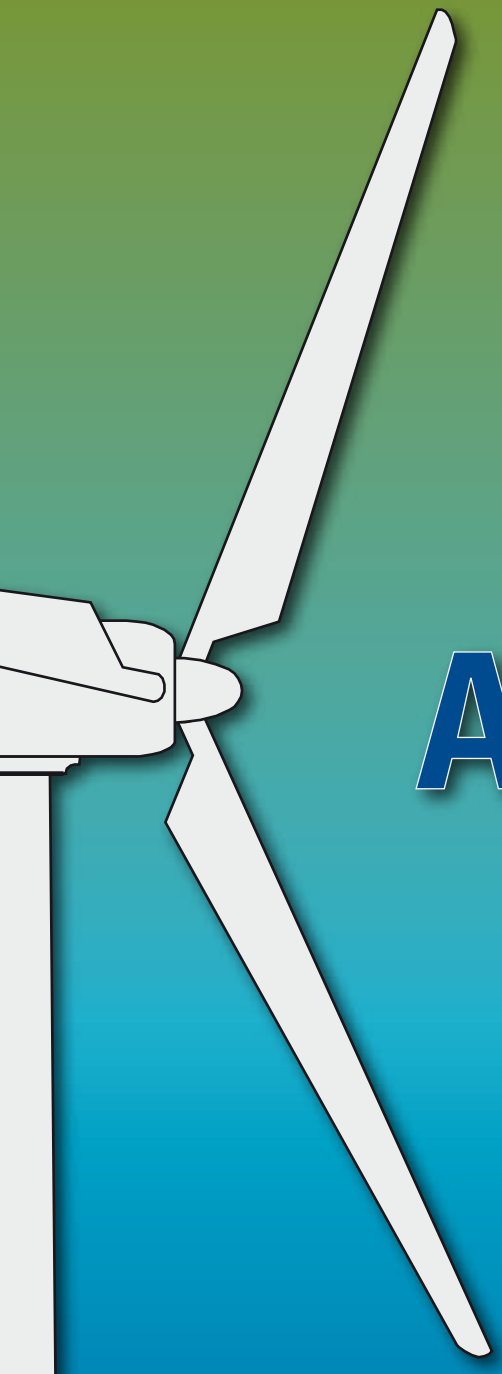

Annual report 2009

NOWITECH

Norwegian Research Centre for Offshore Wind Technology

www.NOWITECH.no

NOWITECH Annual Report 2009

March 2010

Editorial: Nils Arild Ringheim and John Olav Tande

Contribution from the following members of the Centre Management Group:
Roy Stenbro, Bård Wathne Tveiten, Torgeir Moan,
Kjetil Uhlen, Jørn Heggset, Petter Andreas Berthelsen,
Geir Moe, Jan Onarheim and Per Finden.

SUMMARY

NOWITECH's vision is to
- Contribute to large scale deployment of deep sea offshore wind turbines
- Become an internationally leading research community on offshore wind technology enabling industry partners to be in the forefront

The objective is to provide pre-competitive research laying a foundation for industrial value creation and cost-effective offshore wind farms. Emphasis is on "deep-sea" (+30 m) including bottom-fixed and floating wind turbines.

The work packages are:
- WP 1: Development of integrated numerical design tools for novel offshore wind energy concepts.
- WP 2: Investigation of new energy conversion systems for offshore wind turbines.
- WP 3: Identification and assessment of novel substructures (bottom-fixed and floaters) for offshore wind turbines.
- WP 4: Assessment of grid connection and system integration of large offshore wind farms.
- WP 5: Development of operation and maintenance (O&M) strategies and technologies.
- WP 6: Assessment of novel concepts for offshore wind turbines by numerical tools and physical experiments, hereunder developing control systems and combining results from WP2 and WP3.

The main activities in 2009 were:
- Establishing the centre with consortium agreement, work packages, committees and PhD program
- Carry out state of the art reports on main issues in the work packages
- Participating in national and international activities in order to influence future offshore wind research strategies, establish and maintain international R&D networks, and become a partner in new R&D projects on offshore wind
- Collaboration with NORCOWE and CEDREN, hereunder two joint applications on research infrastructure
- Planning of Wind Energy R&D seminar in Trondheim jointly with NORCOWE

The Consortium has a General Assembly (GA), a Board, a Centre Director, a Scientific Committee (SC), a Committee for Innovation and Commercialisation (CIC) and a Centre Management Group (CMG). The CMG consists of the Centre Director, Centre Manager, two Vice Directors, all WP leaders and representatives from the SC and CIC.

All consortium partners are members of the GA. The Board has 11 members, whereof 8 are from the industry, one from SINTEF, one from NTNU and one from IFE. The SC is responsible for developing a top quality PhD and post doc programme in collaboration with CMG. The CIC shall ensure industry relevance in NOWITECH's research and contribute to commercialisation of positive ideas created in the centre.

Participation from industry partners in centre activities is mainly carried out through the reference group of each work package, industry in-kind contribution and CIC attendance. In addition, participation takes place as GA and Board activities.

Twelve PhD scholarships and two Post Doc scholarships were granted in 2009. Of these, seven PhD students and one Post Doc started in 2009, whereas the other five PhD candidates and one Post Doc are appointed and will start in 2010.

The accumulated costs in 2009 was NOK 20,9 million.

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1 VISION AND OBJECTIVE

VISION

- Contribute to large scale deployment of deep sea offshore wind turbines
- Become an internationally leading research community on offshore wind technology enabling industry partners to be in the forefront.

OBJECTIVE

Provide pre-competitive research laying a foundation for industrial value creation and cost-effective offshore wind farms. Emphasis is on “deep-sea” (+30 m) including bottom-fixed and floating wind turbines.

2 RESEARCH PLAN AND STRATEGY

2.1 CHALLENGE AND POTENTIAL

The EU 2020 target implies a massive installation of offshore wind. A ballpark estimate is investments of NOK 750 billions for installation of offshore wind farms in European seas during the next 10 years. Only about 2 GW of offshore wind farms have so far been installed in Europe, and with the exceptions of HyWind, Alpha Ventus and Beatrice, all relatively close to shore using what can be called on-shore wind technology. See also Figure 1.

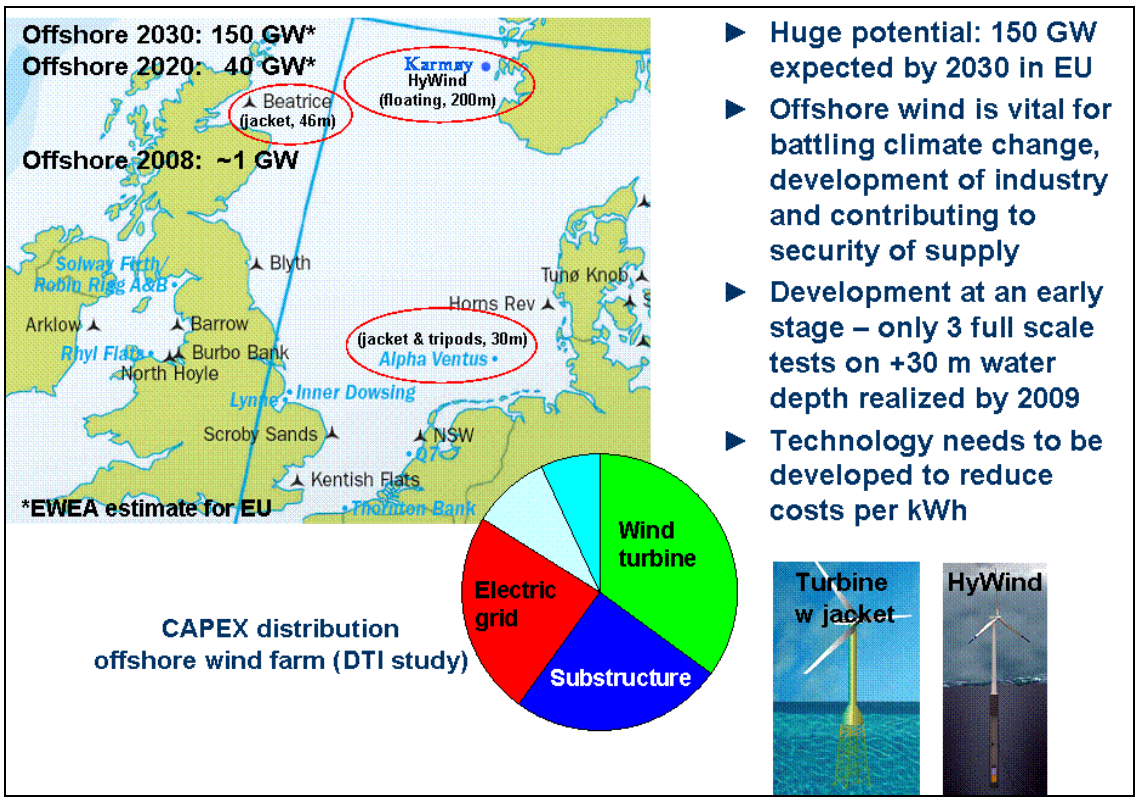


Figure 1 Strong motivation for research efforts on offshore wind technology.

The potential for wind farms at deeper water is huge provided that costs can be reduced to a competitive level. This requires development of offshore technology, and within this field Norwegian industry and research units are in the forefront. Examples are jacket design by Owec Tower for the Beatrice wind farm, manufacturing of tripods by Aker Solutions, and the floating concepts HyWind, SWAY and WindSea (see Figure 2). Considerable research efforts are needed to support this development.

Deep-sea offshore wind farms are expected to be large, e.g. Dogger Bank is planned for 9 GW and located 125 to 195 km from shore. The environmental conditions here differ considerably from standard onshore conditions and new different design specifications have to be taken into account. This gives a basis for development of novel wind turbine concepts optimized for operation at rough off-shore conditions. The distant offshore location and size of installations further calls for development of new systems for maintenance, grid connection and system integration.

Figure 2 Floating concepts, from left: HyWind, SWAY and WindSea.

2.2 NOWITECH'S APPROACH

The Centre comprises interdisciplinary tasks that are required for successful development of offshore wind farms. Emphasis is on "deep-sea" (+30 m) including bottom-fixed turbines and floaters. The Centre will

- Combine wind technology know-how with offshore and energy industry experience to enhance development of offshore wind.
- Establish a recruitment and educational programme that provides for highly qualified staff at Master and PhD level for serving the industry.
- Build strong relations with selected top international research partners.
- Facilitate active involvement by industry partners to ensure relevance and efficient communication and utilization of results.
- Support to industry is through pre-competitive research – commercial development will come as a result and be run in separate projects.
- Actively pursue opportunities to increase R&D activity on critical issues.

The research is carried out in six work packages (WPs):

- WP 1: Development of integrated numerical design tools for novel offshore wind energy concepts. The goal is establishment of a set of proven tools for integrated design of deep-sea wind turbines, hereunder characterization and interaction of wind, wave and current.
- WP 2: Investigation of new energy conversion systems for offshore wind turbines. The goal is to contribute to the development of efficient, low weight and robust blade and generator technology for offshore wind turbines.
- WP 3: Identification and assessment of novel substructures (bottom-fixed and floaters) for offshore wind turbines. The goal is to pin-point cost-effective solutions for deep-sea wind turbines.
- WP 4: Assessment of grid connection and system integration of large offshore wind farms. The goal is to develop technical and market based solutions for cost-effective grid connection and system integration of offshore wind farms.
- WP 5: Development of operation and maintenance (O&M) strategies and technologies. The goal is to develop a scientific foundation for implementation of cost-effective O&M strategies and technologies for offshore wind farms.
- WP 6: Assessment of novel concepts for offshore wind turbines by numerical tools and physical experiments, hereunder developing control systems and combining results from WP2 and WP3. Assessment is by numerical tools (WP1) and by utilizing "in-house" labs and results from full scale field tests (e.g. HyWind).

The WPs are closely interlinked (Figure 3) with a joint aim to provide new knowledge, tools and technologies as basis for industrial development of cost-effective offshore wind farms at deep sea. The research is mainly of pre-competitive nature including a strong PhD and post doc programme. Dissemination of results are through international conference papers, continuation and development of the established yearly wind R&D seminar in Trondheim, work-shops for industry and public bodies, newsletters and web.

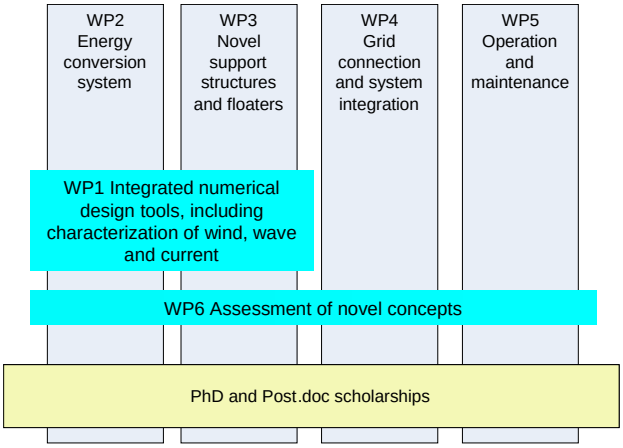


Figure 3 Interplay between work packages

Work is carried out in coordination with the two other CEERs on offshore wind, CEDREN and NORCOWE. Together, the three centres contribute to a strong research effort on offshore wind, see Figure 4. There is, however, still need for further increase in the research efforts. NOWITECH will in coordination with CEDREN and NORCOWE continuously seek opportunities to establish new research projects, research infrastructure as well as test and demonstration projects.

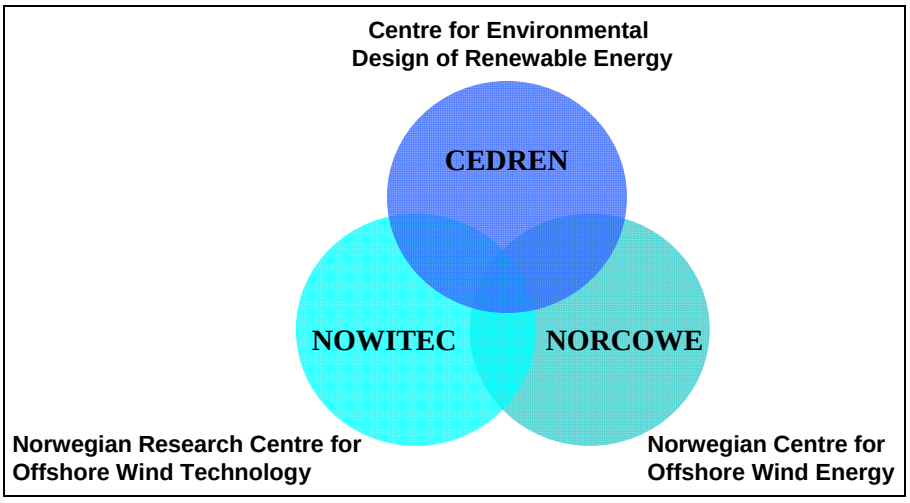


Figure 4 The three CEERs constitute a strong cluster on offshore wind.

3 ORGANISATION

3.1 GOVERNANCE STRUCTURE

NOWITECH is organised as shown in Figure 5.

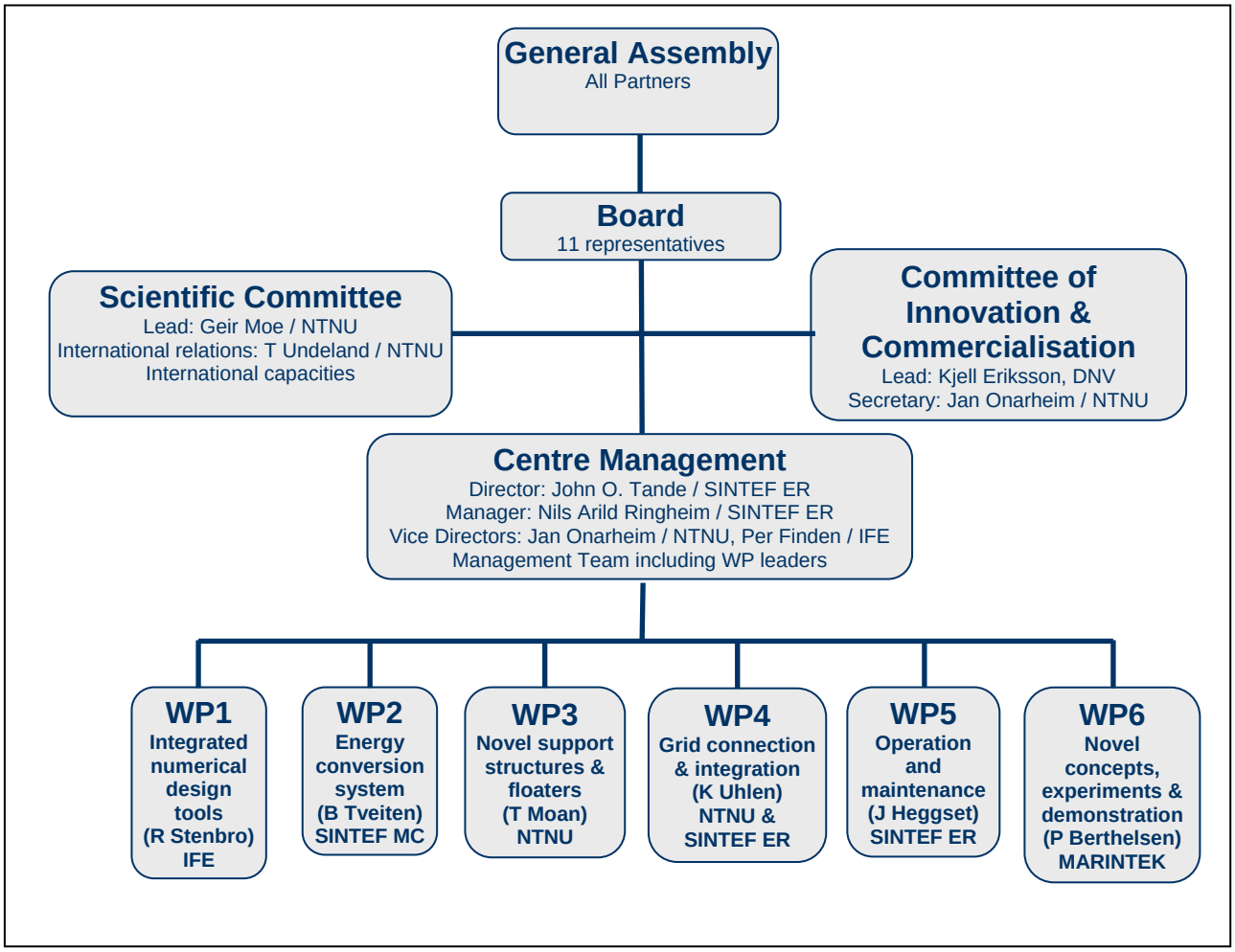


Figure 5 Outline of governance structure for the NOWITECH Consortium.

The General Assembly is the ultimate decision making body of the Consortium where all partners are represented.

The Board is the operative decision-making body for the execution of the Consortium with 11 members: 8 from industry, one from SINTEF, one from NTNU and one from IFE.

Industry partners are involved through representation in General Assembly and Board and through direct involvement in the Work Packages and their reference groups.

SINTEF Energi has appointed John Olav Tande as the Centre Director.

NOWITECH is managed by the Centre Director in close cooperation with the Centre Management Group (CMG). The CMG consists of the Centre Director, Centre Manager, two Vice Directors, the Work Package leaders, representatives from the Scientific Committee and Committee for Innovation and Commercialisation and other staff appointed by the Centre Director. The CMG meets on a regular basis, for the time being every second week.

3.2 SCIENTIFIC COMMITTEE

The Scientific Committee (SC) is the responsible for developing a top quality PhD and post doc programme in collaboration with CMG. This includes an active recruitment strategy, invitation of international capacities for giving lectures, arrangements of scientific colloquia and seminars, and exposing scholars to industry and leading international research groups. The members of the SC are listed below:

- NTNU-members
  - Geir Moe, (chairman)
  - Tore Undeland, NTNU (international relations)
  - O.G. Dahlhaug, NTNU
  - Trond Kvamsdal, NTNU
  - Torgeir Moan, NTNNU
  - Jan Onarheim, NTNU
  - SC Secretary, Debbie Koreman, NTNU

- Other Norwegian members
  - Tor Anders Nygaard, IFE
  - Ivar Langen, UiS
  - Finn Gunnar Nielsen, Statoil
  - Terje Gjengedal, Statnett

- Associated members
  - Paul Sclavounos, MIT, USA
  - Walt Musial, NREL, USA
  - Peter Hauge Madsen, Risø-DTU, Denmark
  - Hans-Gerd Busmann, Fraunhofer IWES, Germany
  - Olimpo Anaya-Lara, Strathclyde University, UK

3.3 COMMITTEE FOR INNOVATION AND COMMERCIALISATION

The Committee for Innovation and Commercialisation (CIC) shall ensure relevance for industry in NOWITECH's research and contribute to commercialisation of positive ideas created in NOWITECH. The members of the CIC are listed below:

Chairman:	Kjell Eriksson, DNV
Secretary:	Jan Onarheim, NTNU
Other participants:	Kristian Holm, ScanWind/GE; Bergny Irene Dahl, Innovasjon Norge; Erik Wold, TTO/NTNU (representing SINVENT and Campus Kjeller); Jørn Holm, Dong Energy; Kristin Aamodt, Statoil; Kurt Benonisen, NTE; Lars Øystein Widding, NTNU Entrepreneurship Centre; Inger Marie Malvik, Fugro OCEANOR; Mette Rostad, Aker Solutions; Morten Bygland, Navitas Network; Tor Arne Hafstad, NFR; Kjell Olav Skjølsvik, ENOVA; Anne Worsøe, Statkraft; Jan Pedersen, Dong Energy

3.4 NOWITECH PARTNERS

The NOWITECH Consortium Partners per March 2010 are listed below:

The Host Institution:	SINTEF Energy Research
Research Partners:	Norwegian University of Science and Technology (NTNU) Institute for Energy Technology (IFE) Norwegian Marine Technology Research Institute (Marintek) Stiftelsen SINTEF (SINTEF)
Industry partners:	Aker Solutions Devold AMT AS Det Norske Veritas AS (DNV) DONG Energy Power AS EDF R&D Division (new partner in 2010) Fugro OCEANOR AS GE Wind Power (Norway) AS (new partner in 2010) Lyse Produksjon AS NTE Holding AS SmartMotor AS Statkraft Development AS Statnett SF Statoil Petroleum AS TrønderEnergi Kraft AS Vestas Wind Systems AS Vestavind Kraft AS

In addition NOWITECH has agreements on cooperation with the following associate partners:

Associate research partners:	Massachusetts Institute of Technology (MIT), USA National Renewable Energy Laboratory (NREL), USA Risø-DTU, Denmark Fraunhofer IWES, Germany University of Strathclyde, UK
Associate industry partners:	Innovation Norway Enova NORWEA NVE Energy Norway Navitas Network

4 SCIENTIFIC WORK AND RESULTS

This section presents the objectives and tasks of the existing work packages (WP) in NOWITECH as well as the results achieved in 2009.

4.1 MANAGEMENT (WP 0)

The objective is to manage and coordinate NOWITECH, ensuring progress and cost control according to approved plans.

The Work Package is divided into three tasks:
0.1 Start-up of centre
0.2 Day-to-day operation of centre
0.3 Outreach activities

The management carries out the everyday management as well as the long term management activities, including coordination towards other projects and FME's, dissemination of results and organisation of the Scientific Committee and Committee of Innovation and Commercialization.

Two committees are established in 2009: The Scientific Committee (SC) and Committee for Innovation and Commercialisation (CIC). The SC is responsible for developing a top quality PhD and post doc programme in collaboration with the Centre Management and the WP leaders. Geir Moe, NTNU, is the Chairman of SC. The CIC's main objective is to ensure relevance for industry in NOWITECH research and contribute to commercialisation of ideas created in NOWITECH. The Chairman position is held by Kjell Eriksson, DNV.

Close cooperation with CEDREN and NORCOWE is established. This has resulted in two joint applications to the Research Council on infrastructure:
1) EFOWI in collaboration with NORCOWE (17 Mkr). Status: Approved.
2) NOWERI together with CEDREN and NORCOWE (82 Mkr). Status: Passed to the second round.

In addition, emphasize was placed on a Norwegian offshore test and demonstration program on offshore wind. Strategic planning was started as regards national partners, relevant sites, possible connection to EU infrastructure applications etc. This 2009 work was an early start of NOWITECH's involvement in the common approach to define a national plan for an offshore wind demonstration program by Arena NOW, Arena Vindenergi, NORCOWE and NOWITECH (Demo 2020).

The Centre Director has taken part in the task force "Vind" in Energi21, outlining future research strategy for on and offshore wind. Furthermore, participation in relevant international activities has been emphasised, as described in section 5.3.

Several spin-off projects have arisen from the NOWITECH consortium. Two examples of projects co-funded by the Norwegian Research Council are: Fugro OCEANOR's BIP project on metocean measurements and SINTEF Energy Research's KMB project on role of North Sea power transmission on realising the 2020 renewable energy targets. In addition, several international projects have been initiated, see chapter 4.9.

A project e-room is available to all NOWITECH partners, where all internal information and project results are presented. NOWITECH's web site has been in operation since the start of the centre (www.nowitech.no).

4.2 INTEGRATED NUMERICAL DESIGN TOOLS (WP 1)

The objective is establishment of a set of proven tools for integrated design of deep-sea wind turbines, hereunder characterization and interaction of wind, wave and current.

The WP is divided into two tasks.
1.1 Code development
1.2 Wind, wave and ocean current

WP1 will develop software that accurately simulates the behavior of wind turbines. Such tools are vital to those doing research, development and engineering of whole wind turbines and its components. Tools for optimization of components and systems will also be developed. A research activity will be carried out on the interaction of waves, current and wind, which is the origin of motion, loads and power output of an offshore wind turbine.

In 2009 the WP has emphasised state of the art activity on computational tools for integrated simulations of floating wind turbines as well as CFD analysis for wind turbine rotors. Since the WP is closely related to NORCOWE activities, a close cooperation is established. This is especially relevant for the common infrastructure applications submitted to the Research Council, whereof one is approved (17,5 Mkr) and the other submitted to the second round (82 Mkr).

A PhD has started in 2009, see appendix A.1.4, while additional three PhD positions will be advertised in April 2010.

Fugro Oceanor participates directly in task 1.2 activities through their annual in-kind contribution. Other industry involvement is shown in 4.8.

4.3 ENERGY CONVERSION SYSTEM (WP 2)

The objective is to contribute to the development of efficient, low weight and robust blade and generator technology for offshore wind turbines.

WP2 is split into two tasks:
2.1 Rotor blades
2.2 Generators

The energy conversion system of the offshore wind turbines being installed today are basically as for onshore wind turbines. The expectation is that significant life-cycle cost reductions can be achieved by developing an energy conversion system specifically for offshore conditions. The research activities given in WP2 are defined in order to “bridge” the competence gaps and to create a basis for innovation necessary to move beyond the today’s “show stoppers” that the industry is facing. Emphasis in WP2 is on the rotor blades (Task 2.1) and generators (Task 2.2), searching for lightweight and robust solutions.

A paper on wind turbine coatings has been accomplished in 2009. Two state of the art studies on respectively smart blades and generators constitute the main activities of 2009 and two accompanying reports will be accomplished in first part of 2010.

One Post Doc has started in 2009, see appendix A.1.4. One PhD started in January 2010. During April 2010 additional two PhD positions will be advertised.

Two of the industry partners spent their whole annual in-kind contribution in WP2 (Devold AMT task 2.1 and SmartMotor task 2.2), while Aker Solutions participated with part of their in-kind contribution in task 2.2. Other industry involvement is shown in 4.8.

4.4 NOVEL SUPPORT STRUCTURES AND FLOATERS (WP 3)

The objective is to develop novel, cost-effective support structures and floaters for deep-sea wind turbines.

Three tasks are defined:
3.1 Bottom-fixed support structures
3.2 Floating support structures

3.3 New coatings

WP3 deals with the analysis and design of bottom-supported and floating support structures for wind turbines. The purpose is in particular to assess design criteria, establish benchmark analysis procedures for evaluating the structural effects of wave, current and wind loads on wind turbines as well as to assess the feasibility of existing coatings for use in the offshore wind turbine support structures. This research will be based on experiences gained in other marine industries, especially the oil and gas industry in combination with land-based wind turbine technology to generate the unique information needed when the wind turbine industry moves offshore.

The work in 2009 included a state of the art report on coatings for corrosion protection, erosion protection and anti-icing/anti-soiling properties in draft form. Initial work on assessing analysis tools applicable for floating and fixed offshore structures supporting wind turbines has started. Several new projects on coating were proposed: An initiative on "Design and testing of large wind turbine blades" within the “Renergi” framework was successful. In addition, NTNU partners on WP3 tasks 3.1 and 3.2 are involved in an EC FP7 project: The Marina Platform, which was accepted in 2009. The purpose of this project is to investigate the synergy between wind and wave energy. They are also involved in other ongoing EC initiatives, like HiPRwind.

Two PhD students were engaged in 2009, see appendix A.1.4. Within April 2010 two additional PhD positions belonging to task 2 will be advertised.

Industry involvement is shown in 4.8.

4.5 GRID CONNECTION AND SYTEM INTEGRATION (WP 4)

The objective is to develop technical and market based solutions for cost effective grid connection and system integration of offshore wind farms.

The work is divided into three tasks:
4.1 Internal electrical infrastructure for offshore wind farms
4.2 Grid connection and control
4.3 Market integration and system operation

Offshore wind power is of little value unless the power plants are well integrated in the power system and able to compete successfully in the electricity market. This requires cost effective solutions on grid connection and system integration that will contribute to attract investments in offshore wind. The research activities in WP4 aim to remove barriers and close competence gaps on grid connection solutions, wind farm operation and control concepts, market design and regulatory issues. The main focus is on system analysis and model developments for simulation of wind farm operation and control. Moreover, models are developed for grid design and analysis in order to make recommendations on market adaptations and regulatory framework.

Two conference papers are written and accepted (“Control of Multiterminal HVDC Transmission for Offshore Wind Energy” and “Optimal design of a sub-sea power grid in the north sea”) and one journal paper is submitted. The development of the PSST simulation tools for offshore grid design and power market analysis with large scale wind integration have been significantly improved. The model is regarded as a state-of-the-art tool for integrated power market and network analysis concerning very large scale wind integration studies. In addition, two reports are completed: One overview report on alternative grid solutions and technologies and another one on power system operation with larger amounts of wind energy as part of a IEA collaboration..

One PhD student has started in 2009, see appendix A.1.4, while another is appointed and will start in March 2010. Within April 2010 two additional PhD positions in task 2 will be advertised.

Industry involvement is shown in 4.8.

4.6 OPERATION AND MAINTENANCE (WP 5)

The objective is to develop a scientific foundation for implementation of cost-effective O&M concepts and strategies for offshore wind farms. This will be achieved through the following secondary goals:

- Development and adaption of methods and tools for assessing optimal O&M strategies, with particular emphasis on condition based maintenance
- Assessment of low-cost and efficient surveillance and condition monitoring concepts
- Analyses of various access methods and assessing their impact on the maintenance opportunities and O&M costs
- Development and adaption of methods and tools for assessing optimal logistics strategies

The work is divided into four tasks

5.1 Maintenance strategies
5.2 Surveillance and condition monitoring
5.3 Access and logistics techniques
5.4 Experience/data

One of the bigger challenges in the development of deep water offshore wind power is the cost and limited opportunities for maintenance, and at the same time fulfilling HSE requirements. This calls for new solutions when it comes to O&M strategies, condition monitoring, remote operations, access and logistics - just to mention the most evident challenges. Thus, WP5 is addressing these topics, and at the same time seeking a holistic view on the whole value chain from design to disposal where O&M are important pieces of the bigger picture. A life cycle profit (LCP) model will be a valuable tool for ensuring holistic thinking and avoiding sub-optimisation of the different phases in the life of a wind power plant.

The 2009 work included state of the art studies on qualitative assessment of maintenance requirements regarding coatings and surface protection. A paper describing transfer of methods and experience on O&M from other industries to offshore wind farms is in progress. In addition, joint collaborations/applications with European research institutes are started, such as

- AERTO proposal: Operation and Maintenance (monitoring) of Offshore wind parks
- Nordic Energy Research proposal: Nordic RAMS database for wind power farms (application approved in 1st phase, final application in March 2010)
- EU FP7-ENERGY-2010: HiPRwind (O&M activities)

Furthermore, a process has taken place on technical clarification and definition, including information exchange meetings with industry partners.

One PhD has started in 2009, see appendix A.1.4, while two additional Phd students are appointed and will start respectively March and April 2010. Furthermore, one additional PhD position will be advertised in April 2010.

Industry involvement is shown in 4.8.

4.7 ASSESSMENT OF ALTERNATIVE DESIGN CONCEPTS (WP 6)

The objective is to develop and assess novel concepts of deep-sea wind turbines by numerical tools and physical experiments, hereunder developing control systems and combining results from WP2 and WP3. Assessment is by numerical tools (WP1) and by utilizing “in-house” labs and results from full scale field tests.

The work is divided into three tasks:

6.1 Development of advanced control system
6.2 Assessment of alternative and novel design concepts
6.3 Experiments and demonstration

New improved concepts and technologies for offshore wind turbines should be developed by combining wind and offshore oil and gas experience. Robust and reliable technology is of paramount importance in order to keep repair and maintenance costs down. Conceptual design studies, exploring the interaction between the energy conversion, support structure and control system, should be carried out in order to minimize life cycle costs. Therefore, proper tools for these integrated design studies must be developed (WP1) and validated with experiments. Further, applying smart control systems for load mitigation and structural stabilization is also a key for cost reduction.

In 2009 emphasis has been on international collaboration and the joint application with NORCOWE and CEDREN on large scale infrastructure (82 MNOK), which has passed to the second round.

One PhD student started in 2009, see appendix A.1.4, while two others are appointed and will start respectively January and August 2010. Within April 2010 two additional PhD positions belonging to task 6 will be advertised.

Industry involvement is shown in 4.8.

4.8 INDUSTRY INVOLVEMENT

Industry involvement in NOWITECH is carried out through participation in general assembly and board meetings, work package reference group meetings, industry in-kind contribution and Committee of Innovation and Commercialisation (CIC). An overview of the NOWITECH partners' meeting attendance is shown in Table 1.

Table 1 Overview of meeting attendance by NOWITECH partners in 2009.

Partner	GA	Board	WP1	WP2	WP3	WP4	WP5	WP6	CIC	SC
Aker Solutions	x	x		x	x	x			x*)	
Det Norske Veritas	x	x	x	x	x	x	x		x	
Devold AMT				x						
DONG Energy Power	x				x				x*)	
Fugro OCEANOR	x	x	x						x	
Lyse Produksjon	x			x	x			x		
NTE Holding	x	x							x	
SmartMotor				x						
Statkraft Development	x	x	x*)		x	x	x*)	x	x*)	
Statnett SF	x					x				
Statoil Petroleum	x	x	x*)	x	x	x	x	x	x	
Trønder Energi Kraft	x						x			
Vestas Wind Systems	x	x								
Vestavind Kraft	x	x			x	x		x		
ScanWind/GE (not signed contract)	x						x		x	

*) Partner did not have the opportunity to participate on industry meeting, but has communicated suggestions previous to the meeting

4.9 SPIN-OFF PROJECTS

Many NOWITECH partners have participated in applications for national and international research projects in 2009. Table 2 shows a selection of some of the relevant projects.

Table 2 Overview of some of the projects applied for in 2009 by NOWITECH partners.

Project title	**Project type** [BIP, KMB, EU]	**Partners**	**Status**
ORECCA (**O**ff-shore **R**enewable **E**nergy **C**onversion platforms **C**oordination **A**ction)	EU	Coordinator: Fraunhofer IWES. Partners: NTNU, LyseEnergi etc	Approved
Autonome målinger av vindprofil, strømprofil og bølger for kartlegging av energipotensialet, design og operasjon av vindmøller til havs	BIP	Coordinator: Fugro Oceanor. Partners:, StatoilHydro, MARINTEK, CMR, UiB GFI	Approved
Marine Research Infrastructures Network for Energy Technologies: MARINET	EU	Coordinators: HMRC University College Cork. Partners: SINTEF ER, NTNU etc.	Approved to second round
Design and testing of large wind turbine blades	BIP	Coordinator: GE Wind Energy. Partners: IFE, MARINTEK etc	Approved
Role of North Sea power transmission in realising the 2020 renewable energy targets	KMB	SINTEF ER	Approved
Nordic wind power RAMS database (WIND-RAMS-DATA)	Nordic	Coordinator: SINTEF ER Partners: NTNU, Risø, VTT	Applied for
Korea – offshore wind	Industry	SINTEF MK, MARINTEK	Approved
Marine Renewable Integrated Application Platform (MARINA platform)	EU	Coordinator: Acciona, Partners: NTNU etc	Approved
Future Deep Sea Wind Turbine Technologies (DeepWind)	EU	Coordinator: Risø DTU. Participants: Statoil, SINTEF ER, MARINTEK etc.	Applied for
High power, high reliability offshore wind technology (HiPRwind)	EU	Coordinator: Fraunhofer. Participants: SINTEF ER, NTNU etc.	Applied for
Operation and maintenance (monitoring) of Off-shore wind parks (OMO)	EU Aerto	Coordinator Fraunhofer. Partner: SINTEF ER etc.	Approved
Grid integration of offshore wind farms	EU Aerto	Coordinator: SINTEF ER. Partners: VTT, Fraunhofer	Approved

5 INTERNATIONAL COOPERATION

This section outlines NOWITECH's international cooperation in 2009.

5.1 INTERNATIONAL COOPERATION THROUGH SCIENTIFIC COMMITTEE

The Scientific Committee (SC) was established in 2009, made up by
- NTNU members
- Other Norwegian members
- Associated research members

The associated members of the SC are international experts on relevant topics within offshore wind. The associated research partners are:
- Paul Sclavounos, MIT, USA
- Walt Musial, NREL, USA
- Peter Hauge Madsen, Risø-DTU, Denmark
- Hans-Gerd Busmann, Fraunhofer Institutt, Germany
- Olimpo Anaya-Lara, Strathclyde University, UK

The SC accomplished one meeting in 2009 where the associated research partners participated. Although their role is not completely defined, preliminary keywords are visiting lectures, exchange of PhD candidates and evaluation of scientific results in NOWITECH.

The SC, lead by NTNU, is responsible for planning and execution of the EAWE 6th International PhD Seminar on Wind Energy in 2010 in Trondheim and preliminary planning started in 2009.

5.2 INTERNATIONAL COOPERATION THROUGH WORK PACKAGES

Several work packages took part in EU applications, collaborating closely with other European research partners in the accompanying work. Examples of this are:
- EU FP7-ENERGY-2010-FET: DeepWind (application)
- EU FP7 Infrastructure Marinet (scored 14,5 out of 15 points; approval expected mid 2010)
- AERTO proposal: Developing offshore wind turbines for application beyond coastal shallow waters sites (approved)
- AERTO proposal: Operation and Maintenance (monitoring) of Offshore wind parks (approved)
- Nordic Energy Research proposal: Nordic RAMS database for wind power farms (application approved in 1st phase, final application in March 2010)
- EU FP7-ENERGY-2010: HiPRwind (application)
- Participation in IEA Wind working groups on offshore technology and power system integration
- Participation in IEC TC 88 working group on IEC 61400-27 (Ed. 1.0) Electrical simulation models for wind power generation

5.3 OTHER INTERNATIONAL ACTIVITIES

A comprehensive part of NOWITECH's work is the international activity accomplished by the Management. This covers heading standardisation activities, joint research applications, organising and planning of future joint research programmes etc. It is regarded as highly appropriate for NOWITECH to establish and expand our international networks, influence future European R&D activities within offshore wind and position ourselves favourably towards new propositions.

Some examples are:

- EU TP Wind, www.windplatform.eu (member of Steering Committee)
- EAWE, www.eawe.eu (member of Board)
- EERA, www.eera-set.eu (participating in joint programme on Wind Energy and coordinating sub-programme on Offshore Wind Energy)
- EIT KIC SEEIT, http://eit.europa.eu/ (partner in proposal headed by DTU)
- ESFRI WindScanner, http://cordis.europa.eu/esfri/ (partner in proposal headed by Risø DTU)
- IEA Wind, www.ieawind.org (alternate in ExCo)
- IEC TC88, www.iec.ch (heading the Norwegian sister-organization NK88, and representing Norway in TC88)

6 RECRUITMENT

Seven PhD students and one Post Doc candidate started in 2009 with funding from NOWITECH, see appendix A.1.3. In addition, another five PhD candidates and one Post Doc are appointed and will start in 2010. At the same time, preparation has started to advertise for additional eleven PhD candidates in the first quarter of 2010. Parallel to this, 22 PhD candidates with funding from sources outside NOWITECH, works on relevant topics and are associated to the NOWITECH research team. See appendix A.1.4.

A research school for offshore wind power has been started by the Scientific Committee. The research school has the goal to improve the quality of research within the field of
Offshore Wind Power. In 2009 a seminar on mechanical issues (wind, areodynamics and mechanics) has been accomplished. Two additional themes are identified (electrical and environmental) and will have separate seminars in 2010. Furthermore, two international experts have given lectures on respectively wind turbine design and operation, and rotor design trends (Gererd Van Bussel and Peter Jamieson).

During 2009, professors and scientific staff at NTNU with relations to NOWITECH were supervisors for 17 Master Degree theses. See appendix A.1.7.

7 COMMUNICATION AND DISSEMINATION

NOWITECH publications include a total of 29 publications in 2009, whereof 1 journal paper, 7 conference papers, 13 conference presentations, 2 reports and 6 media contributions (newspaper articles and feature articles). See appendix A.3.

NOWITECH partners have access to a project e-room, where all internal information and project results are presented. Further, NOWITECH has a web site (www.nowitech.no), where relevant NOWITECH news and information is presented to external interests.

An annual Wind Power R&D seminar is held in January each year in Trondheim. This seminar has been arranged every year since 2004, and has been established as an important venue for the wind sector in Norway. The seminar is a mix of plenary presentations with broad appeal, and presentations in parallel sessions on specific technical themes. NOWITECH made the preparations in 2009 and arranged the seminar in cooperation with NORCOWE. News for year 2010 are that all presentations were held in English allowing for more international participation, introduction of poster presentations by PhD students and a strong focus on deep sea offshore wind.

A.1 PERSONNEL

A.1.1 Key Researchers

#	Name	Institution	Main Research Area
1	Belsnes, Michael Martin	SINTEF Energy Research	WP4
2	Eek, Jarle	SINTEF Energy Research	WP4
3	Eggen, Arnt Ove	SINTEF Energy Research	WP5
4	Feilberg, Nicolai	SINTEF Energy Research	WP4
5	Grinden, Bjørn	SINTEF Energy Research	WP4
6	Gustavsen, Bjørn	SINTEF Energy Research	WP4
7	Heggset, Jørn	SINTEF Energy Research	WP5, Management
8	Hernando, Daniel Huertas	SINTEF Energy Research	WP4
9	Hofmann, Matthias	SINTEF Energy Research	WP5
10	Korpås, Magnus	SINTEF Energy Research	WP4
11	Pleym, Anngjerd	SINTEF Energy Research	WP2
12	Ringheim, Nils Arild	SINTEF Energy Research	Management
13	Svendsen, Harald	SINTEF Energy Research	WP4
14	Tande, John Olav Giæver	SINTEF Energy Research	Management, WP1-WP6
15	Trötscher, Thomas	SINTEF Energy Research	WP4
16	Warland, Leif	SINTEF Energy Research	WP4
17	Berge Erik	IFE	WP1,
18	Finden Per	IFE	Management
19	Knauer Andreas	IFE	WP1, WP2, WP3, WP6
20	Nygaard Tor Anders	IFE	WP1, WP3
21	Rij Jennifer Van	IFE	WP1, WP2, WP3
22	Stenbro Roy	IFE	WP1, WP2, WP3, WP6, Management
23	Anders Valland	Marintek	WP5
24	Atle Minsaas	Marintek	Management
25	Chittiappa Muthanna	Marintek	WP6
26	Dag Fergestad	Marintek	WP3
27	Elin Halvorsen Weare	Marintek	WP5
28	Erik Dyrkoren	Marintek	WP5
29	Gro Baarholm	Marintek	WP3
30	Halvor Lie	Marintek	WP6
31	Harald Ormberg	Marintek	WP1,
32	Ivar Fylling	Marintek	WP1, WP6
33	Jan Roger Hoff	Marintek	WP1,
34	Jarl Korsvik	Marintek	WP5
35	Jie Wu	Marintek	WP1
36	Joakim Taby	Marintek	WP3
37	Lars Magne Nonås	Marintek	WP5
38	Mateusz Graczyk	Marintek	WP1
39	Neil Luxcey	Marintek	WP1, WP3
40	Ole D. Økland	Marintek	WP3
41	Petter Andreas Berthelsen	Marintek	WP1,WP3, WP6, Management
42	Timothy Kendon	Marintek	WP3
43	Trond Johnsen	Marintek	WP5
44	Amund Skavhaug	NTNU	WP5
45	Andreas Echtermeyer	NTNU	WP2
46	Geir Moe	NTNU	Management (including SC), WP3
45	Gerard Doorman	NTNU	WP4
47	Hans Kristian Høidalen	NTNU	WP4
48	Jan Onarheim	NTNU	Management (including SC, CIC)
47	Jørn Vatn	NTNU	WP5
49	Kjetil Uhlen	NTNU / SINTEF Energy Research	WP4, Management
50	Ole Gunnar Dahlhaug	NTNU	Management (including SC), WP1
51	Olav Fosso	NTNU	WP4
52	Per Åge Krogstad	NTNU	WP6
53	Robert Nilssen	NTNU	WP2
54	Roy Johnsen	NTNU/SINTEF MC	WP5
55	Tor Inge Fossen	NTNU	WP6
56	Tore Undeland	NTNU	Management (including SC)
57	Torgeir Moan	NTNU	WP3, Management (including SC)
58	Trond Kvamsdal	NTNU/SINTEF ICT	WP1
59	Roger Moe Bjørgan	SINTEF ICT	WP1
60	Runar Holdahl	SINTEF ICT	WP1

#	Name	Institution	Main Research Area
61	Andrés Nunes Guzman	SINTEF MC	WP3
62	Anita Fossdal	SINTEF MC	WP3
63	Arne K. Røyset	SINTEF MC	WP3
64	Astrid Bjørgum	SINTEF MC	WP3, WP5
65	Bård Wathne Tveiten	SINTEF MC	WP2, Management
66	Bente G. Tilset	SINTEF MC	WP3
67	Camilla Haavik	SINTEF MC	WP3
68	Christian R. Simon	SINTEF MC	WP3
69	Frode Tyholdt	SINTEF MC	WP3
70	Heidi Johnsen	SINTEF MC	WP3
71	Ingeborg Kaus	SINTEF MC	WP3
72	Jannicke Kvello	SINTEF MC	WP3
73	Joachim M. Graff	SINTEF MC	WP3
74	Juan Yang	SINTEF MC	WP3
75	Monika Pilz	SINTEF MC	WP3
76	Ole Ø. Knudsen	SINTEF MC	WP3
77	Øystein Dahl	SINTEF MC	WP3
78	Per Martin Stenstad	SINTEF MC	WP3
79	Ruth Schmid	SINTEF MC	WP3
80	Sergio Nieto Armada	SINTEF MC	WP3, WP5
81	Sivakanes Luxsacumar	SINTEF MC	WP3
82	Stephan Kubowicz	SINTEF MC	WP3
83	Tommy Mokkelbost	SINTEF MC	WP3
84	Wenle He	SINTEF MC	WP3

A.1.2 Visiting Researchers

Name	Affiliation	Nationality	Sex	Duration	Topic

A.1.3 Postdoctoral Researchers

Name	Nationality	Period	Sex	Topic
Anthonippillai Antonarulrajah	British	2009-2011	M	Influence of material and process parameters on fatigue of wind turbine blades in a marine environment

A.1.4 PhD Students with financial support from the Centre budget

Name	Nationality	Period	Sex	Topic
Lars Frøyd	Norwegian	2009-2012	M	Evaluation of the design criteria and dynamic forces on large floating wind turbines (WP1)
Eric Van Buren	American	2009-2012	M	Bottom-fixed support structure for wind turbine in 30-70 m water depth (WP3)
Marit Irene Kvittem	Norwegian	2009-2012	F	Life cycle criteria and optimization of floating structures and mooring systems (WP3)
Daniel Zwick	German	2009-2013	M	Design and production of offshore jacket structures (WP3)
Amir Hayati Soloot	Iranian	2009-2013	M	Analysis of switching transients in wind parks with focus on prevention of destructive effects (WP4)
Zafar Hameed	Pakistani	2009-2012	M	Maintenance optimization of wind farms from design to operation (models, methods, framework) (WP5)
Tania Bracchi	Italian	2009-2012	F	Assessment of benefits of downwind rotors due to weight savings using new and thinner airfoils and improved directional stability of turbine (WP6)

A.1.5 PhD Students working on projects in the Centre with financial support from other sources

Name	Funding	Nationality	Period	Sex	Topic
Thomas Pagaard Fuglseth	NTNU	Norwegian	2005-2010	M	Control of Wind Energy Plants
Alejandro Garces Ruiz	NTNU	Colombian	2008-2012	M	Electrical system for offshore wind parks: from the generator to the grid connection onshore
Anders Arvesen	NTNU	Norwegian	2008-2012	M	Assessment of environmental benefits and costs of a large-scale introduction of wind energy
Bing Lui	NTNU	Chinese	2008-2012	M	Offshore wind power electronics
Fabio Pierella	NTNU	Italian	2008-2012	M	Wind energy: Full scale and wind tunnel simulated measurements; consequential wind turbine design optimization, model construction and experimental testing
Fredrik Sandquist	NTNU	Austrian	2006-2010	M	Individual Pitch Control of Large Scale wind turbines
Ingrid Øverås	NTNU	Norwegian	2008-2012	F	Grid Integration Technologies of Offshore Wind
Kjersti Røkenes	NTNU	Norwegian	2005-2009	F	Micrometeorological influences on wind turbines
Lijuan Dai	NTNU	Chinese	2009-2013	F	RAMS engineering and management in the development and operation of offshore wind turbines
Madjid Karimirad	CeSOS	Iranian	2007-2011	M	Structural Dynamic Response of Floating Wind Turbine
Muhammed Jafar	NTNU	Pakistani	2008-2012	M	Electrical Conversion Systems for Offshore wind farms: from the generator to shore
Raed Khalil Lubbad	NTNU	Palestinian	2006-2010	M	Dynamic Response of Slender Offshore Structures
Raymundo Torres Olguin	NTNU	Mexican	2008-2012	M	Offshore Wind Farms Electrical System and grid Integration
Sverre Gjerde	NTNU	Norwegian	2009-2013	M	Integrated converter design with generator for weight reduction of offshore wind turbines
Temesgen Haileselassie	NTNT	Ethiopian	2008-2012	M	Grid Connection of Deep Sea Wind Farms
Tobias Aigner	NTNU	German	2008-2012	M	System impacts of large scale wind power
Gursu Tasar	NTNU	Turkish	2009-2012	M	Full Scale Measurements of Wind Conditions Relevant for Offshore Wind Turbines
Karl Merz	NTNU	American	2008-2011	M	Deep water offshore turbine structures
Mahmoud Valibeiglou	NTNU	Iranian	2009-2012	M	Area in Operation and Maintenance –in on-line monitoring and use o f on-line data for maintenance decision for offshore wind farms
Marit Reiso	NTNU	Norwegian	2009-2012	F	Design and analysis of downwind rotor for WT with jacket tower
Wenbin Dong	CeSOS	Chinese	2008-2011	M	Reliability of wind turbines
Haiyan Long	NTNU	Chinese	2007-2009	F	Towers for Offshore Wind Turbines

A.1.6 Postdoctoral Researchers with financial support from other sources

Name	Nationality	Period	Sex	Topic
Muyiwa Adaramola		Started 2008	M	Deep sea wind turbine behaviour in extreme situations
Zhen Gao		Started 2008	M	Reliability and stochastic response analysis of marine structures
Nilanjan Saha		Started 2008	M	Stochastic analysis of marine structures
Elisabetta Tedeschi		Started 2009	F	Design and control of energy conversion systems for the integration of offshore renewable energy sources into the electric grid
Paul Thomassen		Started 2008	M	Deep sea offshore structures

Name	Nationality	Period	Sex	Topic
Rabah Zaimeddine		Started 2008	M	Grid Integration Technologies of Offshore Wind

A.1.7 Master Degrees

Name	Sex	Topic
Jan Beerens (TU Delft)	M	Offshore hybrid wind-wave energy converter system
Quentin Meissonnier (ECN Nantes)	M	Hydrodynamic modelling and validation of TLP mooring systems for a floating wind turbine based spar platform
George Seamans (UCB Berkeley)	M	Fixed offshore wind turbine reliability
John Amund Karlsen	M	Performance calculations for a model turbine
Tom Håkon Holten	M	Yaw-effekter på vindturbiner
Pål Egil Eriksen	M	Structure of the wake behind a wind turbine
Eivind Sæta	M	Design of airfoil for downwind turbine rotor
Christopher Delprete	M	Wind profile effects on a wind turbine energy production
Helle Gjersum	F	Analyses of Floating Offshore Wind Turbines
Hans Kristian Lien	M	Evaluation of Lattic Tower Support Structures for Offshore Wind Turbines
Joakim Kvaale	M	Evaluation of Lattic Tower Support Structures for Offshore Wind Turbines
Jorge Martin Gallach	M	Dynamic analysis of a wind turbine with a tower in a non-metallic composite material.
Kjersti Balke Hveem	F	Vindturbintårn i kompositttmaterialer
Marianne Melling	F	Foundation Modelling and its Influence to the Dynamic Behaviour of Offshore Wind Turbines
Erlend Aasheim	M	Dynamic Response Analysis of Fixed Offshore Wind Turbines
Erik Rød	M	An Assessment of HAWC2's Capabilities for Modeling Jacket Structures, and a Comparison of Structures for a 5 MW Offshore Wind Turbine
Øyvind Rolland	M	An Assessment of HAWC2's Capabilities for Modeling Jacket Structures, and a Comparison of Structures for a 5 MW Offshore Wind Turbine
Eivind Lindeberg	M	Optimal Control of Floating Offshore Wind Turbines

A.2 STATEMENT OF ACCOUNTS

(All figures in NOK 1000)

FUNDING

Name		Amount	Amount
The Research Council			10000
SINTEF Energi	(Host Institution)		1338
NTNU	(Research Partner)		2492
IFE	(Research Partner)		566
Marintek	(Research Partner)		838
SINTEF	(Research Partner)		2284
Aker Solutions		261	
Det Norske Veritas		250	
Devold AMT		491	
DONG Energy Power		250	
Fugro OCEANOR		353	
Lyse Produksjon		250	
NTE Holding		500	
SmartMotor		702	
Statkraft Development		750	
Statnett		250	
Statoil		575	
Trønder Energi Kraft		250	
Vestas Wind System		600	
Vestavind Kraft		500	
Transferred to 2010		-2585	
	Subtotal		3397
Public Partners			
			20915

COSTS

Name		Amount	Amount
SINTEF Energi	(Host Institution)		5352
NTNU	(Research Partner)		4139
IFE	(Research Partner)		2262
Marintek	(Research Partner)		3077
SINTEF	(Research Partner)		3910
Aker Solutions		261	
Devold AMT		491	
Fugro OCEANOR		353	
SmartMotor		702	
	Subtotal		1808
Public Partners			
Equipment			367
			20915

A.3 PUBLICATIONS

NOWITECH publications include a total of 29 publications in 2009, whereof 1 journal paper, 7 conference papers, 13 conference presentations, 2 reports and 6 media contributions. Below you will find the papers and reports listed.

A.3.1 Journal Papers

Title	Author	Journal
A framework to determine optimal offshore grid structures for wind power integration and power exchange	Thomas Trötscher, Magnus Korpås	Submitted to Wiley Wind Energy

A.3.2 Published Conference Papers

Title	Author	Conference
Control of Multiterminal HVDC Transmission for Offshore Wind Energy	Haileselassie, T; Uhlen, K; Undeland, T.	Nordic Windpower Conference; Bornholm; 10.-11. september 2009
Impacts of large amountsof wind power of design and operation of power systems, results of IEA collaboration	Holttinen, H.; Meibom, P.; Orths, A.; Lange, B.; O'Malley, M.; Tande, J.O.; Estanqueiro, A.; Gomez, E.; Söder, L.; Strbac, G.; Smith, J.C.; van Hulle, F.	8th International Workshop on Large Scale Integration of Wind Power into Power Systems; Bremen, Germany; 14.-15. Oct. 2009
Wave and wind induced motion response of catenary moored spar wind turbine	Karimirad, M.; Moan, T.	International Conference on Computational Methods in Marine Engineering MARINE 2009; Barcelona; 2009
Dynamic Motion Analysis of Catenary Moored Spar Wind Turbine in Extreme Environmental Conditions	Karimirad, M.; Gao, Z.; Moan, T.	European Offshore Wind Conference 2009; Stockholm; 14. - 16. september 2009
Corrosion protection of offshore wind turbines – long life protective coatings	Knudsen, O.Ø.; Bjørgum, A.	EWEC 2009; Marseilles; 16.-19. March 2009
A Review of Hydrodynamic effects on bottom-fixed offshore wind turbines	Merz, Karl O.; Gudmestad, Ove T.	OMAE 2009; Honolulu, USA; May 31 - June 5. 2009
Optimal design of a subsea power grid in the North Sea	Trötscher, T., Korpås, M.	European Offshore Wind Conference, Stockholm, 14. - 16. September 2009

A.3.3 Books

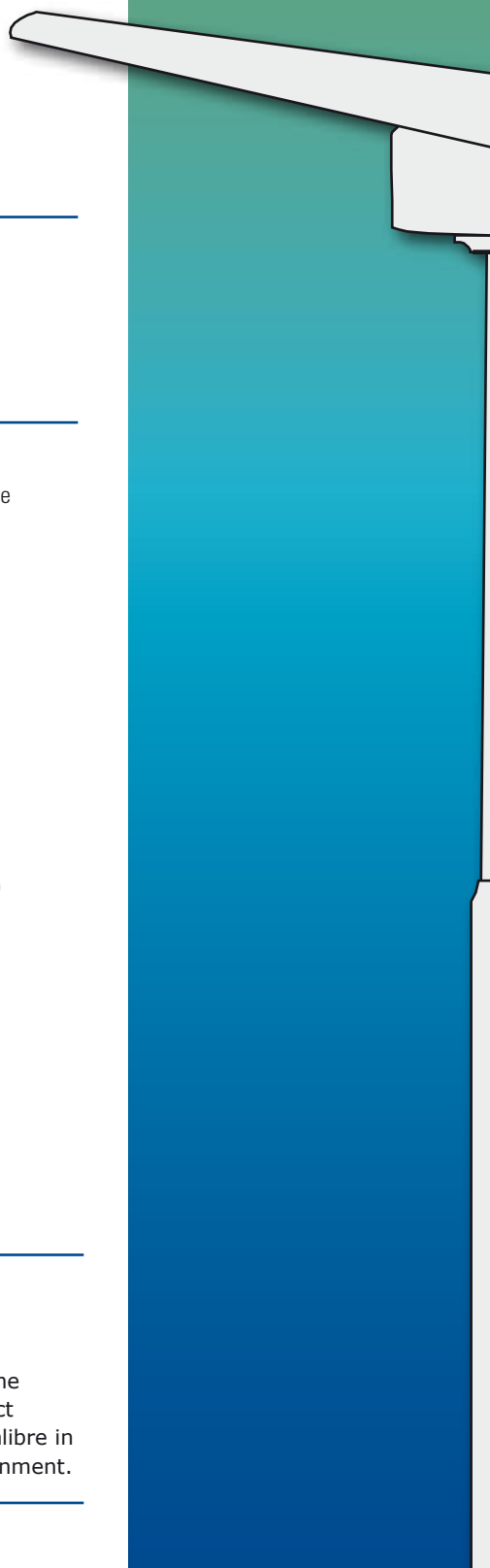
A.3.4 Reports

Title	Author	Institution
Offshore wind grid connection - state of the art	Hernando, Daniel; Svendsen, Harald G.; Pleym, Anngjerd	SINTEF – Technical report
IEA Wind Task 25 - Final report, Phase 1 2006-08. Design and operation of power systems with large amounts of wind power	Hannele Holttinen, Peter Meibom, Antje Orths, Frans van Hulle, Bernhard Lange, Mark O'Malley, Jan Pierik, Bart Ummels, John Olav Tande, Ana Estanqueiro, Manuel Matos, Emilio Gomez, Lennart Söder, Goran Strbac, Anser Shakoor, João Ricardo, J. Charles Smith, Michael Milligan & Erik Ela	VTT TIEDOTTEITA. RESEARCH NOTES 2493

NOWITECH (Norwegian Research Centre for Offshore Wind Technology) is a centre for environment-friendly energy research started in 2009 co-funded by the Research Council of Norway.

The objective of NOWITECH is pre-competitive research laying a foundation for industrial value creation and cost-effective offshore wind farms. Emphasis is on "deep-sea" (+30 m) including bottom-fixed and floating wind turbines. Work is focused on technical challenges including a strong PhD and post doc programme:

- Integrated numerical design tools for novel offshore wind energy concepts.
- Energy conversion systems using new materials for blades and generators.
- Novel substructures (bottom-fixed and floaters) for offshore wind turbines.
- Grid connection and system integration of large offshore wind farms.
- Operation and maintenance strategies and technologies.
- Assessment of novel concepts by numerical tools and physical experiments.



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Research partners
SINTEF Energy Research
Institute for Energy Technology (IFE)
Norwegian University of Science and Technology (NTNU)
Norwegian Marine Technology Research Institute (MARINTEK)
SINTEF Materials and Chemistry
SINTEF Information and Communication Technology

Associated research partners
National Laboratory for Sustainable Energy at the Technical University of Denmark (Risø DTU)
Massachusetts Institute of Technology (MIT)
National Renewable Energy Laboratory (NREL)
Fraunhofer IWES
University of Strathclyde

Industry partners per March 2010
Aker Solutions
Devold AMT AS
Det Norske Veritas AS (DNV)
DONG Energy Power AS
EDF R&D (new in 2010)
Fugro OCEANOR AS
GE Wind Power (Norway) AS (new in 2010)
Lyse Produksjon AS
MARINTEK
NTE Holding AS
SmartMotor AS
Statkraft Development AS
Statnett SF
Statoil Petroleum AS
TrønderEnergi Kraft AS
Vestas Wind Systems AS
Vestavind Kraft AS

Associated industry partners:
Energy Norway
Enova
Innovation Norway
Navitas Network
Norwegian Wind Energy Association (NORWEA)
NVE

CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH

The Centres for Environment-friendly Energy Research (CEERs) scheme is an initiative to establish time-limited research centres which conduct concentrated, focused and long-term research of high international calibre in order to solve specific challenges in the field of energy and the environment.