Annual Report 2007

Strategic Area
Energy and Petroleum
– Resources and Environment

NTNU
Norwegian University of
Science and Technology

What are the Strategic Areas at NTNU?

One of the main goals of NTNU is to be useful to society, by developing and maintaining the national technological skills needed to build a sustainable society. To realize this goal NTNU has given priority to six strategic areas where we aim to provide multidisciplinary team-work of high-quality research with substantial long-term social impact. These are:

- Energy and Petroleum – Resources and Environment
- Globalization
- Information and Communications Technology (ICT)
- Marine and Maritime Technology
- Materials
- Medical Technology

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About Energy and Petroleum – Resources and Environment

Energy is needed to provide for essential human needs like food, housing, clothing, transportation, health and recreation – in short what is needed to live a good life on this planet.

By the end of this century, emission of greenhouse gases needs to be curbed. At the same time around 6 billion new citizens may join in at the global dinner table. How to produce sufficient amounts of clean energy for a future peaceful and sustainable society is today's largest challenge.

There will be a great demand for new knowledge, new technology and new solutions. This is a global challenge which will involve a lot of people in many countries. NTNU, together with SINTEF, wants to play an active and productive role to supply the necessary scientific input to the global transformation processes needed to achieve a sustainable future.

The overall goal is to develop new knowledge and educate the people who can turn that knowledge into clean energy solutions. A successful transition to clean and sustainable energy systems will depend on global innovation processes. Although the solutions that will be implemented will reflect local resources and conditions, they will emerge from the application of a mixture of key technologies with which NTNU and SINTEF are actively working:

- Efficient and sustainable generation, transport and end-user utilization of energy, including oil and gas
- Carbon dioxide capture and storage
- Renewable energy.

Probably, electricity and hydrogen will be the main energy carriers of the future, together with biofuels and biomass. Yet, it is important to propose – within the same time frame – a variety of possible technological solutions to allow for social choices and local concerns.

Norway may be considered an "energy country". Thus, NTNU and SINTEF have established substantial energy related activity. Today, more than 750 scientists are involved in the efforts to create a cleaner future. This "family" includes 170 professors and 350 doctoral students and post-doctoral researchers doing fundamental energy-related research. At NTNU, more than 250 master students graduate each year, to supply the energy sector with highly qualified candidates.

Our vision is
"Clean energy for a sustainable society"

To meet future challenges in a better way, the strategic energy area has developed an organization based primarily on the following six goal-oriented, multi-disciplinary research centres:

- Centre for Smart Energy Efficient Buildings
- Centre for Renewable Energy
- Gas Technology Center
- Centre for Better Resource Utilization
- Centre for Electric Energy and Energy Systems
- Centre for Energy and Society

In addition, there are strategic initiatives that work across the centres:

- CO2-Capture and Storage (CCS)
- Hydrogen technology
- Green Innovation
- NanoLab
- TRANSES (Transition to Sustainable Energy System)

This should make NTNU well prepared for the hard and challenging work that lies ahead.

Faculty – Centre - Matrix

		Contribution to Centres					
Faculties	Professors	BRU	GTC	CRE	ELES	Build	CES
Architecture and Fine Arts	5			X		X	
Engineering Science and Technology	86	X	X	X	X	X	
Natural Sciences and Technology	32	X	X	X			
Information Technology, Mathematics and Electrical Engineering	31	X	X	X	X		
Social Sciences and Technology Man.	7	X					X
Arts	6	X	X				X
Total	167						

The strategic area relies highly on the co-operation and coordination with the Faculties. The team work organization consists of highly professional and unique research groups that handle strategically important science and technology areas. There are more than 20 such research groups within our strategic area. The teams consist of NTNU professors, SINTEF researchers, PhD students and Master students, and operate world class unique laboratories. These research groups are created by the Faculties through allocation of personnel resources and laboratory investments. The development of new research groups to handle new technology areas thus relies on good communication between the Strategic Area and the Faculties.

The Faculty-Centre-Matrix below shows that our strategic area has developed such cooperative networks in almost all faculties at NTNU.

Based upon the Norway's position near the Arctic Basin, with large potential and reserves of both renewable energy and natural gas, the NTNU-SINTEF team has given priority to the following main areas/ strategies where we will contribute in the global innovation process.

We want to develop new technology and solutions for:

- Efficient end use of energy
- Utilization of renewable energy sources
- Carbon Capture and Storage (CCS) to allow the use of fossil fuel and still reduce CO_2 levels
- Smart energy systems that integrate sources and end users in an efficient way
- Utilization of natural gas in an environmentally friendly way
- Hydrogen technology
- Better resource utilization and energy from the Arctic Region

Main events in 2007

- The professors and researchers within NTNU-SINTEF have participated actively in the planning process for the new national energy strategy "Energy21"

- On August 17 Minister of Research and Education Øystein Djupedal awarded a start-up grant for Energy Campus North in Hammerfest, where NTNU together with Universities of Tromsø and Stavanger, and Universtiy Colleges of Narvik, Trømsø and Finnmark will jointly develop an integrated energy education.

- The research groups of the Strategic Area were able to start up 40 new projects financed by the Research Council of Norway in 2007

- Research groups in Gas Technology were successful in acquiring research projects for approximately 60 million NOK in the new GassMaks program.

- On invitation from Research Council of Norway and Ministry of Research and Education, NTNU and SINTEF developed a national proposal on "European Carbon dioxide Capture and StoragE Laboratory Infrastructure" (ECCSEL) to be included in the Road Map of ESFRI (European Strategic Forum for Research Infrastructure)

- The groups proposed 6 new research infrastructures to the new National Strategy for Research Infrastructures developed by the Research Council of Norway

- The main achievement of the Building Energy Centre in 2006 was the finalization of the multidisciplinary research program "SmartBuild", which culminated with the publishing of a book and organizing the conference "Fremtidens smarte energieffektive bygg" with 170 participants. Preparations for a new "Centre for Sustainable Buildings" were started.

- To handle the complex problems of sub sea power equipment a new 7 million NOK "Sub Sea Lab" has been established.

- The Centre for Renewable Energy (CRE) has developed a joint R&D strategy for NTNU, SINTEF and IFE within this multidisciplinary research area, which had a large and positive influence on the development of our external relations.

- CRE has signed a large contract with Statkraft on the development of ocean-based renewable energy.

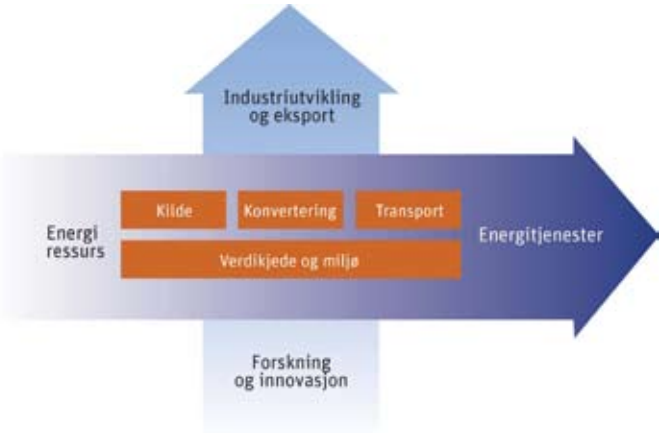
- "1st International PhD Symposium on Offshore Renewable Energy" was organised by PhD-candidates, attracting 38 participants from 13 countries. As an offshoot of the conference, the International Network of Offshore Renewable Energy (INORE) was created.

- Gas Technology Centre (GTC) was involved in initiating the new national research program GASSMAKS.

- GTC was awarded the large EU program DeCarbIt.

- GTC organised 3 conferences and seminars (The Remote Monitoring Conference, The Fourth Trondheim Conference on CO_2 Capture: Transport and Storage (TCCS-4) and an internal CO2-seminar for NTNU and SINTEF)

- On October 2-3 a new international conference in the areas of Smart fields/Inte-



grated Operations (IO07) was organized by the Center for Integrated Operations (SFI) in Trondheim, attracting 250 participants from all over the world. This conference will be followed up with IO08 in October 22-23, 2008.

- The Center for Energy and Society published the book "Mellom Klima og Komfort. Utfordringer for en bærekraftig energiutvikling" with Tapir Academic Press.

- Green Innovation was involved together with our strategic partner NORISS (Norwegian Institute of Strategic Studies) in political positioning of a large industrial initiative based on offshore wind power (Clean Energy for Clean Industry).

- NTNU and SINTEF were invited to participate in the KIC-pilot project awarded for the energy sector to prepare for the European Institute of Technology.

- NTNU and SINTEF participated in the successful KIFEE Seminar December 4-7 organized by a Japanese research group in Otsu, near Kyoto, at the beach of the legendary Lake Biwa. More than 180 people participated (40 Norwegians).

- Financed by BILAT project, NTNU and SINTEF organized a large "Seminar on Utilization of Natural Gas" at Shanghai Jiao Tong University (SJTU - March 27-28). The official part of the Seminar was opened by our Minister of Industry and Trade, Dag Terje Andersen and was attended by a Norwegian delegation and 100 students from NTNU and SJTU. A delegation of 14 participants from Research Council of Norway, StatoilHydro, Elkem and NTNU-SINTEF attended the specific workshops.

- The TRANSES project which involves cooperation MIT and was sponsored by Hydro, Statoil, Shell, Statsbygg, Enova, Statkraft and Statnett, was finalized successfully in 2006.

- GTS and SFFE participated actively in the new technology festival TechnoPort 2007 in October 2007

- 380 publications and 180 communication initiatives delivered within the Area in 2006

New Research Council of Norway projects in 2007

- Engineering Science for a Sustainable Future - Institutionally Based Strategic Program (ISP) from Research Council of Norway – 16 PhDs and Postdoc Fellowships within "Energy from the North" and "Renewable Energy"
- Renewable strategies? Implementation and commercialising new energy technologies
- Building markets, shaping policy? The role of economics in energy policy and energy use
- Participation in IEA PVPS Task 10 Leadership of Subtask 2: Urban Planning, Design and Development
- LifeTime Commissioning for Energy Efficient Operation of Buildings
- Financial Engineering Analysis of Investment and Operations in Electricity Markets
- A new concept for power quality and reliability measurement and management
- Balance Management in Multinational Power Markets
- Offshore Wind Energy in Norway: Setting the Basis
- Deep Sea Offshore Wind Turbine Technology
- Offshore Renewable Energy PhD-Pool
- Nanomaterials for 3rd Generation Solar Cells
- NSF-European Materials Cooperative Activity. "Nanostructured oxide thin films for organic/inorganic solar cell applications"
- Advanced sample preparation and characterisation of fuel cell materials for increased fuel cell durability
- High Temperature PEM Fuel Cells Operating with Organic Fuels
- Improved efficiency and durability of PEM water electrolysers for hydrogen production
- Development of highly efficient nanostructured SOFCs integrating novel Ln(Nb,Ta)O4-based proton
- Optimal operation and control of chemical plants with natural gas feedstock (OPTGASS)
- BEEDIST - Basic energy efficient distillation technology
- Improved process design and operation of natural gas conversion technologies
- Advanced reactor modeling and simulation
- Recovery of CO2 from high pressure gas with membranes
- Converting natural gas components to fuels and petrochemicals
- Fischer-Tropsch synthesis. Studies on the relation between catalyst properties and selectivity
- Development of CNF-polymer composites with high CNT loading
- Conversion of natural gas components in short contact time reactors
- New concepts in the catalytic dehydrogenation of propane
- Compact conversion of syngas to di-methyl-ether (DME)
- Storskalaprosess for konvertering av naturgass til hydrogen og høyverdig karbon.
- Hydrogen production by Sorbent Enhanced Reforming
- Hydrogen production from natural gas in hightemperature membrane reactors: Advanced catalysis from atoms to processes (MIT-NTNU)
- Carbon-supported core-shell electrocatalysts for oxidation of small organic molecules
- Template based synthesis of nanoporous metal-organic frameworks with high surfaces areas
- BIG CO2, Fase 2
- Evaluation Methodology for Power Produstion with CO2 Capture (MIT-NTNU)
- CO_2 Capture, enabling research
- Parameter optimization in preparation of membranes for osmotic processes
- Just Catch
- Modeling of particle deposition phenomena in heat exchangers
- Resource Optimization and recovery in the Materials industry Ringdalen

EU Framework projects at NTNU and SINTEF

- PRIME Policies for Research and Innovation in the Move towards the European Research Area (Network of excellence), http://www.prime-noe.org/
- PEP - Promotion of European Passive Houses, www.europeanpassivehouses.org
- ECO-CITY: Joint Eco-City Developments in Scandinavia and Spain, http://www.ecocity-project.eu/
- BRITA in PUBs: Bringing Retrofit Innovation to Application in Public Buildings, http://www.brita-in-pubs.eu/
- TREES: Training for Renovated Energy Efficient Social Housing, http://www.cenerg.ensmp.fr/trees/
- 3-NITY: 3-fold Initiative for Energy Planning and Sustainable Development at Local Level.
- EMINENT: Early Market Introduction of New Energy Technologies.
- FOXY: Development of solar-grade silicon feedstock for X wafers and cells.
- FCTEDI: Fuel Cell test and dissemination network, SSA-Strategic support action.
- GreenNet-EU27: Guiding a Least Cost Grid Integration of RES-Electricity in an extended Europe.
- NextGenBioWaste: Innovative demonstrations for the next generation of biomass and waste combustion plants.
- SEEWEC: Sustainable Economically Efficient Wave Energy Converter.
- SISI: Silicon for solar cells at low costs on an intermediate scale.
- ThermalNet: European Network for biomass pyrolysis, gasification and combustion.
- WAVESSG: Full-scale demonstration of robust and high-efficiency wave energy converter.
- WILMAR: Wind Power Integration in Liberalized Electricity Markets.
- DYNAMIS: Towards Hydrogen and Electricity Production with CO_2 Capture and Storage (Coordinator)
- ENGAS: Environmental Gas Management Research Infrastructure (Coordinator)
- ENCAP: Enhanced Capture of CO_2 (Project manager)
- CO2Remove: Geological storage of CO_2
- COACH: Co-operation Action within CCS EU-China
- CASTOR: CO2 from Capture to Storage
- ULCOS: Ultra Low CO_2 Steelmaking
- INCACO2: International Co-operation Actions on CO2 Capture and Storage
- CO2GeoNet: Network of Excellence in Geological Storage of CO_2
- NATURALHY: Preparing for the hydrogen economy by using the existing natural gas system as a catalyst
- ZEP: The Technology Platform for Zero Emission Fossil Fuel Power Plants (two members)
- DECARBit ("Decarbonise it") Focus on precombustion gas separation and hydrogen combustion
- CESAR (Postcombustion solvenst and testing in Demo plants)
- CAESAR (SEWGS processes and materials testing)
- ECCO: European value Chain for CO_2

Other international projects at NTNU and SINTEF

wIEA – International Energy Agency

SmartBuild is participating in the following projects and programmes within the IEA:

- IEA ECBCS Annex 44: Integrating Environmentally Responsive Elements in Building,s http://www.ecbcs.org/annexes/annex44.htm
- IEA ECBCS Annex 47: Cost-effective Commissioning, http://www.ecbcs.org/annexes/annex47.htm
- IEA PVPS Task 10: Urban Scale PV, http://www.iea-pvps-task10.org/
- IEA Heat Pump Programme Annex 29: Ground-Source Heat Pumps Overcoming Technical and Market Barriers, http://www.energy.sintef.no/prosjekt/Annex29/

Energy and Petroleum – Resources and Environment in 2007

The successful development of the Strategic area has continued in 2007, by the strategic initiatives carried out within the different Centres and at Management level (see below). We are now gaining valuable experience with the multidisciplinary goal-oriented Centres. The Centres handle the responsibility for the strategies and action plans within their areas. This has allowed us to work strategically and systematically over the whole Strategic Area. The projects and contracts carried out in this period amount to more than 200 million NOK. Thus the annual strategic grant from NTNU of around 2 million NOK is a good investment.

The main task of the Management is to develop overall goals and strategies and to ensure the teamwork and coordination within the Area. One obvious challenge is to find better ways of working together to obtain innovation and industrial development based on the considerable research activity that we are handling. Here, we are accountable to Norwegian society, which is entitled to expect positive outcomes.

In addition the Strategic Area has been involved in several important strategic processes. At NTNU 2007 was above all the "Year of evaluation" for all the Strategic Areas. The evaluation had been decided upon in 1999, when the Board decided to start up this new strategic initiative. The strategy was to invite international experts to analyse how the original goals and strategies for the Strategic Area had been achieved, and to receive invaluable advice on how to further develop and improve our activity. We were very fortunate that Professor David Hunter Marks from MIT, USA, and Director Hans Nilsson of 4Fact in Sweden accepted NTNU's invitation to analyse our Strategic Area.

A Self Evaluation Report from the Strategic Area was sent to the international experts in June, and this served as basis for Evaluation Seminars in September where the International Experts met with NTNU's Rectorate and the leadership team of the Strategic Area. Based on these meetings the international experts presented their report in September. Based on this report the Management Group produced a target plan for the further development for Energy and Petroleum, which was used as basis for internal seminars at NTNU in the end of October where the Rectorate met with all the Strategic Areas and received and discussed their plans and proposals for the further development of the Strategic Areas. This will served as a basis for a proposal to the Board of NTNU in August 2008.

For the Strategic Area "Energy and Petroleum – Resources and Environment" the report from the International Experts was an inspiring document. We received a very good feedback on our team achievements: We have been successful in developing a suitable organization, adapting to the changing needs, and have utilized this organization to create new activities that go beyond the original plan. This shows how dynamic this period has been, and when large energy programs were launched both in Norway and EU, we were ready to propose fundamental research activities that will be important for Norway as a future global energy nation.

We want to continue the development of what we consider to be a modern future-oriented organization, which is action-oriented and which may handle initiatives, both in the interface towards society and industry (outside – in), as well as from researchers and research groups (inside – out).

We also received some very clear and valuable suggestions that we will integrate in a new set of goals and strategies that reflect and address in a better way the change in public awareness and political commitment to the climate change issues, including the need for change in the energy system. Further we should utilize the potential of our wide spectre of projects in a more systematic way, to contribute to a better understanding of sustainability and how our activities may contribute to a future sustainable society. We should also pay more attention to the innovation processes that may bring new solutions to energy issues, taking into account technology development.

To be more successful, we must strengthen our understanding and contacts to the society, understanding policy and innovation processes – to be able to do the "right things". At the same time we must strengthen our cooperation with the Faculties so that we may develop research groups in areas that will be needed to do the "right things".

Energy21

The former Minister of Petroleum and Energy Odd Roger Enoksen in February 2007 started a process named "Energy21" by appointing a widely composed Strategy Group that should develop a broad and unifying R&D strategy for the "onshore" energy sector. The report would cover topics that are relevant to "stationary production of energy, as well as transport and end use, and cover the whole innovation chain, and would be delivered in February 2008 to form a basis for new large national research programs.

Representatives from NTNU and SINTEF were appointed to the Strategy Group, and together with Enova, we organized successful Dialogue Seminars in June and Hearing meeting in November, where around 80 researchers from NTNU and SINTEF participated actively in giving their inputs to the process. Repre-

sentatives from NTNU and SINTEF were also invited to participate in the different "Target groups" that were appointed to make plans for the selected "Target areas."

The Report, which was delivered on time (February 5, 2008) to Minster of Petroleum Aslaug Haga, proposed that Norway should team up to be the most environmentally friendly energy nation in Europe, and that research should be directed at 5 strategic target areas of large national and global importance:

- More efficient energy use
- More power from renewable energy
- CO_2-neutral heating (from bio and ambient heat-heat pumps)
- An energy system for a sustainable future
- Social preconditions and their influence on industry's investments in R&D&I

In addition we should

- Secure the knowledge fundamental for the ???
- Demonstrate technology and solutions
- Fund research infrastucture

The importance of the plan is that it gathers all the players on the national innovation team – industry, research, education and government agencies – in a total plan. Therefore Energy 21 will lead to a substantial increase in the national research budgets in 2009, which makes follow up on Energy 21 and the Climate Settlement a major strategic target for NTNU and SINTEF in 2008 and 2009.

Energy Campus North

The arctic region may be an important energy region, and how we are going to explore and provide valuable energy sources in a sustainable way will require all our skills in petroleum exploration, production, multiphase flow, integrated operations and liquefied gas technology, to mention only a few areas. The Government has put the arctic region on their agenda through the High North Initiative, and NTNU has put on it on their agenda to contribute to achieve the ambitious goals. By our contributions to the development of the Snøhvit field, we were invited by StatoilHydro some years ago to utilize the plant at Melkøya in Hammerfest as an "education facility" for our Master students.

We soon found out that if we wanted to make a real contribution to the development of energy education in Northern Norway, we had to join up and cooperate with the universities and university colleges who are active in the region. So the agreement to form a national team in energy education was born at a large seminar in Hammerfest in September 2006. A working group was formed to make plans for the creation of "EnergyCampus North" in Hammerfest.

The team consists of University of Tromsø, University of Stavanger and NTNU, together with the University Colleges of Narvik, Tromsø and Finnmark. We aim to develop an integrated education program in energy technology, consisting of Bachelor, Master, and Continuing education, as well as training programs for teachers, with the long term goal to increase the energy competence in the region.

Our plans were sent to the Ministry of Education and Research in June 2007, and at a historic meeting in Hammerfest on August 17, the Minister of Research, Øystein Djupedal, announced that the Ministry and Government welcome this initiative very much, and regarded it as an important contribution to the High North Initiative. At the same time, a grant of 3 million NOK was awarded for 2008. This grant was further supported by the County of Finnmark, which added another 500.000 NOK. An Interim Board was formed immediately with the ambitious goal of starting up activity at the EnergyCampus North in August 2008.

EnergyCamupus North is an initiative fronted by NTNU's Rectorate, because it is an important strategic initiative that will demonstrate how NTNU can make its national competence available for innovation processes in other parts of the country. The initiative is handled by the Strategic Area on behalf of NTNU's Rectorate.

Research Infrastructures

The Strategic Area has also been engaged together with SINTEF in making proposals for new research infrastructures to the National Strategy for Research Infrastructures, which has been recently developed by the Research Council. The following research infrastructures were accepted:

- The Norwegian CO_2 Capture and Storage Laboratories 175 mill NOK
- Norwegian Solar Cell Laboratory 230 mill NOK
- HYNOVA - National Hydrogen Laboratory 170 mill NOK
- LNG Laboratory for sustainable arctic gas processing 70 mill NOK
- Test Station for Offshore Renewable Energy 100 mill NOK
- Norwegian Bioenergy Laboratory 40 mill NOK

Centre for Smart, Energy-Efficient Buildings (SmartBuild)

The overall aim of the Smartbygg project was to develop new knowledge, integrated solutions, and technologies that would make it possible to meet our building-related energy needs with substantially less harmful environmental emissions, while still satisfying the whole range of end-user needs such as comfort, aesthetics, costs, operability, reliability and functionality. The knowledge, technologies, and products developed in the program should serve as a basis to strengthen education, research, economic growth, and sustainable development of Norwegian industry, community and individuals.

The main idea behind the project was that interdisciplinary cooperation was required to realise the ambitious goals mentioned above. Thus, the project participants included architects, building engineers, HVAC engineers, and social scientists. The project was organised in three main work packages:

WP 1: The users and the environment
WP 2: The building
WP 3: Energy systems

Each of these work packages consists of a number of tasks that address specific challenges. Substantial effort has been put into the coordination of the tasks and work packages, to ensure that requirements, findings, and solutions are integrated and made available for industrial innovation as well as implementation.

Professor Øyvind Aschehoug, at the Department of Architecture, History and Technology, NTNU, has been the leader of the project. Senior researcher Inger Andresen, SINTEF Building and Infrastructure has been the coordinator and assistant project leader.

Work Package 1 was led by professor Knut H. Sørensen, at Department of Interdisciplinary Studies of Culture, NTNU Work Package 2 was led by professor Anne Grete Hestnes, Department of Architecture, History and Technology, NTNU, and Work Package 3 was led by professor Vojislav Novakovic, Department of Energy and Process Engineering, NTNU.

MAIN RESULTS

The main common task of the research group has been the production of the book "Smarte energieffektive bygninger" (Tapir Akademisk forlag, 2007) and the arrangement of the conference "Fremtidens smarte energi-effective bygg" where the main results of the project were presented. The conference drew 170 participants, and the interdisciplinary target group of the project was well represented at the conference, which was attended by architects, engineers, contractors, developers, public agencies, and NGOs.

Other interdisciplinary projects have been:

- The development of user friendly CO_2 heat pumps for heating and cooling of large buildings
- The development of a smart energy-efficient facade concept
- "Nettbygger" – A consultancy service for inter-disciplinary co-operation in the planning of smart energy efficient buildings, www.nettbygger.net
- Tools for integrated design and continuous commissioning

In addition, the Smartbygg project has produced the following tangible results:

- 22 papers in international journals with referee
- 58 peer-reviewed articles
- 7 books
- 48 presentations at international conferences
- 132 reports and presentations at national conferences
- 46 articles and presentations targeted at different user groups
- 16 dissemination actions targeted at the general public
- 9 features in mass media
- 5 new methods/models/prototypes
- 2 PhD and 3 Post Docs completed, 3 more PhDs to be completed in 2008
- At least 7 different companies have adopted new technologies and knowledge developed in the Smartbygg project

.

In 2008, the platform created by Smartbygg will be used to develop a new Centre for Sustainable Buildings, which will be an important contribution to the new substantially increased research activity that will follow as a consequence of the Energy21-initiative and the Climate Settlement in the Norwegian Parliament in 2007 (see above).

Centre for Electric energy and energy systems NTNU-SINTEF

The research centre plays an active role in developing technology for production, transportation and utilisation of electric energy. The Gemini Centre unites the research activity at the Electric Power Department of NTNU and the Electric Power Technology and Energy Systems Departments at SINTEF Energy Research. During 2007 the Centre has continued research activities within the following main subject areas:

Methods for planning and operating energy supply systems

- Energy markets: trading arrangements, financial issues and the environment
- Supply reliability in non-regulated power systems
- End-users: quality and reliable power supply

Transport of electricity

- Materials and components for HVDC
- Condition monitoring, maintenance and renewal
- Over voltage calculations and insulation coordination

Generation, transforming and use of electrical energy

- Renewable sources of energy and new efficient energy systems
- Maritime systems: shipping, offshore, power supply to subsea oil and gas installations
- Installation systems and energy consumption in buildings
- Power electronic drives and control of electric motors

Important contributions have been given to several ongoing projects sponsored by industry, Research Council of Norway and EU, including:

- Trade of wind energy and Sustainable planning.
- Offshore Wind Energy
- Electrification of sub sea oil and gas production

To be able to carry out the advanced and demanding projects, SINTEF Energy has invested 7 million NOK to establish a "Sub Sea–lab", which will facilitate testing of sub sea power equipment at high temperature and

hydrostatic pressure. In additio,n the Centre has taken several new initiatives towards EU's 7th Framework Programme. Contributions to proposals were made in the following areas:

- Simulation tools for European Balancing Market (PanEL)
- Smart Energy Network: Security of Supply, SOS Europe.
- Active Houses

The strategy of the centre has been strengthened and adjusted to better fit the focus areas of Energy 21 with respect to Renewable Energy, Balanced Market and Offshore Power grid.

Centre for Renewable Energy NTNU-SINTEF-IFE (SFFE)

The Centre for Renewable Energy (SFFE) brings together and coordinates the competence at NTNU, SINTEF and Institute for Energy Technology (IFE) within renewable energy. In association with Norwegian industry, SFFE aims to contribute to strategies and knowledge for the innovation and development of new renewable energy technologies. The principal aim of this cooperation is to help improving the environment as well as creating economic values.

The centre focuses on the following activities:

- Promotion and information dissemination of renewable energy related issues, both in media and among partners.
- Initiation of new activities and projects, in order to promote the use and development of renewable energy technologies, as well as exploiting synergy effects and focus on renewable energy systems.
- Coordination of research, education, and dissemination activities.

More information: www.sffe.no

Research Areas

The SFFE-network at NTNU, SINTEF and IFE involves around 200 scientific staff and 60 PhD students. Research is being conducted with respect to a range of technologies and issues related to renewable energy:

- Solar energy – production of power (solar cell silicon) and heat
- Wind energy (onshore and offshore)
- Bioenergy
- Social, economical and political issues
- Small-scale hydropower
- Energy from the ocean (wave, tidal, salt gradients)
- Ambient heat (utilized by heat pumps), geothermal energy and energy use in buildings
- Energy system integration
- Hydrogen technology for energy storage and conversion

Some highlights from 2007

- Developed a joint R&D strategy, covering a range of renewable energy technologies. The strategy calls attention to the need for a general increase in the R&D financing within renewable energy in Norway, as well as a need to strengthen the whole value chain, from research and development to the application of the knowledge in industrial and social settings. In addition there are some areas where Norway has key expertise which may become of significant national importance if increasing the efforts within renewable energy, such as development of solar cells and offshore renewable energy.
- Involved in the national process Energi21. The purpose of Energi21 is to establish a broad yet unifying R&D strategy in the energy sector.
- Involved in uniting the efforts within deep sea offshore wind energy. This multidisciplinary effort involves a new Knowledge-building Project (KMB) initiated by SFFE, a new Strategic University Program (SUP) at NTNU, as well as a new agreement with Statkraft within ocean based renewable energy.
- Research Council Awarded three new PhD fellowships to the PhD-pool.
- PhD-candidates in the former part of the PhD-pool initiated and arranged the 1st International PhD Symposium on Offshore Renewable Energy. 38 persons from 13 different countries participated on the symposium, which lead to the establishment of the International Network of Offshore Renewable Energy (INORE) (see picture).
- A number of seminars and workshop about renewable energy have been held, nationally and internationally.
- Exhibition at Technoport 2007, where the educational programs as well as the research activities were profiled.
- Improved teaching within renewable energy. This includes the involvement in a new Masters Programme in renewable energy systems in East Africa, funded by NORAD.

The offshore wind energy research strenghten by the new cooperation agreement with Statkraft.

Gas Technology Centre NTNU-SINTEF

The Gas Technology Centre was established in 2003 and is the largest centre for gas technology research and education in Norway. The centre brings forward new knowledge and technology which will contribute to efficient, value creating and environmentally friendly utilization of natural gas.

The purpose of the Gas Technology Center NTNU-SINTEF is to increase the quality, efficiency and scope of gas technology educa-

tion, research, development and innovation in Norway. This is to be achieved by coordinating and establishing new activities in the area at NTNU and SINTEF.

Research Areas

Approximately 300 people (researchers, professors, Post Docs and PhD students) are involved in natural gas-related R&D at NTNU and SINTEF. The Centre focuses on exploring the synergism of multidisciplinary research into the natural gas value chain. The Gas Technology Centre handles technology in the entire value chain from source to end-user. Research areas include:

- CO2 capture and storage
- LNG and gas to liquids (GTL) for the world market from the Arctic region
- Offshore fields development including sub-sea technology
- Industrial gas processing and gas products
- Production, storage and use of hydrogen
- Gas engines
- Infrastructure and techno-economic optimization of gas value creation.

Some highlights from 2006-2007

- Contributed to the proposal and subsequent establishing the Centre for Research-based Innovation Integrated Operations
- A number of conferences and seminars have been organised, such as "The Remote Monitoring Conference", "The Fourth Trondheim Conference on CO2 Capture, Transport and Storage - TCCS-4", and an internal CO_2-seminar for NTNU and SINTEF.
- Involved in initiating the national research program GASSMAKS, a new program addressing downstream industrial value creation from natural gas.
- PhD-pool funded by the Norwegian Research Council operating successfully
- The Gas Technology Centre hosted the world's largest conference on Greenhouse Gas Control Technologies (GHGT-8). The conference was a huge success!
- Involved in the organization and content of the Technoport Festival 2007
- Contributed to partnership for NTNU and SINTEF in the EU-projects DYNAMIS, DECARBit, CESAR, CEASAR and ECCO. SINTEF is coordinator in two of these projects.
- Involved in two proposals for the Research Council funding mechanism Centre of Excellence, which made it to the final round.

New Research Council of Norway projects in 2005–2006

- Engineering Science for a Sustainable Future - Institutionally Based Strategic Program (ISP) from Research Council of Norway – 16 PhDs and Postdoc Fellowships within "Energy from the North" and "Renewable Energy"
- Paradoxes of design. Aesthetication as a barrier to sustainable consumption
- Preparing for a rainy day? Configuring climate science for future society
- Building markets, shaping policy? The role of economics in energy policy and energy use
- Climate knowledge on the road.
- aCOM, Cost Effective Utilization of Bioenergy - Advanced Biomass and Waste Combustion (RENERGI, SINTEF Energy Research, 2006-2008, www.energy.sintef.no/prosjekt/acom)
- Deep sea offshore wind turbine technology (RENERGI (KMB), SINTEF Energy Research, 2007-)
- EKSBO - Factor 4 Building Renovation (NFR/Norwegian State Housing Bank, various industry, SINTEF Building and Infrastructure, 2006-2009)
- Offshore renewable energy, Pilot project PhD-pool (RENERGI, 2005-)
- Technology development for integrated SOFC, biomass gasification and high temperature gas cleaning - Up-scaling and long term testing (RENERGI, NTNU, Johan E. Hustad, 2005-)
- BIG CO2: CO_2 Management Technologies for Future Power Generation.
- BIG CLC: Demonstration of Chemical Looping Technology in Natural Gas Power Generation with CO_2 Capture.
- Research program MIT-NTNU on natural gas technology (Transportation systems, Hydrogen production and CO_2 capture)
- Efficient Hydrogen Liquefaction Processes: Improving the energy efficiency for liquefaction.
- Optimal Design and Operation of Gas Processing Plants: Increase the value of natural gas by better operation and design of processing plants for natural gas
- Enabling production of Remote Gas: Address the critical technology barriers related to floating production of natural gas from smaller fields through a coordinated effort by industry and research institutions.
- Centre for Research-based Innovation (CRI) for e-field and Integrated Operations.

Centre for Better Resource Utilization NTNU-SINTEF (BRU)

Background

In September 2004 NTNU's Board of Directors included the upstream petroleum area as a member of the strategic area Energy and Petroleum – Resources and Environment. In 2004-2005, a major effort was invested in developing a new strategic plan for petroleum exploration and production at NTNU. An important element of the development has been visits to and discussions with around 50 oil and gas companies, service companies, governmental agencies, organizations, and the Norwegian Research Council. Based on these visits and on discussions at a seminar at NTNU August 2005, the final BRU Report was published on September 15, 2005. The report may be downloaded from http://www.petroleum.ntnu.no/~kleppe/BRUreport.pdf. The strategic plan identified 4 key areas for research in the years to come:

- Finding and Producing
- Drilling and Subsea Technology
- Integrated Operations in the Petroleum Industry
- Arctic Technology.

Subsequently, task forces in each area have been developing plans for activities to be started in order to enhance research ctivities.

Current major research programs in the area of exploration and production of petroleum

- ROSE - the rock-seismic program
- 4D seismic - reservoir simulation program
- Improved oil recovery program
- Seafloor separation program
- Subsea program
- New drilling methods program
- Smart Fields/Integrated Operations program

Some highlights from 2007

International academic collaboration

NTNU has a wide range of international partners in the petroleum area. Current key countries are Azerbaijan, Bangladesh, Brazil, France, Italy, Mozambique, Netherland, Russia, Spain, Ukraine and US. Close to 50% of the M.Sc. and Ph.D. students in exploration and production are non-Norwegian. In 2007, new formal agreements of collaboration were entered into with Agostinho Neto Universidade (Angola), ASOA (Aserbaijan), BUET (Bangladesh), Carnegie Mellon University, EMU (Mosambique), Kyoto University (Japan), Stanford University, and Pontifícia Universidade Católica do Rio de Janeiro (Brazil).

International Conference in Trondheim – IOO7

During October 2007, an international conference in the area of Smart Fields/Integrated Operations was arranged by the Center for Integrated Operations (SFI) in Trondheim. The theme of the conference was Science and Practice, and presentations were held by academia and industry all over the world. Around 250 persons participated in the conference. The conference will be repeated annually, wtih the next conference scheduled for October 21-22, 2008.

Graduated candidates

In 2007 around 80 MSc candidates graduated in the disciplines of petroleum engineering and petroleum geoscience. In addition 7 PhD candidates defended their research. Around one-third of the candidates are non-Norwegian. Among the Norwegian students one-third spend a one-year exchange period at a foreign university, primary in US, Canada, Brazil and Australia.

Publications

A total of 113 titles, including refereed journal publications, conference presentations, posters, etc. were reported, of which 31 were in refereed journals. In the system of the Norwegian publication points, a total of 44 points were registered, as compared to 33 in 2006, an increase of around 30%.

Industrial collaboration

A close collaboration with industry ensures relevance of education and research and provides financial support for new facilities and research. Key industrial partners during 2007 were StatoilHydro, Shell, TOTAL, DnV, BP, ConocoPhillips, ENI, Gaz de France, IBM, Aker Solutions, FMC, and Kongsberg Maritime.

Centre for Energy and Society

To manage the production and use of energy to cater for a broad spectrum of social needs and in a sustainable way, is a great challenge. This calls for new and innovative strategies related to policy, technology, economy, and everyday life. The Centre for Energy and Society has been set up to do research to support the formulation of such strategies. In particular, the challenge of global warming and the need to curb the emission of CO2 and other greenhouse gases makes the need for new approaches to energy production and consumption even greater. This means that modern societies need to assess both management of current energy sources and the diverse options that exist for the future. Such assessments have to draw on insights from the social sciences and the humanities. What concerns influence investments in new production of energy? What are the strengths and weaknesses of existing options to produce renewable energy in terms of their social, economic and cultural aspects? How may society facilitate the design of buildings that use less energy? How will the climate issues influence ways of thinking about energy?

These are questions that the Centre for Energy and Society addresses through its ongoing research. Of course, such questions have to be answered in dialogue with architects and engineers. Consequently, the centre gives priority to such dialogues with many actors and has ongoing collaboration with most of the other centres of the area. Compared to the other centres, the Centre for Energy and Society is fairly small, comprising 11 researchers (including four PhD students).

From left: Vice Minister of Petroleum, Angola, Mr. Anibal Silva, Rector of UAN, Angola, Dr. João Sebastião Teta, Professor Jon Kleppe,NTNU, Rector of NTNU, Professor Torbjørn Digernes, Executive VP for Technology and New Energy in StatoilHydro, Ms. Margareth Øvrum

Research Areas

- Energy policy and the politics of new renewable energy
- Energy and everyday life
- Energy, energy use and the design of buildings
- The cultural dynamics of new renewable energy technologies
- Visions of the Hydrogen Society
- Energy markets and energy actors
- Climate change and climate knowledge: How it is understood and how it is acted upon.

Some highlights from 2007

- Acquiring two new projects funded by the Research Council of Norway
- Publication of Mellom klima og comfort. Utfordringer for en bærekraftig energiutvikling (Tapir Academic Press), edited by two Centre researchers, Margethe Aune and Knut H. Sørensen

- 1 journal article, 14 book chapters and 15 presentations at workshops and conferences
- One new PhD graduated in 2007

Strategic Initiative "Green Innovation"

The 'Green Innovation' research combines insight into energy and environmental issues in a broad sense, with knowledge about innovation and implementation of technology. A main goal is to study how innovation processes, particularly barriers and driving forces, may help us adapt to, and mitigate, the major change in the energy picture now ahead. Research focus includes strategy- and innovation theory, economic growth and technological change, as well as system dynamics and optimisation of activities operating together in value sequences.

The 'Green Innovation' research group focuses on issues of change in energy use in buildings and not least on development of industry in the area of offshore wind energy and its use in production of solar silicon.

Results in 2007

- A new project "Offshore Wind Energy in Norway: Setting the Basis" was funded by the Research Council of Norway.
- A practical network at NTNU towards offshore wind energy and industrial development. The work has helped increase awareness to the emerging energy crisis and to the great future industrial opportunities where offshore wind replaces dwindling oil and gas.
- Opening speech on industrial development and value creation in the era of energy change at a conference on energy and climate.
- Presentation of future strategies in Parliament and for the Ministers of the Finance and Oil & Energy.
- Interviews and systematic communication in national media e.g. Dagbladet, Klassekampen, Ukeavisen Ledelse, and in NRK TV and TV Norge.
- Strategic cooperation with the Norwegian Institute of Strategic Studies (NORISS).

ENGAS Research Infrastructure

NTNU and its technology transfer partner SINTEF have jointly developed an 8,000 square metre, 38 million Euro research facility, the ENGAS Research Infrastructure, where the energy family work to find ways to clean up CO2, NOx, SOx and other greenhouse gases, as well as investigating the removal of these gases from the oil and gas production processes and their use in industry, buildings and transport.

The Research Infrastructure offers foreign researchers access to an integrated complex of 14 unique laboratories for focused and trans-boundary research within the field of environmental gas management. These laboratories are designed to solve problems related to reducing emissions from the entire technology chain from energy source to end-user. The laboratories have been successfully used in developing new innovative technology and solutions, together with global industrial partners (http://www.ntnu.no/engas/).

International Cooperation

The strategic area, on behalf of NTNU, puts much emphasis on international cooperation, giving priority to regions and countries where Team Norway wants to develop strategic industrial cooperation: the European Union (EU), Asia (Japan and China) and North America. The activity in 2007 has been significant in all these regions.

EU

By systematic strategic team-work NTNU and SINTEF have been able to establish ourselves successfully on the European research area during the development of the 6th framework program (6 fwp). Thus, we are already involved in a substantial amount of projects (see list) within Energy and Society, Energy in Buildings, Renewable energy, Hydrogen and Fuel Cells, and Zero Emission Fossil Fuel Power Plants. The projects have a total NTNU-SINTEF-budget of 14 million Euros. In 2006 and 2007 our attention turned to preparations for the 7th framework program. These preparations are today handled within the different Centres, because they are connected to the invaluable networks which were developed in the 6 fwp. The largest achievement in 2007 was that the large DeCarbIt-project was awarded with SINTEF as coordinator and NTNU as major partner.

In addition to the framework programme projects, the Strategic Area has been involved in strategic activities related to European Institute of Technology (EIT) and Europeand Strategic Forum for Research Infrastrucutures (ESFRI).

To prepare for the development of the Knowledge Innovation Communities (KIC) that will be the main building elements of the future European Institute of Technology, the Commission has initiated three pilot projects to initiate plans for successful development of KICs where the main strategy is to strengthen the knowledge innovation triangle between academia, research institutes and industry. NTNU and SINTEF were invited to participate as partners in a group brought together by TU Karlsruhe. We participated in the preparation meeting in Karlsruhe on June 28 and contributed actively in proposing an application to the "Pilot projects for cooperation between European Institutes of Technology". The application SUCCESS (Searching Unprecedented Cooperations on Climate and Energy to ensure Sustainability) was successfully awarded to act as the pilot project for the energy sector, and SUCCESS will be carried out in 2008 and 2009. This will most certainly give us invaluable contacts and experience that will be important for our preparations towards EIT within Energy.

The other initiative was taken by the Research Council of Norway, inviting NTNU to head a project to develop a national proposal on an energy related Research Infrastructure that may be a part of the Road Map of ESFRI. In the first Road Map issued in 2006, ESFRI particularly addressed the demand for energy research infrastructures outside the nuclear area. So NTNU and SINTEF in cooperation with other research institutes and industrial partners have proposed an initiative "The European Carbon dioxide Capture and StoragE Laboratory infrastructure – (ECCSEL)" which has been through a thorough screening by the Research Council of Norway and the Ministry of Education and Research and forwarded to ESFRI in November. A decision will be made during 2008 whether ECCSEL will be a part of RSFRI in future.

Japan

Supported by the Research Council of Norway

(RCN) and Innovation Norway (IN) in Tokyo, the cooperation through the strategic network Kyoto International Forum for Environment and Energy (KIFEE) has been further developed in 2007. Through the network, NTNU and SINTEF participate in delegations and workshops organised by Innovation Norway, and also receive important visitors from Japanese research and industry.

As mentioned in 2006 NTNU and SINTEF have signed MoUs to develop research cooperation with the prestigious Japanese research institute National Institute of Advanced Industrial Science and Technology (AIST). As a part of this, a successful "AIST-Norway NanoTechnology Symposium" was organised at Senri Life Center in Osaka on December 3, prior to the KIFEE Seminar.

The biggest event and "family reunion" in 2007 was the successful KIFEE Seminar, organised in Otsu near Kyoto, at the beach of Lake Biwa, from December 4 to 7. More than 180 people participated, including a Norwegian delegation of 40 from NTNU, SINTEF and industrial companies. This was made possible by the BILAT projects awarded by the Research Council. More than 70 presentations were given at strategic plenary sessions and parallel workshops organised to present research and plan cooperation within the areas which have been selected.

It is an important strategy of these seminars that young researchers and PhD-students should participate. In this way research stays are organised in a very flexible way. The main event at the Banquet at this Seminar was all the young researchers telling about what they will accomplish because of KIFEE.

So KIFEE, the brainchild of professor Ito, is developing into a most successful market place for Japan–Norway cooperation on environment and energy. That is why we are very happy that the University of Oslo has joined the team. Further the group has decided to include education on energy and environment in the future, so we now have workshop sessions on:

- Process Engineering
- Advanced Biological Materials
- Advanced Inorganic Materials
- Electrolysis Systems
- Education on Energy and Environment

In addition we have agreed to try to organise the next KIFEE-seminar, which will be hosted in Norway in 2009, so that workshops concerning AIST-NTNU-SINTEF cooperation may be integrated.

China

By the systematic strategic work started up in 2004 and followed up in 2005 and 2006, the following strategies have been developed concerning selected universities and areas for long-term cooperation.

Xi´an University of Architecture and Technology

- Sustainable Rural Development Tsinghua University, Beijing
- Energy Conservation in Buildings; ydrogen/Fuel Cells; Renewable Energy (wind, solar, bio); CO2 management; Shanghai Jiao Tong University (SJTU)
- Gas Technology (LNG, Gas Engines, CO2 as working fluid); Renewable Energy Chongqing University
- Gas technology

Tsinghua University

The cooperation within Energy in Buildings has developed well. Financed by BILAT several visits to Tsinghua have been carried out, involving both SmartBuild and Centre for Energy and Society researchers. Presentations from NTNU and SINTEF were included at Energy Seminars during the State visit to Beijing in March 25-26.

Shanghai Jiao Tong University

Financed by BILAT NTNU and SJTU organised a large Seminar on Utilization of Natural Gas in Shanghai, March 27-28. The

The Minister of Industry and Trade, Dag Terje Andersen.

official part of the Seminar was opened by the Minister of Industry and Trade, Dag Terje Andersen and was attended by a Norwegian delegation from Innovation Norway and 100 students from NTNU and SJTU. A delegation of 14 participants from Research Council of Norway, Statoil, Elkem and NTNU-SINTEF participated in the more detailed workshops. All together 23 presentations were given at the 2-day seminar. The successful Seminar was summed up with a face-to-face meeting between SJTU, NTNU-SINTEF and Statoil, where the most promising specific areas of research were identified. Based on this a Strategy document for the development of the cooperation has been set up, giving priority to

1. LNG technology (including small scale production and distribution)
2. Distributed energy systems - CCHP
3. Carbon dioxide capture and storage (CCS)
4. Carbon dioxide as working fluid
5. System analysis and optimisation => Regional energy planning

From right: Professor Wang Ruzhu, SJTU, Vice President Chen Gang, SJTU, Vice President Siv Aasland, StatoilHydro, President Sverre Aam, SINTEF, Strategic Advisor Per-Erling Frivik, NTNU-SINTEF, Professor Lin Wensheng, SJTU, CEO Tom Preststulen, Elkem, Professor Arne Bredesen, NTNU

It should also be mentioned that the management of Statoil, headed by Margareth Øvrum and Morten Loktu visited China on April 23 to 27, and NTNU was also invited to participate. The delegation enjoyed successful visits to both Tsinghua University (Institute of New Energy Technology – INET) and Shanghai Jiao Ting University. NTNU's cooperation with these universities will be a part of Statoil´s strategic activity in China.

Invited by RCN NTNU also participated in the Co-Reach conference in London June 4-5, where development of research cooperation between EU and China is the main target.

USA

In May 2004 USA and Norway signed a Memorandum of Understanding (MoU) on research cooperation within the energy sector, with special emphasis on CO2 management, hydrogen, and new energy technology. NTNU has worked to take an active part in this cooperation by developing strategic cooperation with MIT and University of Maryland.

Since 2002 NTNU has worked successfully to develop strategic cooperation with MIT and their Laboratory of Energy and the Environment. In 2004 we started the energy system project TRANSES (Alternatives for the Transition to Sustainable Energy Systems in Northern Europe), which involves Hydro, Statoil, Shell, Statsbygg, Enova, Statkraft and Statnett as sponsors. MIT, Chalmers, NTNU and SINTEF are research partners. The TRANSES project was finalized in 2006 with a successful Seminar.

In 2005 and 2006 we developed further the MIT-NTNU cooperation, based on a model of paired professors developed by our strategic advisors, Rolf Marstrander and Per-Erling Frivik. In the paired professor model, two professors and two PhD-students from MIT and NTNU work together on a common project. After a successful preparation process we were able to officially start up the "MIT-NTNU Gas Technology Program" with a signing ceremony at the Research Council of Norway in August 2006.

The 18 million NOK program consist of three fundamental projects related to "gas transport systems", "CO2 capture", and "hydrogen production", and is financed by StatoilHydro and RCN. This way of cooperation has attracted large interest and attention, and it will be used as model in development of NTNU´s international cooperation.

The Program organised a successful Seminar at MIT, February 28, 2008, and it was then decided by Statoil and Hydro to develop it further into a full program of 6 pairs.

The cooperation with University of Maryland (UMCP) made good progress in 2006 financed by a BILAT-project from RCN, and a Seminar on Energy and Environment was organised at NTNU in November 2006 with 27 participants from UMCP, Joint Global Change Research Institute (JGCRI), University of Oslo, IFE, SINTEF and NTNU. The following areas were selected for the development of the cooperation.

- Hydrogen/Fuel cells
- Combined Cooling Heating & Power
- Reliability and Safety
- Energy System Analysis (TRANSES)

Within "Hydrogen/Fuel Cell" an application was submitted to RCN in 2006 and was awarded. Financing has now been achieved also on US side, so that specific research cooperation has now been started up within this area.

Within "Energy System Analysis" a proposal for a new project LinkS was submitted to RCN in June 2007. LinkS will involve UMCP, JGRI, University of Oslo (ProSus), SINTEF and NTNU, and will be a follow up of TRANSES. The application starts with the following statement: "In a time when climate change mitigation is at the forefront of political initiatives, the KMB project LinkS is proposed as a joint project in the area between world-leading global top-down climate related research and bottom-up regional energy system studies in Europe." We therefore regard this as a unique project and will work hard to get it financed.

The Petroleum family has a well established cooperation with major partners in US, Holland and Brazil, and also with developing oil producing countries, such as Iran and India. In 2006 new education cooperation projects have been started up in Venezuela, Angola, Bangladesh and Mosambique, supported by NORAD.

What are the added values of the Strategic Area arrangement?

- One of the largest assets of NTNU is that we handle a wide range of disciplines both in technology, society and humanities. The Strategic Area is a tool to utilize this wide range of disciplines to be more useful to society
- The Strategic Area brings excellent research groups from different disciplines together in goal-oriented team work to solve complicated problems that are of great importance to society. These complicated problems can only be solved by multidisciplinary team work, and we have the resources needed "in-house".
- By planning and carrying out things together successfully, we create better communication between disciplines. Walls between disciplines are melting away, and new multidisciplinary arenas emerge. Since multidisciplinary research is necessary to serve the future needs of the industry and society, this attracts new partners and opens up paths into commercialization of research results.
- By working on larger problem areas as one team with a common strategy, we may also improve our visibility and impact, both nationally and internationally.
- We may develop a strategic cooperation with the Research Council of Norway, achieving responsibility for development of larger projects and programs (it is easier to receive a readily made project package, than trying to put it together yourself from individual pieces).
- We may also obtain better results in the European Research Area and strategic international cooperation.
- All this increases the opportunity for external funding of research projects, which has already been excellently demonstrated.

Above all it is a large asset that a Strategic Area acts "on behalf of NTNU", and that our Rector is available and directly behind us.

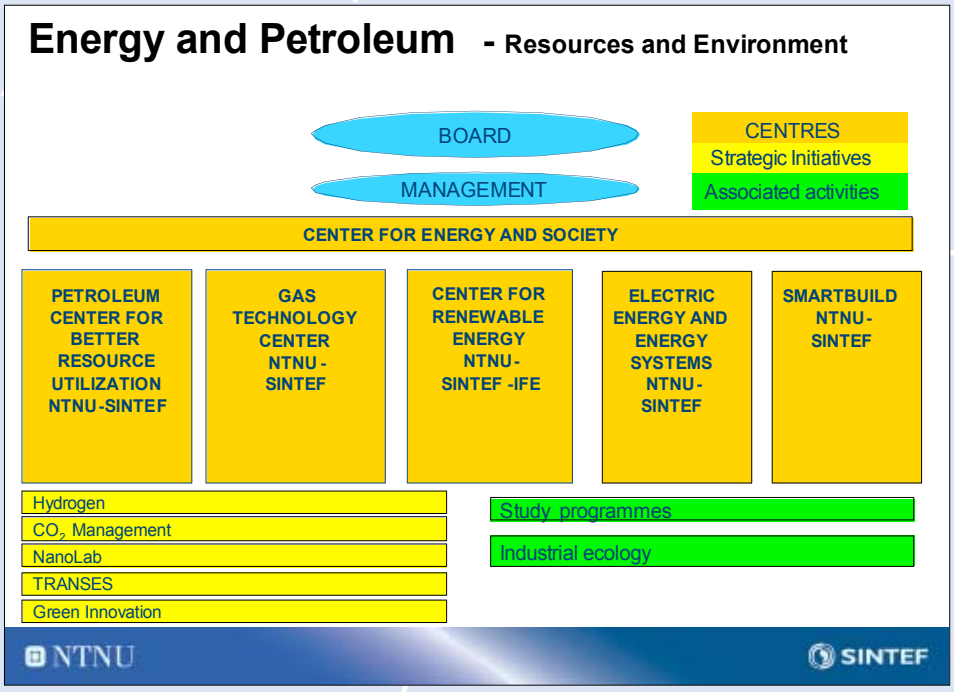
Management 2007

- Centre for Smart, Energy-Efficient Buildings: Professor Øyvind Aschehoug
- Centre for Renewable Energy NTNU-SINTEF: Professor Johan E. Hustad
- Gas Technology Centre, NTNU-SINTEF: Professor Bjarne Foss
- Centre for Better Resource Utilization (BRU): Professor Jon Kleppe
- Centre for Electrical Energy and Energy Systems: Professor Erling Ildstad
- Centre for Energy and Society: Professor Knut H. Sørensen

- Strategic Initiative "Green Innovation": Dr. Harald Gether
- Strategic Initiative "Hydrogen technology": Professor Hilde Venvik
- Strategic Initiative "TRANSES": Dr. Bjørn Bakken
- Study programme Energy & Environment: Professor Ivar Wangensteen
- Research Infrastructures: Laboratory Director Morten Grønli

Strategic Advisors:
- Rolf Marstrander
- Per-Erling Frivik

- Leader: Professor Arne M. Bredesen (arne.m.bredesen@ntnu.no)
- Co-ordinator: Dr. Harald Gether (harald.gether@ntnu.no)
- Secretariat: Anita Yttersian (anita.yttersian@ntnu.no)



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NTNU

NTNU

The Norwegian University of Science and Technology (NTNU) in Trondheim represents academic eminence in technology and the natural sciences as well as in other academic disciplines ranging from the social sciences, the arts, medicine, architecture and the fine arts. Cross-disciplinary cooperation results in ideas no one else has thought of, and creative solutions that change our daily lives.

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