global scale is expected to increase in parallel with the growth of the population and a general increase in our dependence on energy. This development is expected to accelerate throughout the strategy period. For the OECD area (including Norway) a more stable development is expected, in keeping with what we see today (IEA 2010).

2 Seen from a global perspective, the energy question is becoming rapidly and increasingly significant. Countries with strongly growing economies are in a development process that depends on a rapidly accelerating access to energy, while the OECD countries' need for energy is expected to stagnate (IEA 2010).

3 There are great differences in the conditions for supplying the need for energy for transport and energy for stationary use. There seems to be a general agreement that the world's need for energy for transport must be covered by fossil resources in the foreseeable future.

4 Doubts have been emerging about the suitability of various forms of biofuel with regard to the environment and to food resources.

5 Recent crises in the energy industry (Gulf of Mexico, Fukushima) have caused strong swings in international opinion. At the same time, authorities are unable to provide satisfactory answers to the fundamental questions about security and sustainability in the energy system.

6 Norway is in a unique position as a producer of energy, regarding both quantity and variety of energy resources. We are the nett-exporter of energy that has an additional value in the energy market in that Norway is able to guarantee stable delivery of energy under stable economic and political conditions.

7 Because of its great income from export of energy, Norway has a unique responsibility, a unique potential, and a special interest in energy research and the development of energy technology.

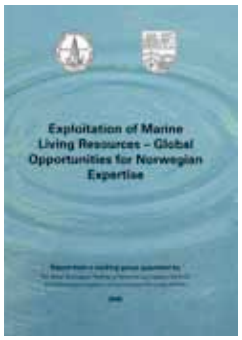
8 During the strategy period, fossil fuels will be important in covering the need for energy in the world. A significant increase of efforts in research and innovation regarding renewable energy is necessary.

The energy strategy will be published as a report in 2012.

VALUE CREATION BASED ON HEALTHY AND PRODUCTIVE OCEANS IN 2050

Trude Olafsen, SINTEF Fisheries and Aquaculture

In 1999, The Norwegian Academy of Technological Sciences (NTVA) and The Royal Norwegian Society of Sciences and Letters (DKNVS) published the report "Norges muligheter for verdiskaping innen havbruk" ("Norway's opportunities for added value in the biomarine industry") concentrating on and describing the national opportunities in developing and exploiting biomarine resources. In 2006, they published a follow-up study of the previous report taking a closer look at the Norwegian opportunities for growth and development in an *international* perspective – "Exploitation of marine living resources – global opportunities for Norwegian expertise". The focus in this work was on the export of Norwegian biomarine expertise as a product in the same manner as production and export of fish.



Since 1999, the marine industry has developed further and in 2011 NTVA/DKNVS established a working group consisting of notable people from industry, science and government administration. Their mandate is to investigate the possibilities and potentials of the Norwegian coastline and oceans when it comes to production of food and other biomarine resources. Norway has a global responsibility in contributing to production of food and energy from the oceans in a sustainable way. Today only 2 % of the world's food production (based on calories) is taking place in the marine environment. Norway is obligated to make a contribution to increase this share to meet the world's fast growing need for food and knowledge. Based on earlier studies, the working group will look into the important global drivers for the biomarine industries, identify important perspectives towards 2050 and suggest possibilities and challenges. The group's work culminate in recommendations.

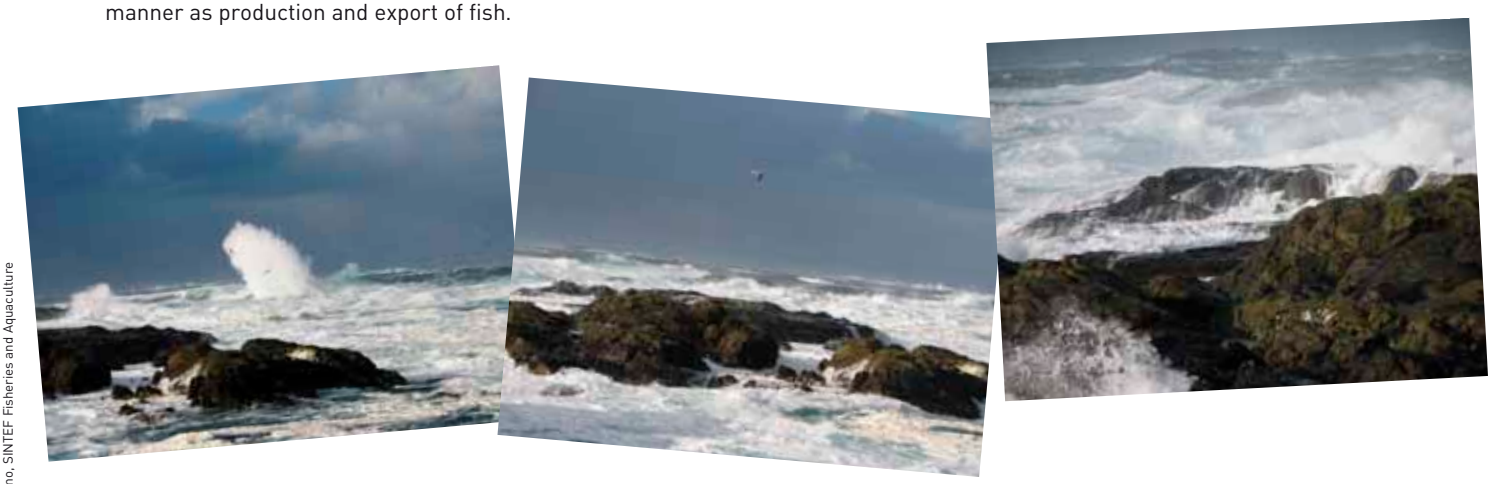


Photo: Leif Grimsmo, SINTEF Fisheries and Aquaculture

A new book based on the research project "A knowledge based Norway" by Torgeir Reve, professor at BI, has also given valuable input and inspiration to the work: "Norway has three, and only three, industries with a potential to be global knowledge hubs and that is offshore-based industries (suppliers and service industries), maritime industry and seafood industry". Hopefully the recommendations from the working group will be useful to other important policy processes going on at the moment like HAV 21 (www.hav21.no) and the new White Paper the Department of Fishery and Coastal Affairs is now preparing for the Norwegian Parliament. The report will be published in 2012.

NTVA **AND THE INTERNATIONAL YEAR OF CHEMISTRY 2011**

On the occasion of the International Year of Chemistry in 2011, NTVA invited to seminars in Trondheim and Oslo with the provocative title

"CHEMISTRY – A SUBJECT FORGOTTEN BY THE SCHOOLS?"

The seminars were organized as a joint effort between the Forum for Industrial Cooperation ("Samarbeidsforum") at NTNU and the trade organization Tekna. The number of primary applicants for the study programs in chemistry within higher education in Norway has declined in recent years. The following questions were given attention at the seminars: What may be the cause of the decline in the number of applicants? What can be done to create greater interest for chemistry? In what way does society wish to benefit from offering education within chemistry? Which workplaces want to employ chemists? Why should pupils choose subjects in chemistry at school? Do we need more better qualified chemists?

In order to demonstrate the importance of chemistry to Norwegian industry, Research Director Kristin Misund, Borregaard, and Professor Øyvind Gregersen, NTNU, held a presentation entitled "Wood pulp – More than cardboard and paper?"

Assistant Professor Wilhelm R. Glomm from the Uglestad-laboratory at NTNU reported from medical research based on chemistry. His message was that combining mathematics, physics, chemistry and biology gives good possibilities for taking advantage of chemical competence within medicine.

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The leader of "Naturfagsenteret" (Norwegian Centre for Science Education) at the University of Oslo (UiO), Anders Isnes, gave a report regarding chemistry subjects within the ten-year compulsory school, as well as the training of teachers for this level.

Professor Bjørn Pedersen, UiO, gave his point of view regarding the future of chemistry as a subject. He referred to challenges caused by the fact that UiO does not educate teachers within chemistry. The university colleges are supposed to educate teachers within natural science, but still they do not have many university lecturers in the field of chemistry. Biology dominates natural science part of education at the moment, both in school and at the university colleges.

Professor Øyvind Weiby Gregersen, NTNU

Department head Anders Isnes, UiO

Senior Scientific Officer Wilhelm Robert Glomm, NTNU

NTVA IN **BERGEN**

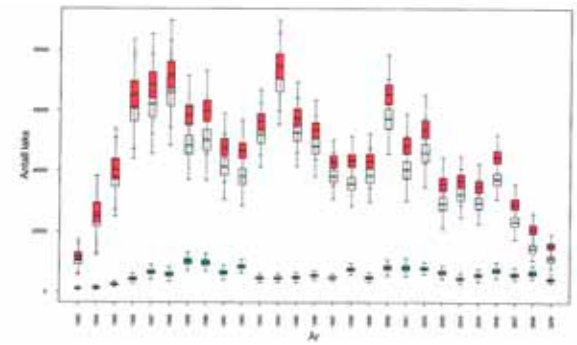
In 2011, NTVA arranged seven events in Bergen. The topic on 5 April was:

ENVIRONMENTAL ASPECTS OF ATLANTIC SALMON FARMING – SOME SCIENTIFIC ISSUES – FOCUS ON SALMON LICE AND ESCAPEES

Kjell Maroni, R&D director, aquaculture
Norwegian Seafood Research Fund (FHF)

Production of salmon is the largest food production in Norway with a harvest volume of 980,000 tons in 2011. How can society, industry, politicians and other relate to and evaluate the environmental impact from this production? Can authorities, industry, environmental organizations, salmon anglers agree on measurable indicators? These questions are well known to scientists both in Norway and abroad. This article is based on a presentation to NTVA in Bergen, 5 April 2011, and focuses on aspects related to sea lice and escapees.

Salmon lice are parasitic with four free-living planktonic life stages and seven on the salmon. The industry has a strong focus on reducing the number especially of mature female lice, as larvae from salmon lice on farmed fish is seen as a threat to wild salmon and trout. Details in the dynamics of salmon lice populations and relations between farmed and wild salmon populations are still under scientific discussion, making it difficult to agree on a finite acceptable goal for number of lice on farmed salmon – per salmon in a farm, per farm in total or in total in a region. Hydrodynamic modeling and spatial sea lice dispersal biology, genetic variation between salmon in sea lice resistance, reliable counting of lice on farmed and wild salmon, potential salmon lice vaccine are examples from ongoing research. A tool to trace back to determine whether a salmon louse larva comes from a female louse living on a farmed or a wild salmon would be helpful. In this context it is also interesting that lice on wild salmonids can be found in high numbers also in areas very far from farming activities.



Escaped farmed salmon

Escaped farmed salmon
Calculated number of farmed salmon in catches during the period 1983–2009. Red boxes show total catch; white boxes catch in the sea; green boxes catches in rivers, with 25 and 75 percentiles. Thin lines show the span from lowest to highest numbers from the simulations.

Source: Rapport fra vitenskapelig råd for lakseforvaltning rapport 2 – 2010.

From a peak with 921,000 reported escaped salmon in 2006, the numbers over the last 6 years have varied +/- 200,000. The industry vision is zero. Official statistics show a steady reduction since early 1990s from 30% escapees in autumn catches from Norwegian rivers to +/- 12% over the last 10 years and still showing a downward trend. The calculated number of farmed salmon in the wild catches also shows a marked reduction (see figure). The very significant variation both between rivers (many rivers have very few escapees, a few have many), and between different locations in each river make average numbers less useful in a scientific context. Methods for accurate measurement of escaped salmon in river catches, and also what percentage can be accepted as sustainable, is under heavy debate. Genetic markers can be used to trace genetic influence from farmed salmon in wild populations. However, the biological significance of this is questioned by many as evolution is proposed for the selection of individuals most fit for each river.

NTVA IN **OSLO**

In 2011, NTVA arranged eight events in Oslo. The topic on 21 September was:

SYNTHETIC LIFE: RISK, POSSIBILITIES AND CONSTRAINTS

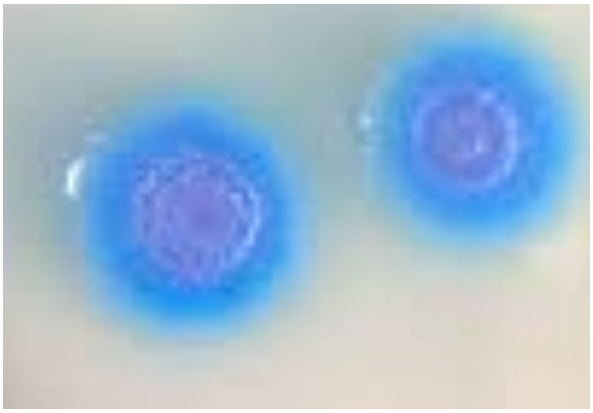
Dag O. Hessen, Professor
Dept of Biology, Centre for Ecological and Evolutionary Synthesis (CEES), University of Oslo

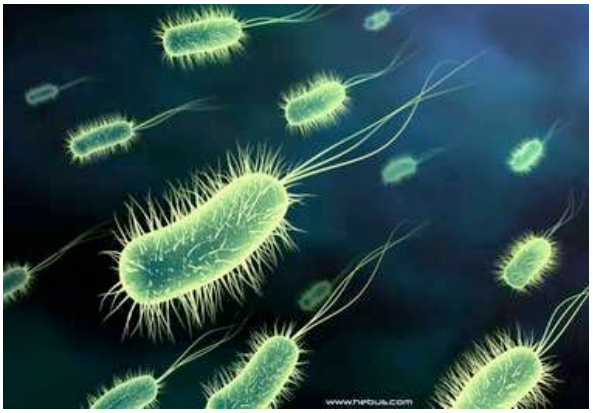
Synthetic life took the final step from science fiction to science in 2010 when scientists at the Craig Venter Institute made a 1.08 million base-pair synthetic Mycoplasma mycoides (a bacterium) genome from scratch and added it to an "empty" bacterial cell. The genome started working, and "Synthia" was a fact. It is, however a matter of debate whether this is a novel organism or more like adding a new engine to an old car, but clearly it represented a major step towards artificial or synthetic life. So, is this the start of Frankenstein's horror show, or the start of a new era with tremendous possibilities? Time will show, but it is probably more towards the last than the first (and very unlikely) scenario.

The basic argument for pursuing this kind of research is that it firstly provides unique possibilities for fundamental insights into the core of life, gene-function, gene regulation, synthetic evolution and so on. On the more applied side, this opens potentially up for bioproduction of organic matter, bioenergy, polymers, and in principle an almost endless list of organic products. Clearly there are strong commercial interests involved, but the official arguments from the Venter institute are related to alternative sources of energy: "... we believe we all share a responsibility to find new energy sources and to uncover ways to mitigate our negative impact on the planet. We're using our pioneering genomic science to explore new biologically-driven sources of energy." The main prospects, besides bioproduction of hydrogen, ethanol and carbon-sequestration, are also to use artificial life in the pharmaceutical industry, breakdown of organic contaminants and so forth. The ultimate goal would be to create a very simple "tool-box" bacteria, like a kitchen machine with exchangeable parts (genes for the bacteria) can than be used for a multitude of purposes.

The basic arguments against synthetic life is partly more of theological or ethical concern (e.g. we are "playing God"), or that we run the risk of producing potentially harmful organisms that may spread and contaminate the environment, or that this could be a powerful tool for bio-terror. At least the latter concern is clearly relevant.

Progress is deeply rooted in humans, and science is always heading forward. Thus there is every reason to believe that the efforts to produce more sophisticated and useful forms of artificial life will proceed. Modern humans have existed for more than 100 000 years, but it is less than 60 years since the structure of DNA was discovered, less than 40 years since DNA was exchanged artificially between species, 15 years since the cloning of "Dolly". No-one can tell where we will be 50 years from now, but synthetic life above simple bacteria is still science fiction and will probably (and hopefully) still be so in the foreseeable future.





NTVA IN **STAVANGER**

In 2011, NTVA arranged six events in Stavanger. The topic on 22 September was:

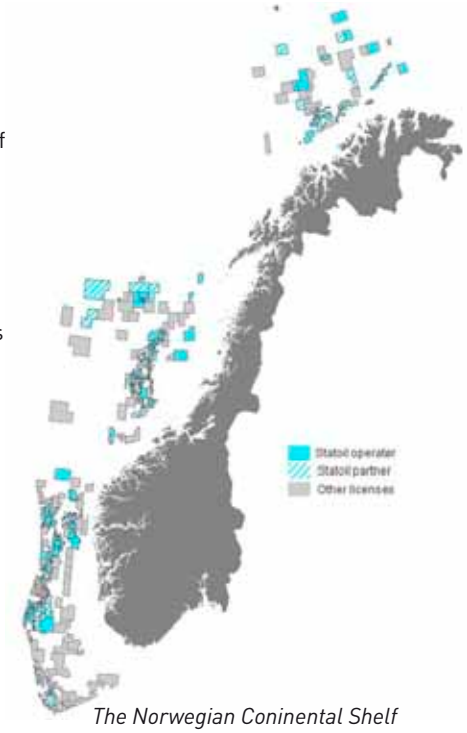
THE NEW DISCOVERIES ON THE NORWEGIAN CONTINENTAL SHELF IN PERSPECTIVE

Sigrid Borthen Toven,
Vice President Exploration,
Statoil

In the period between 2000 and 2010, few discoveries were made on the Norwegian Continental Shelf (NCS). Only one discovery of more than 250 million barrels of oil equivalents (boe) was made, and nine discoveries in the order of 100-250 million boe. However, in the last 4–5 years, exploration activity has increased significantly on NCS and a large number of companies have participated. 194 exploration and appraisal wells were drilled in the period 2007–2010, resulting in approximately 2.5 million boe in discoveries. There is a clear correlation between increased exploration activity and increased proven resources.

There are three distinct exploration clusters on the NCS: the North Sea, the Norwegian Sea and the Barents Sea. All three provinces have the potential of discoveries in the order of 2 billion boe through exploration the next 10 years. Statoil has sharpened their exploration strategy on the NCS and our ambition is to becoming a leading exploration company. The two big discoveries on NSC this year, the Skrugard discovery in the Barents Sea and the Johan Sverdrup discovery in the North Sea, are very important contributors in reaching this ambition. If we look at all the offshore discoveries made worldwide in 2011, Statoil participated in the four biggest discoveries and operates three of them. This is something we are very proud of.

The Johan Sverdrup discovery (previously called Aldous/ Avaldsnes) is located in a mature area of the NCS. Statoil's Aldous Major South well and Lundin's Avaldsnes well has the same oil-water contact, which proves that this is one continuous discovery and will therefore be developed as one, with one name. It extends over a large area of approximately 180 square kilometres, and there is considerable variation in both reservoir thickness and oil column height in the structure.



The Norwegian Coninental Shelf

The Skrugard discovery is located 100 km north of Statoil's gas field Snøhvit, and 200 km from Hammerfest. It is a substantial discovery and the Havis discovery made in early January 2012 confirmed a volume potential of 400–600 million boe for Skrugard and Havis in total. Skrugard and Havis is a break-through for opening up a new petroleum province in the North.

FACT BOX
Barrels of oil equivalent (boe) is the term used by oil and gas companies as a way of combining oil and natural gas reserves and production into a single measure. One barrel of crude oil is approximately 159 litres.


Core sample appraisal well Aldous

NTVA IN **TRONDHEIM**

In 2011, NTVA arranged eleven events in Trondheim. The topic on 11 October was:

WHAT DID WE LEARN FROM FUKUSHIMA?

Geological conditions associated with the earthquake of March 11, 2011, safety issues and future consequences

Kuvvet Atakan, Professor, Department of Earth Science, University of Bergen

The mega-thrust earthquake and the tsunami that hit Tohoku, Japan on March 11, 2011 (M=9) was a disaster that the Japanese society will remember for centuries. Despite the high public awareness and the continuous efforts of the Japanese authorities and scientists, the event came as a surprise to many. In total, the number of casualties reached 15769 in addition to the 4227 missing and 5278 injured with an economic loss of USD 300 billion. The Tohoku-Oki area lies in an active deformation zone as a consequence of the collision between the Pacific plate in the east and the Okhotsk micro-plate in the west. The high rate of convergence along this plate boundary (9.2 cm/year) builds up enormous stresses along the plate interface that are released through large earthquakes. Historically, there have been a large number of earthquakes with magnitudes in the range 7.0-8.5, which led to the assumption that the accumulated crustal stress was almost completely released. Hence, the potential of having a mega-thrust earthquake of M=9 along the same segment of the plate boundary was neglected.

In retrospect, using a variety of data sets from the seismological networks in Japan and around the world, it was possible to understand the fault rupture processes as well as the associated very strong ground shaking. Based on an analysis of satellite gravity data, the areas of strong coupling along the plate interface were highlighted. The plate interface offshore Honshu dips towards the west underneath the Okhotsk micro-plate with an angle of 14o. The shallower part of this fault rupture area accumulated a significant amount of stresses where much of the energy was released during the Tohoku-Oki earthquake coinciding to the strongly coupled parts as was delineated by the gravity data. The resulting displacement was extreme, reaching more than 50 m along this shallow asperity (strongly coupled zone in a fault plane) and less at the deeper parts of the rupture plane. As a consequence of this, the coastline of Honshu was moved 2-5 m towards the ocean, whereas the largest horizontal sea-bottom displacement measured close to the trench was 24 m. The vertical uplift of this zone of up to 3 m caused the subsequent tsunami. The wave-heights were measured to be 5-10 m on the average with maximum values reaching almost 30 m. The tsunami-walls that were built according to the wave-heights experienced during a large tsunami recorded in 1896 could not protect the population centers along the eastern coast of Honshu. The last mega-thrust earthquake in the area was recorded by the tsunami deposits on the shallow coast of Sendai 1142 years ago. Incomplete records of such catastrophic events can easily lead to misinterpretation of the earthquake and tsunami potential of subduction zones. In the future, more efforts should be made to understand the processes that lead to such disastrous earthquakes. The foreshocks that occurred at the location of rupture initiation only three days prior to the mega-thrust event was one of such indices. Now, there are still accumulated stresses in the outer-rise area, as well as in the triple plate junction in the south close to Tokyo, where the likelihood of a repetition of the great Kanto earthquake of 1923 is increased.

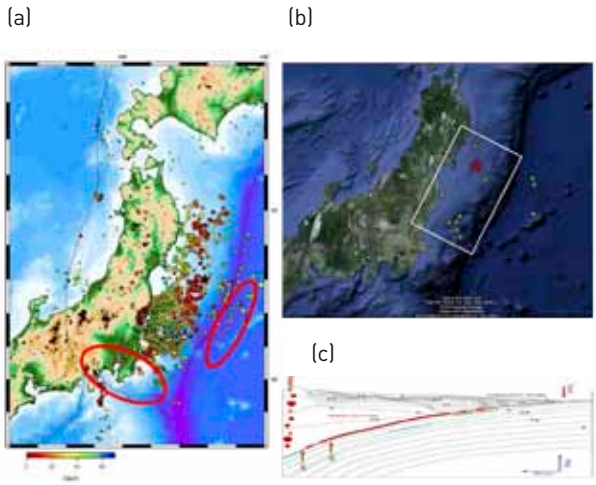


Figure 1. *(a) The aftershocks of the Tohoku-Oki earthquake of March 11, 2011 (modified from Nishida, 2011). The red ellipses outline the areas where future large earthquakes can be expected in the outer-rise in the east and in the Tokyo area in the south. (b) The approximate location of the fault rupture area (white rectangle) and the epicenter (red star). The base map is from Google Earth. (c) A cross section showing the plate interface (red line). The stippled red line and its continuation towards the sea-bottom close to the trench corresponds to the area of highest slip (modified from Nakanishi et al., 2004).*

NTVA Review 2011

NORWEGIAN ACADEMY OF TECHNOLOGICAL SCIENCES

NTVA'S INDUSTRIAL COUNCIL

NTVA has an Industrial Council made up of representatives from business companies, public institutions and research institutes. The council assists NTVA in realizing its objectives and strengthening its links to industry by promoting research, education and innovation to the benefit of Norwegian society. The council's executive committee had the following members in 2010/2011:

Knut Åm, Director, Chairman
Kjell Arne Ingebrigtsen, President NTVA, Professor NTNU
Karl Almås, Managing Director, SINTEF Fisheries and Aquaculture
Marianne Harg, President, TEKNA
Ole Gunnar Selvaag, Senior owner and a board member in Selvaag Gruppen A/S
Lars Holden, Managing Director, Norwegian Computing Center
Hein Johnson, Secretary General, NTVA

Council members:

ABB
AS Norske Shell
Christian Michelsen Research AS
ConocoPhillips
Det Norske Veritas AS
Forsvarets forskningsinstitutt
Fred. Olsen & Co
GE Oil & Gas Norway
GE Vingmed Ultrasound AS
Havforskningsinstituttet
Innovasjon Norge
Institutt for energiteknikk
International Research Institute of Stavanger (IRIS)
Leiv Eiriksson Nyfotek AS
MARINTEK
Microsoft Development Center Norway AS
NEXANS Norway AS
NHO
Norconsult AS
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Selvaag Gruppen AS
Simula Research Laboratory AS
SINTEF
SINTEF Raufoss Manufactoring AS
Statoil ASA
SYSLAB International AS
TEKNA
Telenor R&I
Umoe AS
Unifob AS

Annual meeting

The annual meeting for the Industrial Council was arranged in Oslo, 4 March. On this occasion Auke Lont, President and CEO, Statnett, gave a speech with the title: Energy Policy for Norway – if it were up to mew




From left: Auke Lont, CEO, Statnett. Arve Johnsen, former CEO, Statoil. Professor Kjell Arne Ingebrigtsen, President NTVA in 2011. Knut Åm, Chairman NTVA Industrial Council

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