European Academy of Wind Energy

messenger

No. 1 / July 2004

Kick-off for the European Wind Academy

The Wind Academy's founding declaration being signed at TUDelft. From left to right: Gerard van Bussel (TUDelft), Gijs van Kuik (TUDelft), Jürgen Schmid (ISET), Jens Norkær Sørensen (DTU), Spyros Voutsinas (NTUA), John Dalsgaard Sørensen (Uni Aalborg), Takis Chaviaropoulos (CRES), Jos Beurskens (ECN), Erik Lundtang Petersen (RISØ).

Delft, October 17th, 2003

The European Academy of Wind Energy (EAWE) was officially founded during a ceremony at TU Delft, as a response to an increasing demand for coherence in the European wind energy research. During the past years, four leading European R&D institutes – ISET, ECN, CRES and RISØ – laid the grounds for this unique competence network. Unique, as each of the research centres had before established a national network with universities being closely connected with the institutes.

Thus, eleven founding members acceded to reach a better co-ordination of research and teaching, and to act jointly on the research and education market:

- CRES (Greece), together with the University of Patras and NTUA, the National Technical University of Athens
- ECN (The Netherlands) together with DUWind, the Delft University Wind Energy Research Institute
- ISET (Germany), in collaboration with the University of Kassel
- RISØ (Denmark), in a Danish national network together with the Technical University of Denmark (DTU), Aalborg University and DHI Water and Environment.

"By the joint training of doctoral candidates, exchange of specialised staff, international training measures and research projects, this network will contribute to further enhance the top position of the European wind energy technology on the booming world market for wind energy technology", said Prof. Jürgen Schmid, chairman of ISET's management board and newly elected president of the Academy in his opening address in Delft.

Towards the "European Research Area"

At present, Europe is leading in the wind energy field, with respect to the industry, to the size of installations and to its research capabilities. This top position, however, paradoxically seems to be the reason that the demand for continued fundamental wind energy research is being questioned. The technology being mature enough is one of the alleged arguments. The message of the Wind Academy is clear and precise in this point: To maintain the position and fully exploit the growth perspectives requires both continued technology development as well as education and training of a highly qualified workforce in Europe. Continued R&D in long-term aspects is essential to provide further reductions in cost and uncertainty, strengthen acceptability and reliability and increase the overall value of wind power. The new approach of the Wind Academy is fully in-line with the European Commission concept and its instruments to come closer to ERA – the "European Research Area". The official Communication COM 612 says: "The Commission recognises that (to bring a new economy and knowledge-based society) into reality will require a joint effort by the EU, its Member States and research stakeholders and requires that the shape and content of European research efforts are reassessed. In particular it is suggested that there is a need for a more structured approach, to balance technical development and recognise excellence as well as to increase cohesion between EU research activities and those of Member States." EAWE's nodal network aiming at a systematic co-operation between research centres and universities indeed allows for long-term and high level research and at the same time for an international and intercultural education, especially on PhD level. One of the most prominent activities in the past months has been the initiative of Prof. Gijs van Kuik and Dr. Gerard van Bussel from DUWind / TUDelft for the conference "The Science of Making Torque from Wind". The explicit objective of this conference was to meet the academic standards as applied in several other branches of science and technology. Strict peer-reviewing of the proposed conference contributions guaranteed high quality and new insights in the progress of the science concerned.

Collaboration with EWEA

From the beginning, a close collaboration with the European Wind Energy Association EWEA was on the agenda of the Wind Academy. It was agreed between the organisations, that the Wind Academy will manage the "Scientific Stream" of EWEA wind conferences, i.e. to be responsible for the abstract and paper review process, and to organise the programme, which shall meet the highest academic standard. At the moment, this process is under way for the coming "2004 Wind Energy Conference & Exhibition" in November in London. Since April 2004, the Academy is a formal member of EWEA, and the series of joint EWEA and Wind Academy "Special Topic Conferences" shall be continued. Next on the agenda could be "Wind Power Integration and Grid Management", possibly to be held in spring 2005 at Aalborg University.

Academy open for enlargement

The kick-off for the European Wind Academy was realised by the group of core members looking forward to the enlargement of this network. Accordingly, the founding declaration communicates: "EAWE is open for new members, provided they offer research and education in wind energy at the highest level." EAWE has now agreed on accession criteria: "A new member of the European Academy of Wind Energy shall be organised in a national network, comprising of a nodal institute and associated partners and governed by a formal agreement on cooperation on wind energy field on research, both long-term research and applied research, education of candidates and researchers (PhDs), dissemination in terms of training of technical staff, consultancy and other technical services. The national network shall represent a majority of the national activities of the above-mentioned areas, comprise at least an annual R&D effort of 25 man-years, and, provide a university educational programme in the wind energy field on the master-level as well as a PhD-programme." Brochures with a description of the Wind Academy's concept, its activities and details on every member institute can be obtained through info@eawe.org.

Cornel Ensslin

Editorial

With this issue we want to start a series of EAWE-Messengers. The brochure should increase internal communication between the existing eleven member organizations on all possible levels. We have in fact a long way to go before we know each other. The Academy Brochure can be seen as a first step but it does not give any information on persons belonging to it with the exception of the board members. I would therefore invite all persons, which are members of our Academy to contribute with both, scientific and personal information which might be of interest for the others. Since our EAWE-Messenger is made only for internal use, I see basically no restriction in subject, but don't forget pictures! Cornel Ensslin at ISET (censslin@iset.uni-kassel.de) is waiting for your contributions.

As one of the first actions to increase our Academy's visibility, the Special Topic Conference on "The Science of making Torque from Wind", which has been organized by DUWind has been a big success, thanks to the enormous efforts of our colleagues Prof. Gijs van Kuik and Dr. Gerard van Bussel. As a next step, the organization of the scientific part in the prestigious EWEA conference managed by our colleague Erik Lundtang Petersen from RISØ will further highlight the Academy's importance in wind. Unfortunately, our efforts to get support for our "Wind Doctors" from the European Commission has not led to a success. The more I appreciate Gijs van Kuik's reaction who coordinated the proposal: 'We will learn from the comments given by the evaluators and apply again!' He proposed further to educate our existing PhD-students according to the rules we have developed for the proposal. I would be glad if this could be realized soon.

The interest of further organizations to become a member of our Academy is huge! Alone in Germany four universities would like to do so and I can imagine a similar tendency in other countries as well. This is a very good sign and if we apply the rules, which have jointly been worked out by ECN and RISØ, we should be able to keep or even improve the scientific level in our membership.

All in all, we have made good progress and our Academy is being recognized increasingly. Lets keep the momentum and let our Academy by an active part of the European Research Area which the European Commission would like to see in future.

Jürgen Schmid
President of the
European Academy of Wind Energy

The Science of making Torque from Wind

First Joint Conference of the Wind Academy and EWEA in Delft

At 19-21 April 2004, the Special Topic Conference,The Science of making Torque from Wind' took place at Delft university, jointly organized by EWEA and EAWE, the European Academy of Wind Energy. This was the 3rd special topic conference for EWEA (after one on offshore wind energy and on grid issues) and the first conference for the Academy. The conference was for ‚engineers and scientists only': in-depth presentations and discussions on the progress on all scientific aspects of the primary energy conversion step. The conference was well-attended by 180 persons from universities, R&D institutions and companies mainly from Europe and North America. The intention of the conference was to reach a high quality level, comparable to the highest academic standards. Therefore each paper had been peer-reviewed in advance by two independent experts. Combined with the availability of the proceedings ahead of the conference, and the luxurious half-an-hour scheme for each presentation and discussion, this gave rise to comments during the coffee break like, this is what we were waiting for'.

Since the conference was dedicated to all aspects from wind to torque, much progress was reported on wind description, resource assessment, wind forecast, aerodynamics and -elastics. This more or less filled halve of the conference. The loads, dynamics, blade material and construction, design optimisation took the other halve.

The editors of two scientific journals have attended the conference, and it is expected that the majority of the papers will be published in these journals.

The proceedings become available on CR-ROM, and can be ordered at:
info@duwind.tudelft.nl (50 euro).

Prof. Gijs van Kuik

Airfoil aerodynamics session during the conference at the Aula Conference Centre, TU Delft

EWEA Publications

EWEA: R&D Strategy Launch

Brussels, 27th January 2004 An industry-wide coordinated Research and Development (R&D) strategy on wind energy was launched in Brussels by EWEA – the European Wind Energy Association.

"Europe is the world leader in wind power and European wind turbine companies have a 90% world market share. R&D has been central to the wind industry's success to date. The European industry's future ability to maintain its global dominance in this sector depends on maintaining its R&D leadership, with the potential prize of an annual wind market of €75 billion by 2020. There is still much need to support long-term R&D in wind energy development, not least to develop new off-shore technology", said Prof. Arthouros Zervos, President of EWEA.

The European Commissioner for Research, Philippe Busquin, concurred that "Wind power is a prime example of how an ambitious European R&D effort, supported by the European Union for more than 20 years, can give Europe a very strong leadership in a promising hightechnology market, creating already more than 85,000 jobs in the Union. EWEA's R&D strategy will now be an important reference for our activities in order to maintain Europe's technological and industrial leadership in the future."

The R&D strategy outlines nine priority areas for further development and demonstrates to European institutions the industry-wide needs. The report also demonstrates how wind power can help attain overall EU objectives, such as those under the Lisbon strategy, and the Barcelona Objective, and how wind power can help resolve issues such as security of energy supply, tackle climate change, and contribute to economic growth.

Although wind power can be applied commercially under suitable conditions and has proved to be able to contribute significantly to national and regional electricity supply systems, continued R&D is required to bring costs down to the point where it competes fully with conventional electricity generation. This is the case as the external costs of electricity from traditional fossil and nuclear fuels continue not to be reflected in the price of electricity.

"As the industry grows stronger and is dispersed around the globe, present EU dominance will face stiffening competition in technology, markets and knowledge leadership. Its strength can only be achieved with increased R&D", said Zervos.

Hugo Chandler

Prof. Arthouros Zervos

Wind Industry: Worth € 80 Billion / Year by 2020

Global analysis details how to achieve 12% of the world's electricity from wind power

Hamburg, 11th May 2004 --- Launched today at the opening day of WindEnergy 2004 - the international trade fair for the wind industry - the wind industry's strategic blueprint Wind Force 12 details how wind power can supply 12% of the world's electricity by 2020. Wind power is successful today, and with a stronger green light from Governments this success story can expand worldwide. Wind power already installed throughout the world generates the equivalent electricity needs of 19 million European households. The wind industry can increase its sales tenfold by the year 2020, from the present €8 billion to an €80 billion. If existing barriers such as grid access and administrative barriers are lifted, the wind industry is capable of delivering such global growth", said EWEA CEO Corin Millais.

By 2020 wind power can deliver:

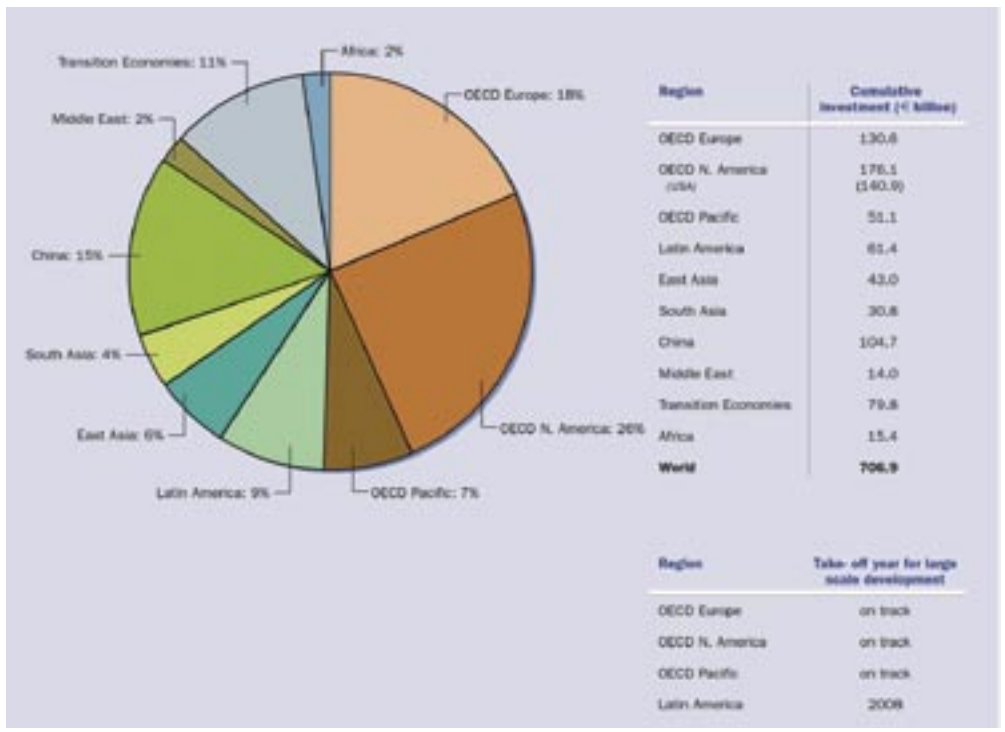
- 12% of global electricity demand, equal to 3,000 TWh
- Installation of 1,245,030 MW
- An annual €80 billion business
- 2.3 million jobs
- Cumulative CO_2 savings of 10,771 million tonnes
- Cost reduction to 2.45 € cents/kWh with installation costs of € 512/kW.

The OECD countries are expected to take the lead in implementation, especially Europe with € 131 billion cumulative investment by 2020 and North America with € 176 billion, other regions such as China will also make a major contribution with € 105 billion. Wind Force 12 is the global wind industry's input to Governments' representatives and experts who will meet in two weeks time in Bonn at the international conference 'Renewables 2004' (June 1-4). "The conference will chart the way towards an expansion of renewable energies worldwide, responding to the call of the Johannesburg summit for the global development of renewable energy". More than 3000 delegates and participants are expected to meet in Bonn, among them official governmental delegations including energy, environmental and development ministers, representatives of the United Nations and other international and non-governmental organisations, civil society and the private sector.

"Think big, not in dribs and drabs," urges Greenpeace's energy expert, Sven Teske. "In Germany offshore installations can treble the proportion of wind energy meeting global electricity demand, from five to fifteen per cent. These are opportunities we should not miss."

Economic measures have been introduced in some countries to encourage investment in renewable energy technology. In addition to such measures, a successful policy for promoting wind power should include regulation on grid access and streamlining of administrative procedures.

Hugo Chandler



Region	Cumulative investment (€ billion)
OECD Europe	130.6
OECD N. America (USA)	176.1 (140.9)
OECD Pacific	51.1
Latin America	61.4
East Asia	43.0
South Asia	30.8
China	104.7
Middle East	14.0
Transition Economies	79.8
Africa	15.4
World	**706.9**

Region	Take- off year for large scale development
OECD Europe	on track
OECD N. America	on track
OECD Pacific	on track
Latin America	2009

Wind Energy - The Facts: An Analysis of Wind Energy in the EU25

Brussels, 3rd May 2004 The European Wind Energy Association (EWEA), and the European Commission's Directorate General for Transport and Energy (DG TREN) have published "Wind Energy - The Facts", a detailed overview of the wind energy sector. The 330 page, five-Volume report provides a comprehensive overview of wind energy's past, present and future in the EU-25 covering: technology, costs and prices, industry and employment, environment, market development and R &D (1).

The wind industry has changed significantly over the past decade. Global installed capacity has increased from 2,500 MW in 1992 to just over 40,000 MW at the beginning of 2004, at an annual growth rate of near 30%. Over 75% of this capacity has been installed in Europe.

"There has been an explosion in demand for - and interest in - a cleaner energy world from politicians, institutions, policy makers and regulators, the media and the general public. This necessitates a greater depth of understanding of the wind power sector if informed choices are to be made", said EWEA President Professor Arthouros Zervos. "Wind energy provides electricity equivalent to the household needs of 35 million European citizens today, but few people know this - one symptom of the widespread lack of knowledge about the technology.

"More installations exploiting wind power can contribute increasingly to European electricity supply and at the same time dovetail with the Lisbon Strategy providing the EU with high-tech world class technology in the electricity sector. Furthermore this energy option will have a large impact on meeting the targets contained in the EU directive on renewable electricity and will contribute to fulfill the Kyoto commitments and to foster economic growth and employment", said Gunther Hannreich, Director of New Energies and Demand Management at DG TREN.

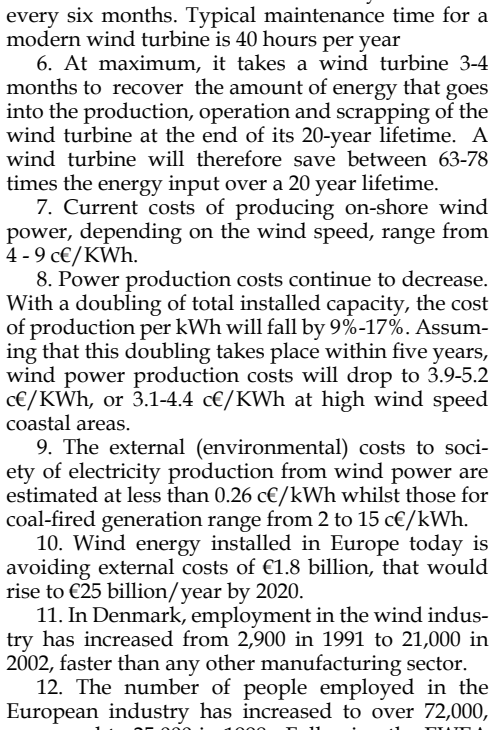
"Wind energy's rapid progress to date has been successful, yet the challenges are only just beginning: to properly exploit the potential of wind energy will help to meet significant goals of the energy security, economic, employment and environmental agendas", said Arthouros Zervos.

EWEA projects that wind power will achieve an installed capacity of 75,000 MW in the EU-15 by 2010 if positive policy support continues to develop, This would represent an overall contribution to electricity supply of 5.5%. By 2020, this figure is expected to increase to more than 12%, with wind power providing electricity equal to the demand of 195 million European household consumers.

Some Key wind energy facts:

1. Penetration levels in electricity production have reached 20% in Denmark and about 5% in both Germany and Spain. The north German state of Schleswig-Holstein has 1,800MW of installed wind capacity, enough to meet 30% of the region's total electricity demand, while in Navarra (Spain) 50% of consumption is met by wind power.

2. Even small changes in wind speed can produce large changes in the economic performance of a wind farm. For instance, a doubling of average wind speed increases the energy content of the wind by a factor of 8. Understanding the resource is the single most important step in establishing a wind farm.



3. Commercial wind turbines began in earnest in the 1980s and in the last 20 years turbine capacity has increased by a factor of 100. In the same period wind power generation costs have declined by some 80%.

4. A modern power generating wind turbine is designed to operate continuously, unattended and with low maintenance for more than 20 years, or some 120,000 hours of operation. By way of comparison, a car engine has a design lifetime of 4,000 to 6,000 hours.

5. A wind farm can be monitored remotely, with a mobile team of roughly two personnel for every 20-30 turbines. Maintenance is usually carried out every six months. Typical maintenance time for a modern wind turbine is 40 hours per year

6. At maximum, it takes a wind turbine 3-4 months to recover the amount of energy that goes into the production, operation and scrapping of the wind turbine at the end of its 20-year lifetime. A wind turbine will therefore save between 63-78 times the energy input over a 20 year lifetime.

7. Current costs of producing on-shore wind power, depending on the wind speed, range from 4 - 9 c€/KWh.

8. Power production costs continue to decrease. With a doubling of total installed capacity, the cost of production per kWh will fall by 9%-17%. Assuming that this doubling takes place within five years, wind power production costs will drop to 3.9-5.2 c€/KWh, or 3.1-4.4 c€/KWh at high wind speed coastal areas.

9. The external (environmental) costs to society of electricity production from wind power are estimated at less than 0.26 c€/kWh whilst those for coal-fired generation range from 2 to 15 c€/kWh.

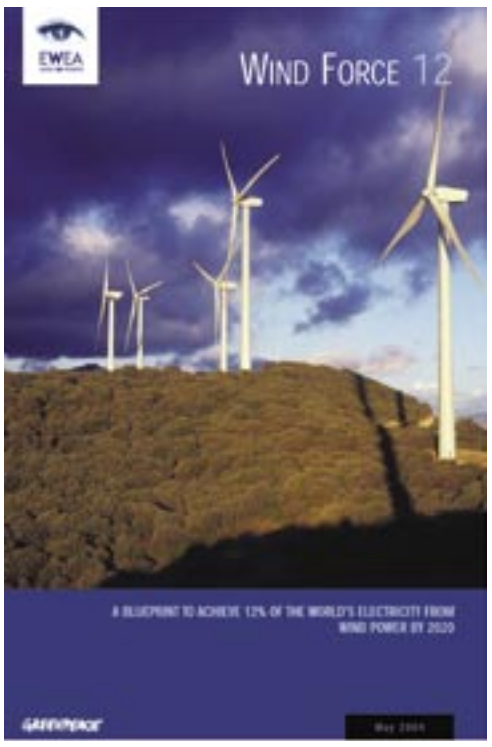
10. Wind energy installed in Europe today is avoiding external costs of €1.8 billion, that would rise to €25 billion/year by 2020.

11. In Denmark, employment in the wind industry has increased from 2,900 in 1991 to 21,000 in 2002, faster than any other manufacturing sector.

12. The number of people employed in the European industry has increased to over 72,000, compared to 25,000 in 1998. Following the EWEA Wind Force 12 scenario, employment in Europe could reach almost 200,000 by 2020, and in excess of 200,000 jobs in the rest of the world.

13. Under a conventional scenario, the world wind energy market would reach some 80,000 MW by 2007 and 161,000 MW by 2012. In the advanced scenario, the world market would reach 106,000MW by 2007 and 311,000MW by 2012.

Hugo Chandler



"Wind Energy The Facts - an analysis of wind energy in the EU-25", a publication by EWEA in partnership with the European Commission, May 2004.
http//www.ewea.org

If you wish to obtain a free copy of the executive summary – please contact Ann van Dyck, EWEA, at ***ann.vandyck@ewea.org****, phone +32 2 546 19 40.*

ECN Wind Energy

Energy Research Centre of the Netherlands (ECN)

In 1955 ECN was established as a nuclear research facility. After the oil crisis in 1973, the scope of the institute was widened. The first so-called non nuclear research programme that was initiated was dealt with wind energy, closely followed by the research programme on clean conversion of coal. Thus since the mid seventies, ECN is involved in wind energy research. Its first experimental facility was the 25mHAT. A 25 meter rotor diameter, 300 kW turbine with a variable speed conversion system and blade pitch control. It was a very flexible test bed, which has been in operation from 1981 to 2000, one of the longest living test beds, in the world. In the picture you see the top section of the turbine, which has been converted into a monument, which has historic value and, according to some of us, is also a piece of art!

Wind energy is one out of eight present ECN's research units, all working on different aspects of a sustainable energy system. Jos Beurskens, who has been active in the field of wind energy since 1972 (the time of 'the Club of Rome') is leading the unit Wind Energy. Recently two other important initiatives came to fruitition: the Laboratory for Wind Turbine Materials and Components (WMC), the ECN Wind turbine Test station Wieringermeer (EWTW) and a national programme for reserach on offshore applications 'we@sea'. The brand new state-of-the-art WMC was set up together with the Delft Technical University. Bert Janssen, the assistant unit manager also manages the WMC facility together with Don van Delft. The EWTW, in which also the land owners and neighbours are participating, is managed by Wim Stam and, finally, the 'we@sea' programme is managed by Chris Westra. In the next issue of the Messenger we will present more members of our staff and we will elaborate a bit more on our research activities and achievements.

Contact: wind@ecn.nl

Jos Beurskens

Bert Janssen

Chris Westra

ECN's working fields

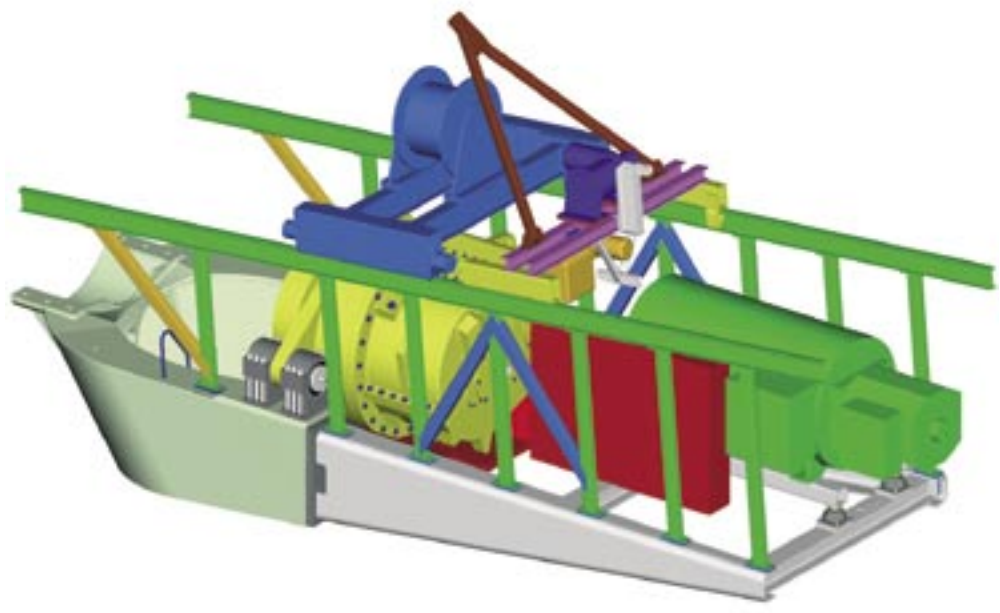
Operation & Maintenance

A successful long time operation of a wind energy system very much depends on the operation and maintenance strategy, linked to the actual lifetime consumption of the wind turbines being in operation. This not only depends on the quality of the turbines but also very much on external conditions, such as extreme wind gusts, temperature, lightning, and emergency stops. Condition monitoring is the crucial component in making maintenance depending on the condition of various components and thus minimising O&M cost.

ECN Wind Energy Team

Wind turbine technology

Traditionally ECN has been focussing on the basic technologies underlying the design and analysis of wind turbines. These expertises include aerodynamics, aero-elastics, structural dynamics, control strategies and electric conversion. ECN continues refining and expanding analysis methods and design tools as wind turbines are getting bigger and the applications also incorporate offshore systems. applications.



Dutch offshore Wind Energy Convertor

Design of wind farms

ECN's R&D efforts are focussed on getting the most out of investments in wind farms. To this end it is crucial to assess the local wind energy potential, to design a lay-out which leads to minimum grid connection cost and minimum interference between turbines. Further the control system optimising energy output and capacity factor on farm level is crucial. Knowing the possible degradation of the power performance of a wind farm after commissioning is not trivial. ECN has developed a unique flow visualisation technique which allows a very fast field diagnosis of the aerodynamic characteristics of a rotor.

ECN was responsible for training, farm lay out, environmental impact assessment and grid feed in study of the 20 MW wind farm at Tejoina, Costa Rica.

Facilities & Services

WMC. State of the art laboratory for fatigue testing of wind turbine materials and constructions. Blades up to a length of 60 meters can be accommodated. This is a joint operation of ECN and the Delft University of Technology.

EWTW. The brand new test station for multi megawatt turbines enables manufacturers and wind farm operators to have their prototypes and wind cluster concepts tested. ECN is using the new facilities for wake interaction research, operational verification of conditioning monitoring systems and measuring vertical wind gradients and all relevant external conditions. The test station provides space for 5 machines of 2.5 MW each for wind farm research and 4 foundations for up to 6 MW turbines each for proto type testing.

Other facilities include SODAR wind speed measuring unit for wind speed measurements at large heights, stall flag measurement systems for field flow visualisation and a laboratory for acoustic noise emission determination, power quality measurements. ECN is a member of the European quality network for wind energy technology laboratories MEASNET and operates under the ISO 17025 regime. As a direct derivative of its research activities ECN provides specialised services for planners, project developers, manufacturers and wind farm owners & operators. Examples of such services are technical assistance to EIA's, risk analyses (ECN produced a handbook on risk analysis), integral design tools for wind turbine systems, wind farms and components.

ECN is an active participant in a number of international networks, such as the EWEA, EUREC, IEA, IEC, CNENELEC, MEASNET and of course the European Academy of Wind Energy.

Jos Beurskens, unit manager

News from Risø

RISØ National Laboratory

Risø is a national laboratory under the Ministry of Science, Technology and Innovation. Risø carries out research in science and technology, providing Danish society with new opportunities for technological development. The research contributes to the development of environmentally acceptable methods for industrial and agricultural production as well as for the generation of the energy necessary for modern society. Risø National Laboratory employs totally 750 persons and Risø Wind Energy Centre, which encloses all wind energy activities at Risø, employs 130. The wind energy activities take place in the Wind Energy, Material Research and System Analysis Department. The Wind Energy Department of Risø is steadily growing and employs year 2003 a permanent staff of 120 persons, of which 2/3 are scientists and engineers. The department is organised in research programs with attached commercial and technical services. Around 90 % of the activities in the department are within the wind energy area. The System Analysis Department performs research related to wind energy (economics, energy market, life cycle analysis and reliability for wind turbines) and the Department for Materials Research performs materials research connected to application for wind energy and testing of materials used for wind turbines.

Contact: vea@risoe.dk

The New WAsP project, 2003

Risø's Wind Atlas Analysis and Application Program (WAsP) undergoes continual improvements and we have just embarked upon a new project, which we expect will yield major improvements to the program. A horizontally homogeneous flow model has been developed and we intend to use this as the starting point of a more complete solution for neutral atmospheric flow over complex terrain. Unlike previous models, the present work uses general orthogonal coordinates. We have employed a strong conservation form of the model equations in order to allow a robust and consistent numerical procedure. Flow variables are expressed in a transformed coordinate system in which they are horizontally homogeneous. The model utilizes a k-(turbulence model and it is part of a new perturbation solver presently being developed. We hope that this will prove more accurate than the current standard WAsP program and that it will also achieve a high execution speed. The latest version of WAsP, 8.0, was released at the end of 2003. Today, WAsP is more or less the industrial standard throughout the world and we have more than 1,300 WAsP users in more than 90 countries and territories. As for licences, 2003 has been the best selling year ever.

National test station for wind turbines in India

For more than a decade, Risø has been involved in the acceleration of wind power utilization in India. The latest activity is supported by the Danish development agency DANIDA and concerns assistance to the Indian government institution Centre for Wind Energy Technology, located in Tamil Nadu. The purpose of this project is to establish a national test station with the necessary facilities for testing and certification of wind turbines, and the capacity for monitoring their technical performance. The project also includes the preparation of standards and certification rules. During the initial phase, a core organization of professionals was established as were the facilities for stationary and field power performance measurements. A preliminary type approval procedure was also developed at this point. At the end of 2003 a full professional organization has been established, and staff has participated in workshops and on-the-job training as regards testing, certification, and technical support. The provisional type approval system is fully implemented and a final type approval system, based on international standards, has been completed and is now ready for implementation. The entire project was completed by the end of June this year.

Offshore wind turbine reliability: optimised and uniform safety

We are currently investigating how the overall structural safety of wind turbines depends not only on the structural reliability of the wind turbine itself, but also on the reliability of the control and safety systems. Using data from working wind turbines during the period from 1982 to 2000, we have confirmed the existence of a suspected imbalance between the structural reliability and the reliability of the safety and control systems. There has been a limited quantity of data available to this study due to a regrettable decline in reports from manufacturers in the latter years. An improved understanding of the theoretical structural safety seems now to have been established and has led to contributions to the present committee-stage draft for the IEC standard 61400-1 as well as ongoing work on an IEC standard for offshore wind turbines.

HAWCStab predicts the stability of wind turbines

A new program has been developed at Risø, aimed at investigating the dynamics of wind turbines. HAWCStab is the first numerical tool that uses eigenvalue analysis to predict the limits of aeroelastic stability of wind turbines. This program calculates the eigenfrequencies as well as the damping characteristics of either structural or aeroelastic oscillations of a working wind turbine. Calculations of aeroelastic damping from HAWCStab including the effect of the wind's aerodynamic power have already been used in actual experiments aimed at predicting and understanding observed oscillations of a wind turbine. By animating these oscillations, we have been able to obtain a better understanding of the dynamics of wind turbines as well as the cause of undampened oscillations.

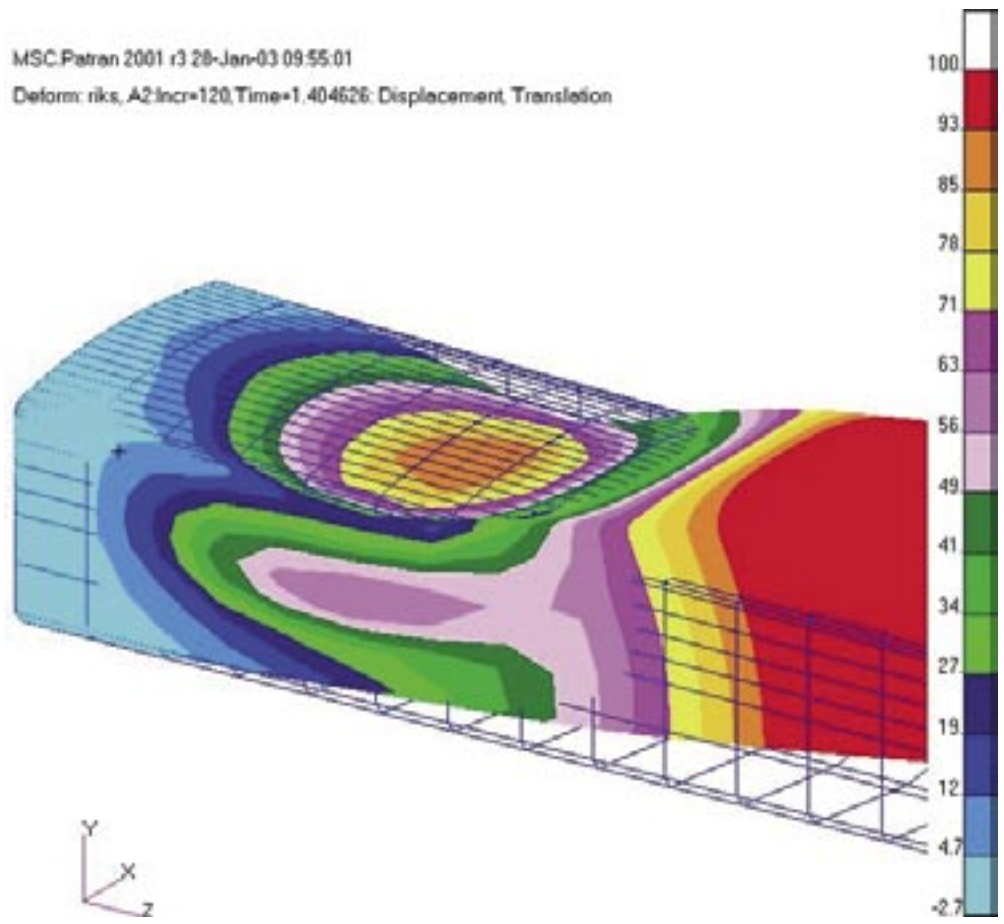
Simulation and validation

Stability of the electric power system as well as security of supply both depend on the reliability of the generators supplying the power. With the increase in wind power utilization, the influence of wind turbines on power system stability grows significantly. Various models for simulating this influence have been developed by the utilities as well as research institutes and the wind turbine industry. In order to validate a number of these models we have carried out a series of experiments on a Danish wind farm, comprising six 2 MW wind turbines. Experimental events were successively simulated by means of models developed by Risø and Aalborg University in DIgSILENT software, and with models developed by the NVE utility in EMTDC software. These models were developed in a collaboration with NEG-Micon Control Systems, suppliers of the control systems for the wind turbines in question. The validation process has provided useful knowledge on the quality of the simulation models as well as new ideas for further development.

Improved design base for large wind turbine blades

In the course of a project that examines the ultimate strength of bonded joints in wind turbine blades we have worked with a test set-up for 'mixed mode' fracture growth in bonded joints. An important feature of this particular set-up is that it also applies to a variety of other composite components. The material properties of the joint have been modelled by a cohesive law and the fracture growth in large components has been predicted successfully on the basis of test results from small components. This project also includes an investigation entitled 'Compressive strength of fibre composite blade structures' which has inspired the development of an instrument for measuring local buckling during full-scale testing of wind turbine blades. By using the finite element method, we have successfully simulated the local instability induced by bending the blade. The instability phenomenon has been verified in a full-scale test, performed to the point of collapse.

Buckle sensors on a wind turbine blade during test



Finite element model of main spar in a wind turbine blade
Displacement plot from postbuckling phase

Stand-alone systems for rural areas

In many Third World countries, there is a need for a power technology, specifically designed for the villages that are without connection to the large electrical grids. Due to the climatic as well as economic and technological circumstances of such communities, it is essential, that such isolated systems are robust as well as dependable and scalable. In Denmark, the 11 kW Gaia wind turbine has proven itself with 90 installations since 1995 and an excellent track record. We therefore chose the Gaia wind turbine for this stand-alone system. The wind turbine was modified and attached with a newly developed stand-alone control. The system was subsequently tested and conclusions are that a stand-alone wind turbine in combination with a battery storage is a feasible way of procuring energy for remote villages, provided there is ample supply of wind.

Denmark Focus

Wind Turbine Installations in Denmark

Today, wind power covers approximately 20% of the entire electric energy consumption in Denmark. By the end of 2003, the total capacity of installed wind power in Denmark was approximately 3,114 MW. The distribution of this capacity was 2,708 MW onshore and 420 MW offshore. During the first quarter of 2004, only five new installations with a combined capacity of 1935 kW have been reported, which shows that the installation process has stopped, at least temporarily. Provided that wind conditions are normal, the electricity produced from wind energy will cover almost 20% of the country's present electricity demand, which was about 35,200 GWh in 2003. In spite of a growing capacity, the actual number of wind turbines is decreasing, illuminating the success of the Danish re-powering scheme. The average size of new wind turbines has gradually increased, from 750 kW in 1999 to 889 kW in 2000 and 2001; 1.36 MW in 2002, and 2 MW in 2003.

Growth for Offshore Installations

Danish offshore wind power plants presently constitute more than 80% of the total offshore capacity in the world. In 2003, new offshore installations accounted for 196 MW, whereas onshore capacity increased only by a mere 29 MW. The Nysted wind farm project, comprising a total of 72 2.3 MW Bonus wind turbines, has been completed. Connecting to the grid was commenced in April 2002, installation of cables and turbines began in May 2003, and the last turbine was operational by September 2003. Another offshore farm, Samsø, consisting of ten wind turbines from Bonus Energy A/S, was inaugurated on 28 February 2003. This farm has an installed capacity of 23 MW and is located approximately 4 km to the south of the island of Samsø. The turbines are 100 m in height and they have been erected on monopiles. Finally, the utility Elsam has established an experimental offshore cluster of four wind turbines on a harbour site in Frederikshavn. The cluster is made up of two 3 MW Vestas turbines, one 2.3 MW Bonus turbine, and one 2.3 MW Nordex turbine.

Finance

The off-shore development means that private investment in wind turbines, which has been the driving force through the entire history of deployment in Denmark, now has been replaced by professional investors and the utilities. By the end of 2003, more than 50% of the capacity in the eastern part of Denmark was owned by the utilities, whereas more than 80% of the capacity in the country as a whole was privately owned.

Policy developments in Denmark

On 29 March 2004 the Minister for Economic and Business Affairs in Denmark entered into an agreement with six of the coalition parties (V, K, S, SF, RV, KD) on the construction of new offshore wind farms and the replacement of wind turbines in unfavourable locations by the erection of new wind turbines in more suitable places. This agreement calls for increased research and development as well as further demonstration of advanced energy technologies. The primary objective is to ensure that electricity is sold at market value. Some salient points of particular relevance to wind energy are given in the following.

Off-shore wind farms

With respect to the long-term reliability of energy supply and continued diversification of power supply to a wide range of energy sources, and in order to continue to support the development of wind energy technology, the parties agree to ensure the underlying financial basis for the construction of two offshore wind farms, each with a capacity of 200 MW. This process will begin with a call for bids. The locations proposed will be Horns Rev and Omø Stålgrunde. A final decision on the location will not be made until the environmental impact assessment (VVM) has been negotiated. Bidding will be in the form of 'bids after negotiations'. The first round - pre-qualification screening of interested investors - will be followed by a second round; entering of bids. Subsequently, the Danish Energy Authority will enter into negotiations with the bidders who delivered the lowest bids for the various contracts.

Consumers' obligations

The agreeement also includes a cancellation of the consumer's former obligation to purchase electricity produced by wind energy and a simplification of discounting rules. The obligation of the consumers to purchase wind-produced energy will be fully replaced with financial support, thus ensuring an unchanged discount price for wind turbine owners in accordance with the transition regulations in force. The present low rate of interest could make it advantageous for wind turbine owners to convert previous loans into new obligation loans with land collateral. For existing wind turbines that are no longer covered by the transition regulations, a simplified calculation of the market price will be offered as well as a subsidy of up to 0.36 Dkr/kWh. Also, the market price will be fixed as a monthly average as opposed to being based on the spot price for each individual production hour.

Høvsøre test station

Scrapping of old wind turbines

New scrapping regulations include the removal of approximately 900 older wind turbines with capacities of up to 450 kW. The aim is to establish a new overall capacity of up to 350 MW within the next five years. Scrapping will be subsidized at a rate of 0.12Dkr/kWh, paid in connection with production from a new wind turbine during 12,000 full-load hours, and covering twice the installed effect of the scrapped wind turbine. If the average monthly discount price for wind turbine producers exceeds 0.48 Dkr/kWh in any month, scrapping credits will be reduced accordingly.

Research, demonstration, and development

Due to the so-called PSO programme (Public Service Obligation), the authorities in charge of the national transmission grid are obliged to invest a certain proportion of their annual turnover in research, demonstration, and development projects in order to further an environmentally friendly and reliable electricity supply in Denmark. The financial basis for this research will be increased by DKr 30 million to a total of DKr 130 million per year over four years.

Høvsøre test station

During the last couple of years a major effort has been put into the establishment of a new test station for multi-megawatt wind turbines. We have chosen a location at Høvsøre on the north-west coast of Jutland in order to obtain a reasonable number of high wind situations during each test, which is bound to take place within a limited span of time. At this particular location, the average wind speed in the course of a year is 9.1 m/s at a height of 78 metres, and the wind frequently exceeeds 15 m/s. Furthermore, the terrain is flat and therefore well-defined, all in all an ideal location for testing under extreme wind conditions. The test site comprises five test stands large enough to allow turbines of up to 165 metres in height and a capacity of up to 5 MW each. To the west of each test stand a met-mast has been erected, as well as two 165 m masts equipped with air traffic warning lights. The first wind turbine at the test site, a 3 MW turbine with a rotor diameter of 90 metres and a hub height of 80 metres, was put into operation on 7 November, 2002. At present, five wind turbines are installed at the test site. The manufacturers are Bonus Energy A/S, Nordex Energy GmbH, and Vestas Wind Systems A/S.

Dr. Peter Hauge Madsen
Dr. Erik Lundtang Petersen

NTUA

NTUA

National Technical University of Athens

The National Technical University of Athens (NTUA) is the oldest and most prestigious educational institution of Greece in the field of technology, and has contributed unceasingly to the country's scientific, technical and economic development since its foundation in 1836. The Electric Energy Systems Laboratory (EESL) has been actively involved in research in the areas of Power System Analysis, Planning and Control, since 1978. Research on Wind Power dates since 1980. Since that time it has developed significant experience in issues relating with the tech-nical constraints and problems in the integration of wind power into the electrical grids, the management and control of isolated power systems with increased wind power penetration, the issue of electricity tariffs for dispersed renewable generation, issues of power quality of wind turbines and wind parks, as well as with the design of electrical components for variable speed machines, such as electrical generators, including permanent magnet synchronous generators, power electronics converters and controls, and lightning protection of wind turbines and wind parks.

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Situation in Greece

In total, 100 WECS having an installed capacity of around 75,5 MW, concerning 18 separate projects, have been connected to the electricity supply network within 2003, bringing up the total installed wind energy capacity to 424,4 MW (772 machines). The current national target for the wind energy is now 2000 MW for the year 2010, following EU directions. The energy produced from wind turbines during 2003 is approximately 850 GWh, while the energy produced in 2002, 2001, 2000, 1999, 1998 and 1997 was 650 GWh, 756 GWh, 460 GWh, 160 GWh, 71 GWh, 38 GWh, respectively. The total energy consumption in the country is of the order of 50 TWh, so the energy produced from wind turbines accounts for about 1.5 % of the energy demand.

For the 2010 the total energy consumption in the country is expected to reach 72 TWh.

PhD Thesis Fotis D. Kanellos
Contribution to Simulation and Identification of Wind Turbines with asynchronous Generator for the Development of reduced Order Equivalent Models

ABSTRACT: This thesis consists of two major parts. The first part deals with the simulation of wind turbines using conventional detailed models. Several control and modulation techniques are also modeled. In the second part equivalencing techniques are applied. These methods depend on the simulation results of the detailed models that have been derived in the first part of the thesis. The second part of the thesis can be further divided in two sections concerning the use of conventional methods for the identification of linear systems and the use of artificial neural networks.

In more detail, the detailed mathematical models of constant and variable speed wind turbines with asynchronous generator are examined. The models of the aerodynamic system, the mechanical system (three or six elastically connected masses) and the asynchronous generator are next derived. The way that the optimal speed characteristic is derived is also described. Next the models of the indirect, direct vector control and scalar control of the asynchronous generator are described. Also, the cases that the output power is controlled via output current or voltage regulation are examined. The above models are used for the comparison of variable and constant speed wind turbines with asynchronous generator and the examination of the network voltage control system of a variable speed wind turbine.

Some of the most important modulation techniques are examined and the obtained simulation results are compared. Modulation techniques that use carrier signal, (SPWM, ramp comparison), and PWM techniques without carrier signal as hysteresis current control and voltage or current space vector modulation, are modeled. The models of modulation techniques are combined with the models of the subsystems of a wind turbine and through the obtained simulation results conclusions for voltage quality, harmonics propagation throughout a network, avoidance of mechanical resonances etc, are extracted.

Next the method of extracting equivalent models for variable or constant speed wind turbines is described. System identification theory is used for the derivation of the equivalent models. The wind turbine system identification is performed for two cases and two different equivalent models are derived. The first model is suitable for power quality studies while the second can be used for the calculation of the wind turbine behaviour, when a symmetrical three phase fault occurs. The wind turbines' equivalent models are combined with the equations of a distribution network and a reduced order equivalent model of the system is derived. Simulation results confirm the accuracy and the advantages of the equivalents models for both power quality and fault current estimation studies.

Artificial neural networks are an alternative for the identification of a variable or constant speed wind turbine system. For the system identification feed-forward and recurrent neural networks, can be used. The obtained equivalent models of constant and variable speed wind turbines are suitable for power quality studies. The obtained equivalent models are used for the simulation of a simplified model of an actual distribution network and the obtained results are compared with the ones of the detailed models.

All the derived models are integrated in software with a friendly interface named WIN.T.LAB., developed in MATLAB. Except the models' libraries several other tools are also incorporated e.g. for the parametrical development of different kinds of artificial neural networks, for the reproduction of random wind speed time-series etc., enhancing program's capabilities.

News from CRES

Center for Renewable Energy Sources (CRES)

CRES was founded in 1987 and since 1994 is the Greek national coordination center for Renewable Energy Sources and Energy Saving. CRES is supervised by the Ministry of Development, enjoying, however, financial and administrative independence. The Wind Energy Department of CRES has accumulated a notable experience through its participation in numerous wind energy related national and international projects, covering all aspects of wind energy, including wind energy potential assessment, wind turbine and wind turbine components design, testing and assessment, wind powered desalination and integration in autonomous power systems.

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DAMPBLADE - "W/T Rotor Blades for Enhanced Aeroelastic Stability and Fatique Life Using Passively Damped Composites Blades"

A four-year research program enabling development of damped wind turbine blades, having the acronym DAMPBLADE, is supported by the E.C. under its 5th Framework Programme and coordinated by CRES.

In DAMPBLADE, unique composite damping mechanisms are exploited aiming to increase structural damping: tailoring of laminate damping anisotropy, damping layers and damped polymer matrices.

Additional objectives of the project are the development of missing critical analytical technologies enabling explicit modeling of composite structural damping and a novel "composite blade design capacity" enabling direct prediction of aeroelastic stability and fatigue-life; development and characterization of damped composite materials; and evaluation of new technology via design and fabrication of damped prototype blades and full-scale laboratory and field-testing.

After three years work, a 19m glass/polyester damped blade was designed, manufactured and tested. Modal analysis of this blade at CRES' testing facility showed a nearly 80% increase of the damping ratio of both the first flap and lag modes, compared to the earlier - standard - design practice.

STABCON - "Aeroelastic Stability & Control of Large W/T"

The main objective of the STABCON project is to develop reliable design tools for analysis and optimization of large wind turbines with respect to aero elastic stability and active control. Derived guidelines will describe how to:

- Identify important parameters for aero elastic stability, and optimize them for increased damping to passively suppress instabilities and reduce loads.
- Identify the potentials of active aero elastic control to reduce loads by suppressing instabilities and alleviating gusts, and enhance power production.
- Perform integrated design studies of active-stall and pitch-regulated turbines to allow control of lifetime consumption and adaptation to specific conditions.

CRES contribution to the project deals with the development of a new, state-of-the art aero elastic stability tool covering complete wind turbines in operation, the assessment and the refinement of it through measurements in a 2.5MW pitch regulated wind turbine, the morphological study of aero elastic control concepts, and evaluation of different control systems.

The final outcome of the above is modelling guidelines for wind turbine designer. So far an aero elastic tool has been developed, which is refined by analysis of wind turbine measurements.

KNOWBLADE - "Wind Turbines Blade Aerodynamic and Aeroelastics: Closing Knowledge Gaps"

The objective of the project is through research activities to fill in important knowledge gaps in the wind turbine community by applying Navier-Stokes solvers to a series of unsolved aerodynamic and aero elastic problems.

More precisely the project has set out to:

- Improve the power prediction capability of Navier-Stokes solvers in connection with rotor computations. To this aim, laminar/turbulent transition models of different complexity have been employed into the rotor codes, and the potential of advanced turbulence models has been investigated.
- Model different aerodynamic accessories commonly used in wind turbine blades as pulsating jets, vortex generators, stall strips and zig-zag tapes.
- Investigate flow details of practical interest to the wind turbine industry as the stand still operation, and the influence of the tip shape.
- To advance state of the art Navier-Stokes aero elasticity tools from 2D to quasi-3D and fully 3D codes, making it possible to investigate the aeroelastic stability of real rotor blades.
- To investigate the aero elastic damping characteristics of aerodynamic accessories on 2D airfoil sections.

CRES is involved in the modelling of the aero elastic accessories and the aero elastic computations of real rotor blades. So far, a phenomenological model for vortex generators has been devised and it has been employed in a 2D Navier-Stokes solver for computations around airfoils.

In addition the influence of stall strips and roughness tapes on the aerodynamic performance of airfoils have been investigated.

Also a quasi-3D aeroelasticity tool has been developed and it has been used for stability computations in real 3D rotor blades. At the same time, aeroelastic investigations of the stability of 2D airfoil sections are carried out.

Finally CRES is to combine the knowledge produced by the 2D and 3D computations carried out in configurations with vortex generators and the aeroelastic stability investigations of real wind turbine blades into engineering-type models.

SODAR - "Wind Energy Sodar Evaluation (WISE)"

The general aim of the project is the application of the SODAR (sound detection and ranging) technique for wind speed measurements in relation to the operating characteristics of large wind turbines. Accurate power curves are essential for the assessment of the financial risk of the installations at a certain site.

CRES contribution in this project has to do with the installation of the SODAR system at CRES wind park in order to evaluate its performance on the measurement of large turbines power curves.

The power curves of large wind turbines will be measured using SODAR over a several weeks time period. These power curves then will be compared to power curves measured with a meteorological mast. The uncertainty of power performance measurements with a SODAR system will be determined.

The SODAR system has already been installed and measurement campaign is ongoing.

SODAR System at CRES Wind Park

RES2H2 - "Cluster pilot project for the integration of RES into European Energy Sectors using Hydrogen"

It is common that areas with a good wind resource are remote and the available electricity distribution grid is too weak to be able to transport all potentially available electricity to consumption centres without major transmission line refurbishment or extension.

Wind park developers thus have to wait for new lines to be built to be able to obtain installation permits and erect wind parks. The possibility of producing a different product altogether - Hydrogen - that would be transported through alternative means - road network - and fed to the existing Hydrogen market as an industrial gas or the future Hydrogen market as an energy carrier will be investigated in the context of the RES2H2 EC project.

A wind-hydrogen system will thus be developed at the wind park of the Center for Renewable Energy Sources (CRES), near Athens, in Greece. Construction is planned to start in the second half of 2003. A 25 kW electrolysis unit operating at a pressure of up to 20 bar will be connected to a 500 kW gearless, synchronous, multi-pole Enercon E40 wind turbine.

The electrolysis unit will operate at variable power input, according to the available wind, in a "peak-shaving" mode. Excess energy will be fed to the grid.

The electrolytic hydrogen will be purified prior to entering into a buffer tank. Part of the produced hydrogen will be stored in novel metal hydride tanks of approximately 50 Nm3 H2 capacity.

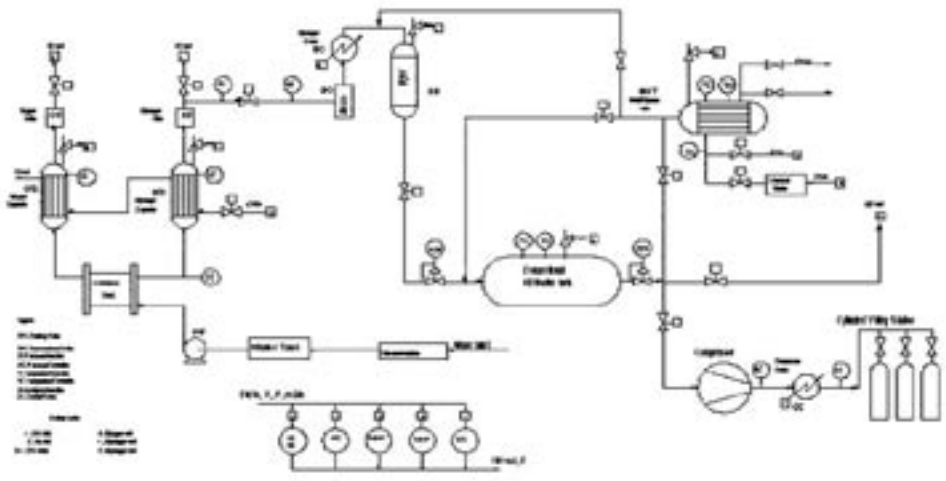
The rest of the produced hydrogen will be compressed to approximately 220 bar and fed to cylinders at a filling station. The process flow sheet of the plant is shown in the Schematic Diagram.

The main CRES responsibilities in the RES2H2 project comprise:

- Theoretical studies
- Design, engineering of the Greek test site
- Study, commissioning and installation of a 25 kW electrolysis unit
- Study, commissioning and installation of control, data monitoring and acquisition unit
- Operation, data logging and analysis of the system

On going activities

- Theoretical studies have been completed
- Design and engineering are in their final phase
- A subcontractor for the study, commissioning and installation of an electrolysis unit has already been identified. A 25kW pressurised electrolyser will be delivered and installed at the wind park of CRES in the second semester of 2004
- A subcontractor to provide a control, data monitoring and acquisition unit will be identified till October 2004



Schematic diagram of the hydrogen system

Researchers Exchange at CRES

From the beginning of the year 2004, two Spanish Researchers, work for CRES within Windeng Research Training Network, funded through the Fifth Framework Improving Human Potential Programme (1998-2002).

Barbara Jimenez is a post-doc fellow. Barbara's work in CRES is divided in two parts:

a. Training about wind energy

The first step is to get into in the field of the wind energy. The steps are as follows:

- knowledge about wind energy: wind turbines, how to measure and evaluate wind at a prospective wind turbine site,
- collecting wind data and developing maps of the average monthly and annual wind speeds, its application.
- statistical analysis of the wind data, including Weibull distribution constants (per direction sector and Exchange global), turbulence intensity evaluation and polar plots (wind roses) of the time and energy distribution of the wind.
- computer skills: WindRose; LINUX; Generic Map Tools (GMP).

The objective of this training will be:

- Create a database on Wind Characteristics.
- Developing maps of the average monthly and annual wind speeds
- Analysis of short-term measurements and correlation to long-term data

b. Training in project management and proposal preparation

The objective will be to acquire project management skills. The steps are as follows:

- Definition of areas of interest for CRES.
- Identification of possible funding schemes. A survey of all available funding sources (EU programmes, national programmes, industry funded programmes, etc) has been made and funding schemes more appropriate for CRES interest and legal status has been identified.
- Preparation of a web page with funding schemes more appropriate for renewable sources of energy: EU programmes, National programmes, legislation, how to search partners, call for tenders.
- Formulation of proposal's main idea.
- Search for partners. Contacts with other institutions, companies, etc.
- Presentation of the proposal. This step includes the preparation of the final proposal text to be submitted to the funding authority, and contacts with the project partners, and the funding authority for the submission of the proposal.

Gil Lizcano Barbezier is a pre-doc Mari Currie fellow. The main tasks of his work are to investigate, implement the mesoscale MM5 operationally for wind energy power forecasting on complex areas. Some efforts have been undertaken to understand the influence of the different PBL schemes implemented in the MM5 model on the simulated wind profile. A verification of the model against measured data is being conducted for Lavrio site.

Future works are to coupling the model with CRES Boundary Layer model. At the moment, most work has been done on computational issues regarding the 24h/day operation of the model.

A close collaboration with two other partners of the Network (EHF, University of Oldenburg, Germany and the Finnish Meteorological Institute, Finland) has established in order to share information about the use of the model, data, relevant papers, etc.

Dr. Takis Chaviaropoulos
Eftihia Tzen

News from Kassel University

University of Kassel

For more than 20 years, the Institut für Elektrische Energietechnik (IEE) at the university of Kassel works in the field of electrical power supply and wind energy research. The institute has ca. 20 employees. The research fields of the institute are, power conditioning, PV hybrid systems and wind energy technology. The main topics in these fields are; the electrical grid formation, the control and supervision of feed-in and storage systems, the grid integration of wind energy turbines, photovoltaic systems, diesel aggregates, phase shifters and battery units and the accompanying inverter technology. Additionally, the institute provide regular and advanced lecturers in the field of energy technology, which include; Fundamentals of Energy Technology, Use of Wind Energy, Control and Grid Integration of Wind Energy Converters, Photovoltaic System Technology, Control of Electrical Energy Supply Systems, Solar Energy and Electrochemical Storage.

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Project: "WindPRO - eGRID"

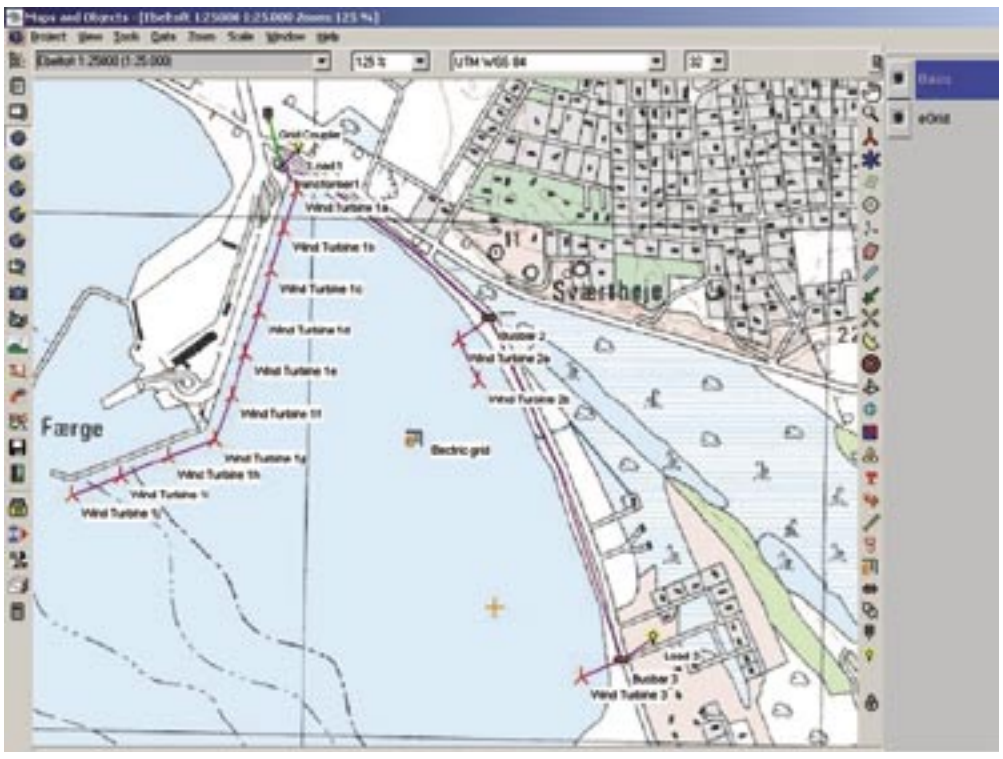
A Tool for Grid Integration of Wind Farms

Within the frame of the European R&D project DISPOWER, Task 4.2, the world leading software for wind energy planning and wind project design "WindPRO" is being expanded by a grid calculation module called "eGRID". It complements the "WindPRO"-software by a tool, which will help to design or to optimise the grid connection of at least one single wind turbine generator (WTG) or up to an entire wind farm. This new software module has been realised during the last two years in close collaboration of EMD and Uni Kassel with ISET and Ratiosoft, whereby Uni Kassel was responsible for the mathematical modelling of the grid components as well for the development of the "eGRID" calculation algorithms.

The intention of the "eGRID" software module was, to develop a user-friendly software tool with integrated models for different WTG types, which makes it possible for customers with limited experiences in grid calculation to design the grid connection of wind power plants much more easier with "eGRID" than with other commercially grid calculation software products. In order to perform the most important wind farm grid connection tasks, it was necessary to implement the following calculation algorithms and tasks in the "eGRID" software: - Design check, - Short-circuit power, - Voltage variations (steady state and transient, due to switching operations of WTG), - Long term flickers and - Electrical losses within the wind farm.

Based on the philosophy of the whole WindPRO package, we have made it also for the "eGRID" module possible to select different wind turbine generators types as well as grid components (transformers, cables and overhead lines), which should be used within the wind farm, out of pre-defined component libraries or to fill in with user-defined data. The new developed "eGrid" tool allows to calculate radial networks of all voltage levels. Besides this, it is possible to check, if the investigated wind farm grid connection fulfils the relevant limiting values of the selected norm or guideline. For the positioning as well as for the interconnection of the grid components geographic co-ordinates in combination with geo-referenced maps are used. The user has the possibility to select different calculation tasks (design check, short-circuit, etc.) as well as the guideline, which will be used to check the calculation results. Naturally, it is possible to define own limit values for each calculation. The calculation results are presented on different pages in WindPRO standard layout. There is one page which contains the main result of all calculations. Further, each selected calculation leads to an additional page for this calculation which contains detailed information about the calculation setup and the results. The new grid calculation tool "eGRID" for the design and optimisation of wind farm grid connection, is implemented in the next version of WindPRO, which will be available on the market in a couple of months.

Dr. Gunter Arnold
Dr. Siegfried Heier



Screenshot of the WindPRO-eGRID module with a map of a windfarm and the used grid components summary WindPRO-eGRID

Farewell to Prof. Werner Kleinkauf

For many years, Prof. Dr. Werner Kleinkauf was chief of the department Elektrische Energieversorgungssysteme (IEE-EVS) at the University of Kassel as well as founder of the Institut für Solare Energieversorgungsstechnik (ISET) e.V.. He was given the emeritus status at the end of the winter semester 2003/2004. Dr. S. Heier was given the provisional management of the department. The outstanding and internationally accredited work of Prof. Kleinkauf was recognized at a celebratory colloquium of the faculty of Elektrotechnik/ Informatik at the University of Kassel on April 21st, 2004 and numerous guests of science, economy and politics attended.

Research and development of efficient techniques to use renewable energies were the thread and the straight line of Prof. Kleinkauf's professional lifework. His impulses for a new energy system technology were always formed with a combination of modern power electronic and micro processor technology as well as the application of intelligent control methods.

Prof. Kleinkauf and the current dean of the faculty of Elektrotechnik/Informatik Prof. Leohold at the celebratory colloquium on April 21st 2004

Since 1976 he was in charge of the department Elektrische Energieversorgungssysteme at the University of Kassel and established the electrical system technology for renewable energies for the education of the students. In order to support the main focus on electrical energy technology, Prof. Kleinkauf established the Institut für Elektrische Energietechnik (IEE) at the faculty of Elektrotechnik/Informatik together with the departments of Antriebstechnik, Elektrische Maschinen and Anlagen- und Hochspannungstechnik in 1991.

1988 he established ISET, which developed to an internationally leading research institute in the field of electrical system technology for renewable energies. This institute works close together with Kassel's University. It has around 70 employees who are working at two different locations - Kassel and Hanau. They are researching and developing techniques to use renewable energies and decentralized energy supply.

Leading ISET and doing lots of buildup work for 10 years, Prof. Kleinkauf handed it over to Prof. Schmid in 1998. Next to his scientific work and his lectures at University of Kassel, Prof. Kleinkauf was dean and dedicated to supplement informatics to the faculty of Elektrotechnik/Informatik. He managed to acquire substantial funds for foundation professor-ships and established a new attractive range of studies.

Next to many activities in committees, boards of trustees and associations Prof. Kleinkauf is still dedicated to extent the scientific and economical upgrade of the know-how for using renewable energies. As chairman of the board of the Kompetenznetzwerk Dezentrale Energietechnologien Nordhessen e.V. (deENet) founded in 2003, he wants to combine the multifarious regional capacities in science, development, production and planning, in order to enlarge the attractive surroundings and the excellent competition position for energy technology in Nordhessen to a global growth market.

Dr. Gunter Arnold

PhD-Thesis Gunter Arnold

In February 2004 Gunter Arnold successfully finished his PhD-thesis, which is entitled "Entwicklung eines Systems zur Stabilisierung von Elektrizitätsversorgungsnetzen mit Erneuerbaren Energien" (Development of a system for the stabilisation of electrical power supply systems by renewable energy sources).

This PhD-thesis is focused on the development of a grid control system for the stabilisation of electrical power systems through wind turbine generators (WTGs) and other renewable energy sources (RESs). The main objective of the new developed grid control system is to use already existing control possibilities of wind turbine generators and other renewable power plants for grid stabilisation and especially for manipulation of the grid voltage.

The technical and legal frame conditions for developing the grid control system, which are required for the grid integration and operation of renewable power plants connected to the grid, are presented in the first part of this thesis. At first the structure and the general operational behaviour of the public power supply systems and the procedures for grid control are described in detail so that the established grid supporting and grid setting-up behaviour of conventional power plants can be transferred to renewable power plants and especially to wind turbine generators. Subsequently, the substantial national and international norms and guidelines for the grid integration and the interconnected operation of renewable power plants, considering the latest changes (E.ON-guideline) are presented.

It is possible to obtain important perceptions concerning the basic behaviour and the magnitudes of the grid influences as well as of the grid stabilising features of the new developed grid control system through the calculation algorithms and the exemplary performed grid simulations, which are explained in the next section. The typical characteristics of the renewable power plants are described in a further section in order to implement already existing type specific control features into the new developed control system.

The comprehensive presentation of the new developed grid control system is very important for this PhD-thesis. At first, based on preliminary theoretically investigations, the general requirements of the components and the principle structure of the grid control system are pointed out. Subsequently, the selected hardware and software components, which are used for the realisation of the grid control system, are described in detail.

The long-time practical experiences observed with the first prototype of the grid control system are presented in the last section of this thesis. With the recorded measurement data, it was possible to obtain a lot of important perceptions concerning the grid stabilising features of the different renewable energy sources and especially of different wind turbine generators as well as the behaviour of the investigated grid area. Furthermore, it was successfully demonstrated that the grid voltage in a well defined grid area could be manipulated in the desired manner by using the new developed grid control system in combination with wind turbine generators or CHP plants.

Gunter Arnold after the PhD-disputation together with his PhD-thesis supervisors PD Dr. habil. Heier, Prof. Dr. Kleinkauf and with the two additional examiners Prof. Dr. Weidemann and Prof. Dr. Schmid.

ISET News

Institut für Solare Energieversorgungstechnik (ISET)

The "Institut für Solare Energieversorgungstechnik e.V." (ISET) was founded in 1988 as a non-profit research institute, associated with Kassel University. In order to realise a strong link to industry needs in the strategic R&D programme, about 50% of the scientific advisory board are representatives from the industry. Today, about 75 employees are working in ISET's facilities at Kassel and Hanau. ISET's activities in the field of wind energy range from theoretical investigations via experimental research and the execution of field tests and measurement programmes to the development of control, inverter and information systems. The main focus is on the electrical and systems engineering aspects of wind power applications which arise both on component and grid integration level.

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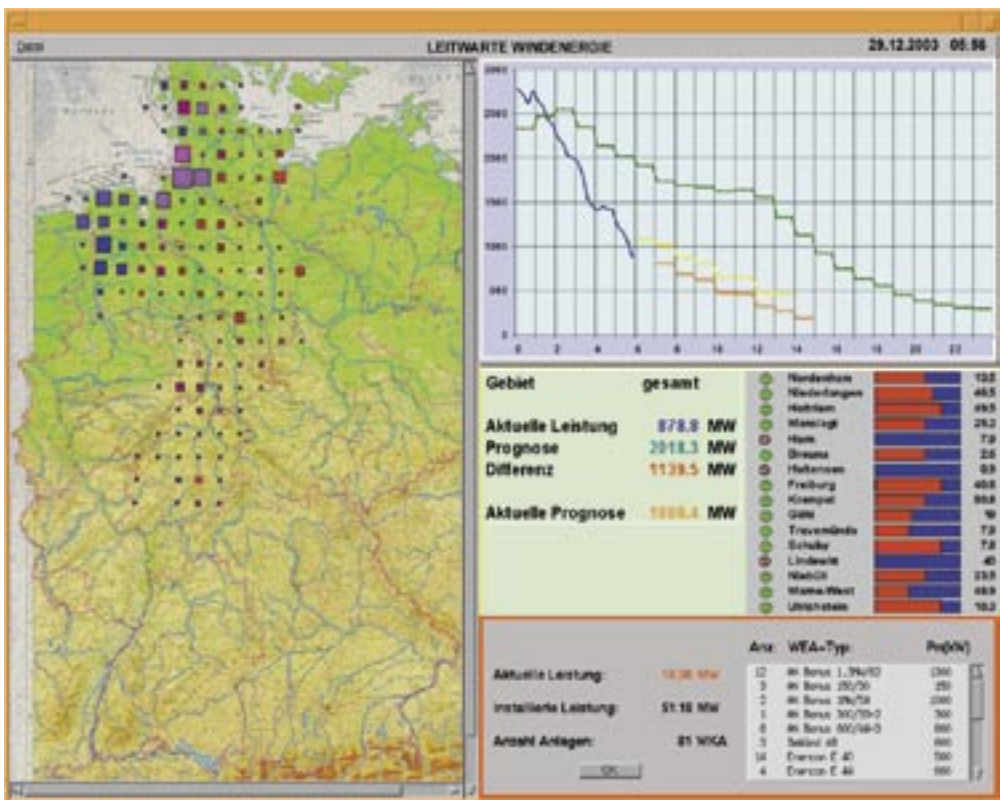
Online Determination of Wind Power Feed-in

In German regions with high wind speed and high penetration of wind power, the minimum load of the grid is already covered by wind energy plants. Due to this development, questions of power contributions from wind energy and their influence on the operation of generation schedules and of load management in the grid are increasingly coming into focus.

As the data compilation of the entire currently feed-in power from all wind plants is economically not possible because of the high number of wind turbines (WT), the total feed-in from the WTs has to be calculated at real time with the help of model calculations. An evaluation model, developed by ISET, transforms the measured time periods of the power output of chosen wind farms to the total feed-in from wind turbines in the supply area. A selection of wind farms was determined, which were equipped with online data acquisition systems to provide the basis for projections. The measurement data from the chosen wind farms is transmitted by leased lines to the control centre. The measured data are the basis for the extrapolation of entire fed-in wind power, which is done by means of equation systems and parameter. The online evaluated time series for the load dispatcher is retrospectively compared with the results of models, using extrapolation of wind and power data, and continually conformed and improved, by means of parameter optimising. A high level of precision can be obtained through this regular testing and conforming of parameters. The ISET model for an online determination of wind power feed-in has been successfully utilised for some years by the power generation schedule of the E.ON grid and is also successfully used since the beginning of 2003 the at the RWE Net and is currently adapted for the operation at Vattenfall Transmission Europe.

Dr. Kurt Rohrig



Wind power forecast: ISET's interface for prediction with artificial networks and online model for current wind power feed-in

Wind Power Prediction

Besides exact information concerning the statistical behaviour of fed-in wind power (cp. Project „Online Determination of Wind Power Feed-in"), the forecast of expected short to medium-term power is important for the load management in the control zone of network operators. They make currently use of Artificial Neural Networks (ANN) and numerical weather forecasts.

The capability of ANN, in predicting wind power output, has been thoroughly examined by several R&D projects. Their advantages over standard computing being usually based on physical models, are that they can ‚learn' from experience, even when their inputs are contradictory or incomplete.

As a result of the intensive R&D investigations during the last years ISET developed a new wind power prediction model in co-operation with the project partners. This model not only makes predictions about the wind power for the control zones of E.ON net and Vattenfall Europe Transmission, but gives also forecasts for the entire area of the German interconnected grid as well as for the planned offshore wind parks. Another objective is an increase in precision with respect to the forerunner model.

Twice a day the Deutsche Wetterdienst (DWD) makes meteorological forecasts for selected representative locations from his local model (LM) for the next 72 hour period. The respective wind generation is then calculated with ANN. ANNs are trained using past wind and meteorological data, to recognise the relationships between variations in the wind and power output of the WTs.

The predicted wind power of selected wind farms will be projected in a next step by the model, which had been presented in the project „Online Determination of Wind Power Feed-in" with respect to the entire feed-in of the control zones.

Every morning at 9'00 o'clock a forecast of the expected wind power for the next 72 hours is 24-hour forecasts calculated for the system management in the control zones. In addition to the predicted wind data the wind power, which was measured online is used as input value for the model to improve the short-term forecast (1-8 hours). For the short-term optimisation of the power generation schedule an increase in precision can thus be attained. The online model enables a prediction of the total wind power feed-in of large utility areas for a period from 1 to 48 hours with an average aviation of approx. 9% (based on the installed wind power). For the additional forecast of 1 to 8 hours the average deviation is reduced to 5 %. The continuation of these approaches will lead to additional improvement of the grid integration of high wind capacities.

Dr. Kurt Rohrig

Test of a 5 kW Prototype of a Wind Turbine

Prototype of a 5 kW wind power turbine for the coupling to the public grid and for the use in small autonomous supply grids

In a common project, encouraged by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the companies SMA, Niestetal, and aerodyn, Rendsburg, develop a wind turbine with a rated output of 5 kW in cooperation with the Kassel University and the ISET. This wind turbine is supposed to be much more economical than the previous small plants on the market and it can be used both at the public grid and in small autonomous supply grids.

The ISET will put into operation the first preproduction model on a small test field in the north of Kassel at an island grid, test its basic functionality and measure the power performance curve. The compatibility of the small plant with the modular built up island grid, developed jointly by ISET and SMA in preceding projects, represents an important aspect of the investigations.

The island system and wind measurement technology which are necessary for the test have already been installed at the site „Alte Schanze" in Immenhausen near Kassel.

Berthold Hahn

OffShore M&R

Maintenance and Repair for Offshore Wind Farms using Fault Prediction and Condition Monitoring

OffShore M&R's main objective is to lay the foundations for condition depending maintenance and repair (M&R) strategies for wind energy converters in offshore wind farms. As a basis for these strategies, condition monitoring and fault prediction have to be integrated into wind energy converter and wind farm technology. Existing condition monitoring and fault prediction techniques will be investigated with respect to their applicability in wind energy converters. New wind energy converter specific techniques will be developed. Algorithms for condition depending M&R scheduling will be worked out. All parts of the project will be designed as "plug-in" components for existing products, e.g. for wind farm management tools (CleverFarm). The project's work will be carried out in several phases. Firstly, the definition of data transfer, the selection of suitable hardware platforms, adaptation of existing and development of new data processing software and design of condition depending M&R strategies will be carried out. In a second step the design results will be integrated into wind energy converter and wind farm technology. Finally, functional testing of the developed components will be carried out in laboratory. The revised components will be tested in wind energy converters of several wind farms. The project consortium consists of research institutes, wind energy converter manufacturers, fault prediction system providers, wind farm operators

Jochen Giebhardt

Training Course for Engineers from Brazil, Argentina and North Korea

In January and February 2004, 18 engineers from Brazil, Argentina and North Korea were trained at ISET in wind project planning. Lectures, sessions and project work treated the whole range of topics from meteorology, technology, to finance and wind turbine O&M. ***Cornel Ensslin***

Latest PhDs in the R&D Division „Information & Energy Economy“

Dr.-Ing. Kurt Rohrig

Rechenmodelle und Informationssysteme zur Integration großer Windleistungen in die elektrische Energieversorgung

Computer Models and Information Systems for Technical Assistance of Large Wind Power Integration

In this thesis several computer models, mathematical models and approaches for the technical assistance of large scale wind power integration into the electrical energy supply system are developed. The model for the simulation of contemporaneous fed-in wind energy computes sum curves of arbitrary composed groups of wind turbines, based on measured wind and power data of the near past. The model generates useful data for the analysis of wind power generation, also for future scenarios. For examinations with regard to the impact of spacious distributed wind generation in the range of billion watts, several statistical analyses and descriptive illustrations are elaborated. The model for the calculation of the current fed-in wind energy computes valuable information for the power and frequency control of the grid operators. The model uses online measured wind farm power data of representative wind farms. The corresponding procedures for the determination of the representative sites and the check of the representativeness are the basis for a precise calculation of the wind generation for large areas, based only on a few power measurements. Further valuable tools for an optimised integration of large wind power into the energy supply system are the prediction models and approaches. These models calculate the short- and medium-term expected wind energy. In this thesis, two new models are developed who are based on the use of Artificial Neural Networks. These models determine the course of the expected wind energy generation for grid regions and control zones by evaluating of measured wind farm power data or predicted meteorological parameters. The assembling of the models for the calculation of the current wind generation and the prediction models is an attractive software solution for the implementation of the item wind energy into control centres of the system operators. The interfaces and the modular structure of this tool will enable a simple and fast implementation into any system. Based on the efficiency of the online- and prediction models, new operational control strategies for wind farm clusters in the range of gigawatts are developed. These strategies will enable an economical and ecological optimised integration of the planned offshore wind farms into central power plant scheduling.

Dr.-Ing. Bernhard Ernst

Entwicklung eines Windleistungprognosemodells zur Verbesserung der Kraftwerkseinsatzplanung

Development of a Wind Power Prediction Model for Improving Power Plant Scheduling

In Germany the promotion of wind energy led to research and development of new wind turbines and resulted in a high penetration of wind power in the German electricity supply. Wind-generated power provides a noticeable percentage of the total electrical power consumed and further grow is expected. In some areas of the German Transmission System Operators (TSO) more than 100 % of the electricity consumption has been covered by wind power at times. This indicates that wind has become a significant factor in electricity supply.

The determination of the amount and the sequence of the wind power feed-in for the following day is the most difficult task of the generation schedule. Apart from power station outages and stochastic load variations, variations and forecast errors of wind power cause regulation and compensation power needs.

The new developed prediction model delivers the temporal course of wind power to be expected for 16 representative wind farms for up to 48 hours in advance. For these representative locations, the German weather service (DWD) provides routine time series of predicted meteorological parameters in 1-hour intervals. The corresponding power of the wind farm is calculated with the help of Artificial Neural Networks. This method is superior to other procedures, which calculate the relation between wind speed and power by the use of power curves of individual plants, as the actual relation between wind speed (and other meteorological parameters) and wind farm power output is dependent on a multitude of local influences and is therefore very complex, i.e. physically difficult to describe.

The prediction model is made of two modules. The first one provides the wind power prediction for the following day based on the weather forecast delivered by the DWD. The second module uses meteorological input parameters together with measured power data from the near past. Through the comparison of these time series deviations of the temporal course can be recognised and corrected to obtain a very accurate prediction for the next 3 to 6 hours. The ability of ANNs to derive short-term predictions out of the power measurements of the near past is used here as well. The predictions of the representative wind farms are upscaled by the so called Online-Model to the total wind power in a larger area. The prediction model has its particular advantages in precision, short computing time and low operating costs, as only a low number of forecast and measurement locations are necessary through the use of the already implemented Online-Model.

The described wind power prediction system has been implemented in the load dispatcher of E.ON Netz since July 2001 and is used for establishing the load schedule and for power plant scheduling. However, it can easily be adapted to other areas as only power measurement data of some wind farms and corresponding weather forecasts are needed to train the ANNs.

Dr.-Ing. Martin Hoppe-Kilpper

Entwicklung der Windenergietechnik in Deutschland und der Einfluss staatlicher Förderpolitik - Technikentwicklung in den 90er Jahren zwischen Markt und Forschungsförderung

Development of Wind turbine Technology in Germany and the effects of public funding - Technological development in the 1990'ies between Market and Research Funding

For a good ten years, wind energy use in Germany has experienced an upswing that would not have been thought possible in the mid 1980s. The number of turbines, and installed capacity, has increased with an average annual growth rate of more than 30 per cent during this period. Thereby, the average installed capacity per newly erected turbine increased ten fold and the technical availability now lies at over 98 per cent. With the enlargement of turbines, a clear trend continues to be evident toward concepts with pitch controlled rotor blades and increasingly with variable speed operation. Before the introduction of large-scale offshore wind energy use, which has been predicted by many for the next three to six years, and the immense technical and structural challenges that are connected with it, it seems useful to critically reflect on the 1990s with their underlying basic conditions in regard to support policies. Thereby, the question should be answered of what concrete influence governmental research and funding programmes (particularly the "250 MW Wind" programme) has had on the development of wind energy use. That is, under which conditions particular technologies are able to succeed and how the influence of a protected market (through legally guaranteed feed in tariffs) is to be valued in this development. Furthermore, the erroneous trends that might have occurred will be qualified. In addition, it will be shown (with the aid of experience curves) which overall cost reductions were achieved, how effective the necessary governmental funding measures were and which lessons can be learned from this for the future. On the whole, the work should contribute to the better understanding of advances that have been achieved in technological development in relation to favourable political framework conditions. Furthermore, chances for well-targeted changes to governmental support measures will be realised and emphases for future research programmes in the area of wind energy will be indicated, in order to draw out further potential for cost reductions. Thereby, future research programmes should concentrate more strongly on the three most important fields of application for wind energy: Large-scale offshore application, grid connected decentralised energy supply and also rural electrification by autonomous supply systems for developing and third world countries.

ISET Guest Scientists for Wind Energy Research

Prof. Mohammad Abderrazzaq (centre)
Yarmouk University , Jordan

Prof. Abderrazzaq got his PhD from Manchester University/UK and worked there as a research assistant. During his stay at ISET until January, 2004, he worked in the field of reactive power requirements for grid-connected wind farms.

Prof. Yukimaru Shimizu (left)
Mie University, Japan
with Prof. Schmid

Prof. Shimizu was staying at ISET in 2003 as a guest professor invited by Prof. Schmid. He collaborated with both R&D divisions Information & Energy Economy and Energetic Use of Biomass.

Cornel Ensslin, ISET

In the year 1963, I was born in a place which you will easily find on German wind maps, as the low mountains region "Schwaebische Alb" in Southern Germany is quite a windy place.

I started studying Mechanical Engineering at Karlsruhe University in 1982. Internships abroad were very much "en vogue" in that time, so I ended up in Vancouver for a 6 months programming job, and later – in 1988 – I worked for my diploma thesis at the wind turbine test site of RISØ National laboratory in Roskilde, Denmark. A vocabulary of approx. 20 Danish words, and close relationship with the RISØ friends still remain from that time!

It was then only a small step via the "1st Husum Wind Fair" in 1989 to begin my work as an engineer at ISET. The wind boom in Germany was just about to start, at that time due to a subsidy programme called "250 MW Wind", combined with a long-term monitoring of all aspects of the operating behaviour and cost of wind turbines in Germany to be done by ISET. What an exciting job, to start with the data management and data evaluation of – in the end – more than 1.500 turbines.

Within this research project, I focussed in the coming years on studies of external conditions such as turbulence, lightning strikes, icing, and on the statistics of large- scale wind power generation in Germany. I still well remember the complains of utility people in the year 1995: "We have 1500 MW wind power connected to our grids and we do not have any idea, how much production we have in this moment and in the next hours!". Now in 2004, there is ten times more wind power installed in Germany, and thanks to Kurt Rohrig and many other colleagues, the utilities know more. We have wind power monitoring and prediction systems in operation and continuously improved.

From 1991 to 1995, I attended - in parallel to ISET work - the Master study "International Vocational Education" offered by Kassel University and thus started a second carrier at the institute, organizing training courses abroad and in-house.

I definitely do not recall all names, but many faces of the guests we have had since 1998 from Peru, Bolivia, Brazil, Argentina, Tunesia, Libya, Egypt, Ethiopia, Benin, Jemen, Pakistan, Philippines, South Korea, Mongolia, China and now even North Korea, in our last training course. From now on, the training area will have even much more importance for us – all the best prospects for the WIND ACADEMY as well!

The title of my current position "Head of Electricity Supply Structures" reflects the activities in the field of Distributed Generation, starting with the "Integration" brochure published by the EC in the year 2000. "Communication, Information and Electricity Trading" became the main working field, in EU projects and networks such as "Dispower" and "DGnet".

Now, some private space is still left: I am happily married. With few exceptions – only arising from the fact that I am away on too many business travels.

If you should miss me in the next Academy meeting, then obviously my "Hapkido" (Korean martial arts) competition with my wife ended as in the photo.

G.(Gijs) A.M. van Kuik

G.(Gijs) A.M. van Kuik received his university degree in 1977, at the Delft University of Technology, faculty of Aerospace Engineering, with specialization on theoretical aerodynamics. Hereafter he became one of the first researchers in the Delft University wind energy research, focusing on the aerodynamics and dynamics of the rotor. In 1988 he moved to Eindhoven University of Technology for a PhD study on theoretical aspects of wind turbine aerodynamics. From 1988 he was employed by Stork Product Engineering, involved in technology development and design of wind turbines for all Dutch and some European manufacturers. In this period he also contributed to the formulation of national and international R&D programs, and the development of standards. In 1998 he returned to Delft University to become professor in Wind Energy at the faculty of Civil Engineering and Geosciences. From 2000, he is the scientific director of the newly established Delft University Wind Energy Research Institute DUWIND. This institute formalizes the co-operation between 4 faculties doing wind energy research: Civil Engineering and Geosciences, Aerospace Engineering, Design, Engineering and Production, Information Technology and Systems. Duwind research focuses on large scale application of offshore wind energy, and includes almost all technology aspects. The R&D programme is executed in close co-operation with the unit wind energy of ECN, the Netherlands Energy Research Foundation.

Takis (P.K.) Chaviaropoulos

Takis Chaviaropoulos heads the Renewable Energy Sources Division of CRES, collaborating with 55 research associates in the fields of Wind Energy, Biomass, PV Systems, Small Hydro, Geothermal, Solar Thermal and Hydrogen technologies. He holds a bachelor's and a MsC degree (1982) in mechanical engineering and a Ph.D degree in Computational Fluid Mechanics (1987) from the National Technical University of Athens (NTUA) where he hold a post-doctoral position for seven years in the lab. of Thermal Turbomachinery of NTUA. He has been involved in renewable energy since 1984 having as main field of expertise the wind energy technology. He has more than twenty years experience in R&D projects funded by the E.U., the European Industry and the Greek State in the fields of aeronautics, turbomachinery and wind energy. He has participated over the years in more than 40 research programs. He moved at CRES in 1994 working since in the fields of horizontal axis wind turbines aerodynamics, aeroelasticity and complex terrain wind field modeling. He managed the construction of CRES' 3 MW demonstration wind farm at Lavrio Attikis and he was responsible for the modeling part of the Greek Wind Atlas. He is the author of more than 20 Journal and 40 Conference publications and co-editor of two books on optimum aerodynamic design. He is a member of AIAA and ASME and Associate Editor of the Journal Solar Energy Engineering of ASME on wind energy topics since January 2004. He is a member of the Greek delegation in the E.C. Energy Committee for the 6th Framework Programme. He enjoys sports, in particular basketball and tennis, as well as wine evenings with good friends.

Jos (H.J.M) Beurskens

Jos Beurskens heads the Wind Energy Unit of Energy research Centre of the Netherlands (ECN). He holds a bachelor's degree in electrical engineering and a master's degree in physics from Eindhoven University of Technology in the Netherlands. He has been involved in renewable energy since 1972. His main field of expertise is wind energy technology. From 1972 to 1981 he was a wind energy researcher at Eindhoven University where he was involved in the development of wind turbines for water supply in developing countries. He was the manager of the Netherlands National Wind Energy Programme from 1981 to 1986. He joined ECN in 1986. From 1990 to 1999 Mr. Beurskens was head of ECN's renewable energy research programme as it conducted important research into renewable energy applications in the built environment as well as various aspects of wind, solar and biomass energy systems. Throughout his career, Mr. Beurskens has been extensively involved with various industry associations and policy groups involved in renewable energy. He was a founding member of the Netherlands Wind Energy Association, (NEWIN) and the European Wind Energy Association (EWEA) and continues to sit on their boards. He was one of the founders of the International Meeting of Test Stations (IMTS). He is also a member of the Scientific Advisory Board of the Institute for Solar Energy Technology (ISET) of Kassel, Germany, and the Scientific Committee of the Spanish Institute of Renewable Energy Technologies (ITER). Mr. Beurskens is the ECN representative at the College of Members of the European Renewable Energy Centres Agency (EUREC). He has chaired the executive committee of the Wind Energy programme of the International Energy Association (IEA) and has been retained as an advisor to the European Commission on several research and development programmes in the renewable energy field.

Erik Lundtang Petersen

Erik Lundtang has been head of Wind Energy at Risø since the establishment of this department in 1985. Educated at the Technical University of Denmark with an MSc in civil engineering and a PhD in meteorology, climatology, fluid mechanics, and atmospheric turbulence, Erik Lundtang has been on Risø's payroll since 1970. His main interests lie in wind climatology, wind resources and wind turbine siting. In the late seventies, he was half of the team behind the development of the wind atlas methodology, leading to the publication of The Danish Wind Atlas in 1980. This in turn inspired the initiation of the European Commission's first wind energy research programme and the establishment of a working group made up of scientists from all EU countries and headed up by Erik Lundtang himself. After eight years' research The European Wind Atlas was published in 1989, along with the Wind Atlas Analysis and Application Program (WAsP). WAsP has now become the global standard in wind climatology calculation as well as estimation of wind energy potential. Erik Lundtang is the Risø representative and a founding member of the EUREC Agency.

Hugo Chandler

Hugo Chandler is responsible for the proposal and coordination of all EWEA projects carried out in collaboration with the European Commission, principally in the fields of research and communications, and designed to cover EWEA policy objectives. He has been with the EWEA since the completion of his M.Sc. at Imperial College, London, in 2001. Prior to this, he worked at the Centre for Alternative Technology in Wales, on the operation and maintenance of a wide range of demonstration renewable technologies. This followed a position as press and research aid to the Rt. Hon. Tom King in the House of Commons, as well as stages at the Commonwealth Institute in London, and the OSCE Parliamentary Assembly in Copenhagen.

Gunter Arnold, University of Kassel

I was born 1967 in Korbach, a nice town with about 25000 inhabitants, which is located approx. 50 km to the west of Kassel in the heart of the so called "Waldecker Land"-region.

In autumn 1987, I started to study Electrical Engineering at the Technical University of Darmstadt (TUD). At first, I intended to focus my studies on communication engineering, but due to the practical experiences of some internships at utilities and a hydro power plant (Pumped-storage power plant "Waldeck" at the "Eder"-lake) I decided to concentrate the advanced study period on electrical power engineering.

After completion of my studies at TU Darmstadt, I came back to North-Hesse and in 1994 I started working as scientist at University of Kassel in the department of Prof. Kleinkauf and Dr. Heier. In the first time, I was involved in the development of a multipole synchronous generator for wind- and water-turbines. Subsequently, from June 1996 to June 1998 I worked in the project "250 MW Wind", in which Uni Kassel was responsible for the regional supervision of more than 390 windturbines and the maintenance and extension of the WMEP remote data acquisition network. Within this very exciting period, the first prototypes of windturbines in the MW-range (V 63, NTK 1500, TW 1.5, E 66) were erected in the German inland and at those plants we installed measurement equipment to connect them to the remote data acquisition network of the WMEP. From July 1998 up to the end of 2001 I was responsible for the work and the administration of the EU funded R&D-project "Grid control with renewable energy sources". My work during this project in combination with the ongoing project "DISPOWER", in which I am mainly involved in WP 1, are the reasons why I focussed my scientific interests during the past years on grid integration, grid control and grid stability questions of wind power plants and other DG. Besides the more theoretical work in the office, I also like to perform practical work, such as on-site measurements at windturbines from time to time. February 2004, I finished the PhD thesis, which is entitled "Entwicklung eines Systems zur Stabilisierung von Elektrizitätsversorgungsnetzen mit Erneuerbaren Energien" (Development of a system for the stabilisation of electrical power supply systems by renewable energy sources).

And concerning my private life: I like to spend the small remaining free time together with my wife and my son aged three. Besides this, I play Volleyball and I also enjoy playing trombone in an orchestra. For holidays, we like to travel to Scandinavia, preferably to Denmark or to Norway.

Peter Hauge Madsen

Peter Hauge Madsen is deputy head at the Department of Wind Energy at Risø, where he has been an employee since 1979. With an MSc in structural engineering as well as a PhD from the Technical University of Denmark, his main interests include wind engineering, wind turbine loads and dynamics. He is deeply involved in the development of new standards and sits on a number of committees of the International Electrotechnical Commission, the European Committee for Electrotechnical Standardization, and the Danish Standards Association. Since 1996, Peter Hauge has been responsible for the department's planning, coordination and finance. He is also in charge of the Danish Research Consortium for Wind Energy (a network for R&D, education, and innovation) established in 2002 by Risø National Lab., the Technical University of Denmark, Aalborg University, and DHI Water & Environment.

Jürgen Schmid

Like Cornel Ensslin, I was born in the region of „Schwäbische Alb" in Southern Germany in a very small village. As a schoolboy I have been very much interested in two things: aeroplanes and electronics. As a consequence I constructed the remote control radio-transmitters and – receivers for my model-aeroplanes by myself.

During my studies in aerospace engineering, which I did in Stuttgart together with Jens Peter Molly and Kurt Braun, I was lucky to have the great wind-pioneers Ulrich Hütter as well as Franz Xaver Wortmann as teachers. It was in the early seventies, when energy supply became an issue and when I decided to deal with the most modern and promising energy technology, namely nuclear. Already in 1974 it became clear to my colleagues and me, that a save operation of nuclear reactors might be feasible but that nobody could provide a convincing concept for a long term save storage of nuclear waste. When I heard in 1981 that the first Solar Research Institute will be created, I decided to change the subject and to work for less than half of my previous salary.

The most important subjects in this new environment were: The development of new inverters for photovoltaics and small wind turbines, the build-up of a databank on European Wind Turbines (Eurowin), the writing of two books on Photovoltaic-Systems and of two books on European Wind Energy Technology. There was also some co-operation: I have translated the European Wind Atlas into German language. All in all a fascinating time during which I have met with Eric Lundtang Petersen, Jos Beurskens, Herman Snel and other colleagues which are now members of our ACADEMY.

After 12 years in Freiburg I became Professor for Renewable Energies at the University of Karlsruhe but the unique combination of a Research Institute and a university having many activities in this field led to the decision to move to Kassel in 1995.

Kassel is easy to find: if you look at the map of the unified Germany, our city is right in the middle! Kassel is surrounded by low mountains full of hiking tracks and huts. Since my wife Heidrun and I and our dog Lea like very much hiking, you always can find us in the countryside during most weekends.

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