GrIPP-Net News

A quarterly Newsletter of the ASEM Green Independent Power Producers Network

Vol. 2, No. 5 (January 2004)

Editorial

In this issue, we report the results of the two regional workshops that the Green Independent Power Producers Network has organized last year. The third regional workshop was held last September in the Netherlands. During the workshop, experiences on green independent power production were shared. The major topics discusses included policies and market context, project organization and new financing opportunities as well as technology and approaches and resources.

On the other hand, the fourth workshop was held last November in Singapore. The workshop was part of the "Sustainable Energy in Asia 2003" conference and exhibition that was organized by IIR Exhibitions. The 3-day event brought international energy industries to Singapore to benefit from new information about the latest regulatory, financial and technological developments in the Asian sustainable energy market. It was the perfect venue to for the Network to exchange information on renewable energy and energy efficiency, particularly between ASEAN and EU countries.

Meanwhile, two important articles are also featured in this issue. The first article is about the model-based analysis of large-scale renewable energy production. This article discusses two energy model applications of PERSEUS (Programme Package for Emission Reduction Strategies in Energy Use and Supply), which were developed by the Institute of Industrial Production (IIP) of the University of Karlsruhe, Germany. A large number of studies that use different PERSEUS models have been conducted by IIP.

The second article discusses the European experiences with wind resource assessment. The article mentions that different methods are available today to assess wind resources. Examples are mentioned, such as the Wind Atlas method for Denmark.

INSIDE

Fourth Regional Workshop

ASEM Green IPP Network Fourth Regional Workshop

The Policy and Regulatory Framework for Green IPP Market Development

20 November 2003, Singapore

The fourth regional workshop of the ASEM Green IPP Network was successfully held on 20 November 2003 at the Raffles City Convention Centre in Singapore. The main objective of this workshop was to exchange information on renewable energy and energy efficiency between ASEAN and EU countries. The main focus was policy and regulatory framework for Green IPP market development. The private sector experiences and call for action were also highlighted.

The workshop consisted of four sessions, namely: 1) the Green IPP project outcomes; 2) policy instruments creating green power market; 3) private sector experiences and call for action, and 4) panel discussion.

Session 1 presented the outcomes of the Green IPP Network Project, which highlighted, among others, its objectives, activities, and future tasks and challenges. Green IPP technologies and resources from the EU perspective were also highlighted.

ASEM Green IPP Network Third Regional Workshop

Experiences of Green Independent Power Producers

Approaches in the international context

25 September 2003, Amsterdam, The Netherlands

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Session 2 highlighted, among others, the policy instruments creating green power market (green power market, possible support policies, example from Europe) as presented by European parties and international market for certified emissions reduction were illustrated by Southeast Asian parties.

Session 3 addressed experiences of private sector and call for action, and financing sources and approaches towards the development of green IPP market in Asia.

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Model-based analysis of large-scale renewable energy production

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Introduction

The already ongoing and even more the politically intended future growth of renewable and decentralised power generation in Europe are increasingly challenging for the existing energy system infrastructure and require the development of suitable strategies for energy production.

Among all renewable energy carriers, wind energy is of critical relevance. As wind energy production cannot be arranged, problems can arise for the grid, the operation, and the structure of the conventional plant portfolio, especially in regions with high wind power capacities installed (e.g. northern Germany). Once offshore wind parks with large capacities are realised, this problem will gain even greater importance.

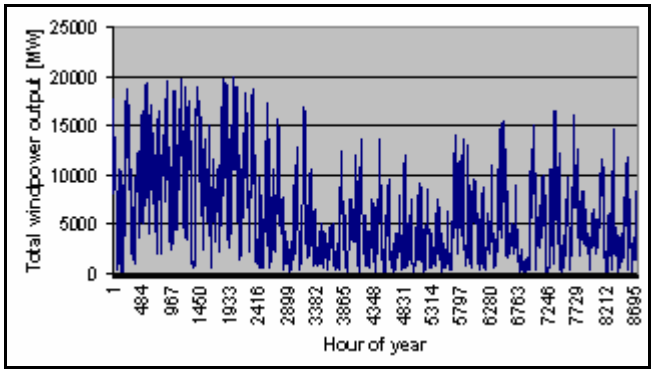

Figure 1: Fluctuating feed-in of wind energy in 2010 (Sensfuß et. al 2003)

The fluctuations of renewable power production will have to be compensated, which can be accomplished by a sufficient provision of stand-by capacities and control power (Krämer 2003). This could partly be realised by hydropower reserves (e.g. in the Alps), while the rest would have to be provided by conventional capacities with good load following characteristics. The grid connection of offshore wind parks, the capacity structure, the role of hydropower, and the scheduling of stand-by capacities, as well as the extension of the grid are interesting aspects for the future of electricity supply.

Two interrelated energy model applications of PERSEUS will be presented in this article, which both arise from an increasing renewable energy exploitation. In the following, a short introduction to the beneficial use of energy models will be given and the PERSEUS model family will be presented.

Energy models have been used for energy system analysis purposes for many years, be it as decision support tools for policy makers or as strategic planning tools for industry players. While the different models have become steadily more sophisticated, the competitive environment of the energy supply industry has experienced significant changes. Market structures and thus competition rules have been altered by the intense re-regulation and restructuring efforts taken by the different European governments in order to put into place the plan of competitively structured, liberalised energy markets. At the same time, the present discussion on climate change and clean air strategies implies new challenges for this sector, given that a significant share of the total emission loads of greenhouse gases, especially CO_2, as well as other harmful gaseous emissions like SO_2 and NO_X are related to power generation and fuel supplies. Furthermore, political decisions and attempts to minimise the environmental and climatic impacts of power production are likely to lead to a large-scale integration of renewables into electricity production.

These new framework conditions require continuously more advanced tools to address the arising research questions: How can existing energy supply systems best be adapted to the new market structures as well as to the existing or expected environmental protection targets? What is the impact of policy measures on existing supply systems regarding costs, technology choice, prices and market shares of different players? How can a large scale integration of renewable energies with a fluctuating energy production characteristic into the existing power system be accomplished? To what degree can the use of hydropower contribute to a compensation of the varying and less predictable energy production of large shares of renewable energies?

The PERSEUS model family

The energy and material flow model family PERSEUS[1] has been developed at the Institute for Industrial Production (IIP) of the University of Karlsruhe (TH) in order to be able to address questions related to energy systems not only on national, but also on regional and utility level.

The modelling approach is based on a detailed representation of energy conversion technologies and

[1] Programme Package for Emission Reduction Strategies in Energy Use and Supply

the interconnecting flows of energy (i. e. electricity and heat) and material (i. e. primary energy carriers, emissions of pollutants and greenhouse gases). The models follow linear and mixed integer programming approaches. Their target functions consist of a minimisation of all decision-relevant expenditure within the entire system. Technical, economic and ecological restrictions are integrated into the models in a suitable way to consider relevant system characteristics of the real energy supply system.
Emissions resulting from electricity and heat generation as well as from the distribution of energy carriers (e. g. natural gas) are calculated. Restrictions can be imposed on individual or cumulated emission levels. Hence, the model cannot only be used as a decision support tool for strategic planning under environmental constraints, but also as an environmental information system which generates data on current and future emission levels of all relevant pollutants and greenhouse gases. A data management system has been designed in order to provide a user-friendly interface.

Using the different models of the PERSEUS model family, a large number of studies, e. g. on regional, national and international emission reduction strategies, international cooperation concepts under the UN Framework Convention on Climate Change, as well as on contracting strategies, have been carried out. Versions of the model have also been developed for electricity suppliers to determine cost optimal strategies for capacity and production planning. The latest version of the model is a multi-regional electricity sector model including 42 European regions (Enzensberger 2003). It has been developed to determine the effects of an international emission trading scheme on the structure of the European electricity sector and the corresponding prices of emission certificates. This comprehensive European model acts as a starting point for two new model applications currently under development.

PERSEUS applications for large-scale renewable energy production

A comprehensive analysis of all aspects of the forthcoming large-scale integration of renewable and/or decentralised energy conversion technologies into the European electricity system are the main focus of a recently started research project. Starting off with a thorough analysis of the state and market share of renewable energy technologies (wind, solar, hydro, geothermal, biomass, biogas) to date, their future market potential as well as possible difficulties for the existing generation and distribution infrastructure are analysed. Due to the fact that about half of the installed conventional capacities installed today will have to be renewed in the course of the next 20-25 years, the analysis will be able to give valuable indications for an economically and ecologically optimised restructuring of the generation system with simultaneously increasing shares of renewable energy production. The central calculation tool used is a modified version of a comprehensive interregional PERSEUS model of the European electricity sector (Enzensberger 2003). This cost-optimising model is used for the analysis of long-term structural developments. The challenges for energy production in the fields of production, feed-in, and distribution (occurring on a much smaller time scale) are analysed with a coupled short-term model based on a system dynamics approach using the commercial Matlab/Simulink® software package applied to both the existing and the future energy system (forecasted by PERSEUS). The effects and problems identified in the short-term Simulink® model when compared to the results of the long-term PERSEUS model are then used as feed-back for an improved and more realistic representation of the energy system in the long-term model. This will be accomplished by a more detailed representation of wind and control power technologies, including a generalised fluctuation pattern that accounts for the short-term effects.

Especially significant regions (e.g. off-shore regions for the exploration of wind energy) are modelled in greater detail, while other areas with a less critical potential of renewables are modelled on a more aggregated level.

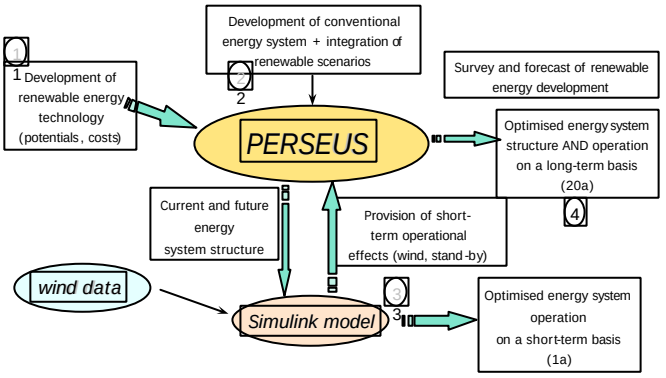

Fig. 2: Interaction of the long- and short-term models

Tasks within the project include the preparation and analysis of a comprehensive data-set, its integration into the optimising long-term energy-system model PERSEUS, plus subsequent model scenario analyses, which simultaneously provide input to the short-term model. Scenario runs conducted with both models will be analysed for each relevant region and examined with a focus on the following short- and long-term aspects:

- Renewable and conventional technology-/fuel-mix
- Effects on conventional capacities
- Influence of a large-scale integration of renewables on the scheduling of existing and planned conventional power production
- Marginal costs of power production, capacity and cost-effects with a special focus on stand-by-capacities and the amount of control power needed
- Infrastructural requirements (grid, fuel-supply)
- Net CO_2-reduction

An example of first results generated with the Simulink representation of the German power generation system is depicted in Figure 3. It shows the conventional power production in the course of the first 3 weeks of the year 2010. The top green line

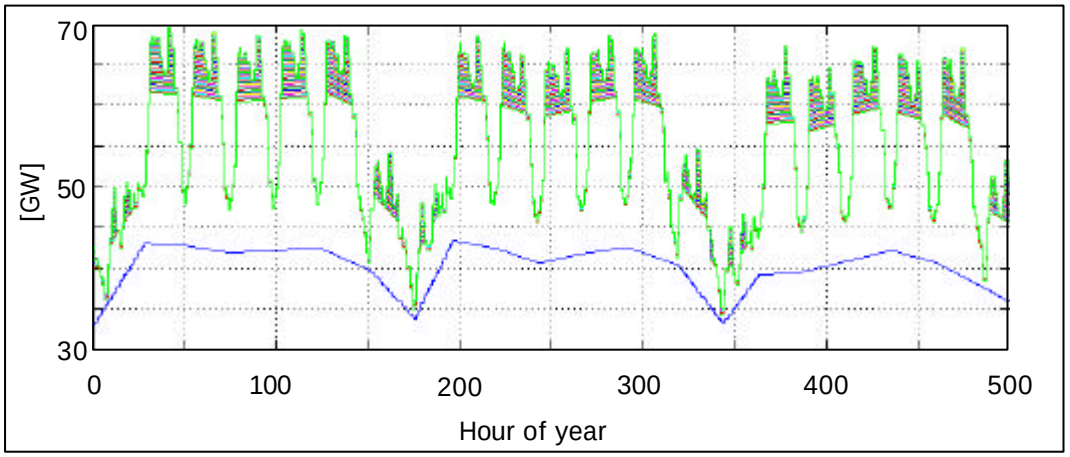

Fig. 3: Load curve and scheduling of base load and peak load

represents the total remaining demand after the deduction of the produced wind energy. Wind power production is calculated in a model by Fraunhofer ISI (Sensfuß et al. 2003) from hourly measured wind speeds at different characteristic wind park locations and the projected development of installed wind power capacities. The figure shows quite well the impact of increased wind power feed-in on the production characteristics of the conventional plant portfolio. The lines below the green line of total demand represent peak-load generation, the space down to the blue line, which is base-load generation, represents intermediate load generation. In a system with a limited feed-in of fluctuating renewable energy, where the load profile and also the coverage by the different plant types would be quite similar from one week to another. Here it can be noted, that in contrast to this regular behaviour even intermediate and base-load power plants have to be adjusted in their schedule in order to cope with the fluctuating amount of wind energy produced. This necessity induces more frequent load changes and switching plants on/off will be necessary more often as well, which leads to a less efficient production in the conventional plants. The net emission reductions are consequently not as high as could be expected when counting wind power feed-in alone. These effects can presumably be minimised by finding an optimised production strategy and by restructuring the plant portfolio to cope with these effects in the best possible way economically and environmentally (e.g. by installing low-emission gas-fired combined cycle power plants that can be used for load-following with smaller losses in efficiency), something that will also be analysed in the further course of the project.

PERSEUS application for analysis of hydropower plant operation and competitiveness

Due to the fact, that the large scale integration of renewable energy poses problems for stand-by capacities, it will further be examined, which new possibilities and tasks result from the changing capacity structure for traditional hydropower plants in the Alps. A detailed energy system model for the alpine region will be coupled with a European energy system model and the effects on the capacity structure will be examined. To analyse the competitive position of hydropower in Switzerland, a new modelling approach of the PERSEUS model will be developed. With this approach the following questions are to be answered:

- What influence do the upcoming structural changes in the European energy system have, especially the integration of large shares of fluctuating wind energy, on the economical evaluation of peak load and stand by capacities, with respect to the reservoir power stations in the Alps?
- Which consequences result for the international energy exchange and the grid extension?

Within a first step, a PERSEUS model will be built up and applied to the Swiss energy sector. Particularly hydropower plants – pump storage, reservoir and run-of-the river plants – will be modelled in detail to analyse their ability to compete in the changing

European energy sector. Thus it is necessary to modify and adapt the existing PERSEUS model approaches for national energy systems to achieve a more detailed and realistic model representation of hydropower operation. The methodology of the existing PERSEUS modelling approaches will be improved by the following measures:

- the seasonal aggregation of the model will be more exact, so that e.g. two months with typical days will be summarised (instead of half years). The seasonal aggregation has to be as detailed as possible within the limits of the modelling system and the calculation time.
- cross linking and networking of water power plants, respectively stages of weirs, will be considered within the detailed modelling approach.
- control energy supply and demand plays an important role and will be considered within the new approach.

The developed model applied to water power operation in Switzerland will be linked to the interregional European PERSEUS model (Enzensberger 2003). In order to realise the integration of the models, results of both models will be exchanged in an iterative process. The results of the respective optimisation will be handed over to the other corresponding model, which will then be optimised in turn producing new results. Transfer and preparation of the exchanged data automatically take place on the basis of defined rules. The iteration process ends when the model results of the system optimisation only change marginally. The integration of the detailed Swiss power system into the European model will be realised using a decomposition algorithm. Within the overall system optimisation and the supposed framework conditions a cost optimised electricity system for Europe will be determined, while a special focus is set on the impact on Swiss water power operation.

Within this linked modelling approach special consideration will be given to the impact of a large-scale integration of fluctuating wind energy into the European energy system (especially in Germany, Denmark, Spain, and prospectively also in France) on water power production, mainly on pump storage and reservoir power plants for peak load.

Consequently, the competitiveness of Swiss hydropower will be examined within the European energy system in order to find a basis for decisions in investment strategies in water power and for the prolongation of water concessions. Furthermore, the daily energy exchanges and the interconnections between the European countries, especially Germany – Switzerland, will be studied and evaluated in detail. Questions arising in the field of energy transmission and grid extension can consequently be answered.

Implementation of the models

The PERSEUS models are implemented as a PC version that can be run on commercial PCs. They require state-of-the-art hardware components due to their high complexity and the resulting large problem size,
An MS Access based data management system has been designed, which permits easy data handling and a fully automated link to the mathematical module. Programming is realised in GAMS (Brooke & al. 1988). The formatted and structured results are made available in MS Excel spreadsheets for further processing. Commercial solvers like CPLEX can be applied to find the solutions to the respective optimization problems. The system dynamics model is realised using the commercially available Matlab/Simulink® package (The Mathworks 2001).

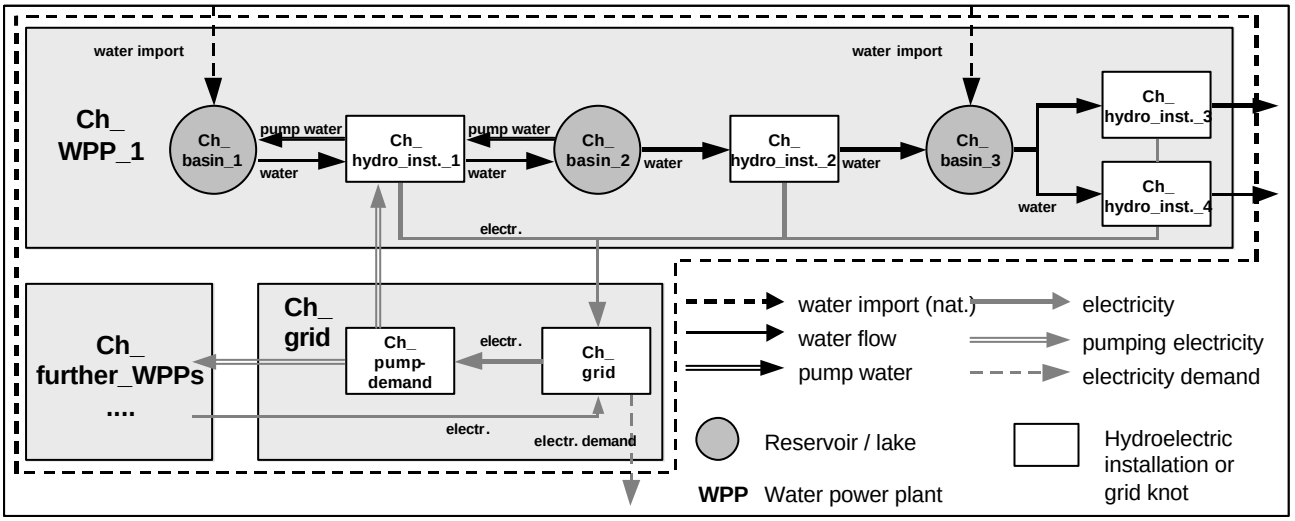

Fig. 4: design of a selected water power cascade and grid

Remarks

The article above is based on an article published in the proceedings of the EnviroInfo 2003 conference in Cottbus (Rosen et al. 2003).

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The *GrIPP Net Newsletter*, the official publication of the Green IPP Network, is published quarterly to communicate network activities and to support the dissemination of relevant information and network results. It is provided free to network members and interested stakeholders, and can be downloaded from this site: www.ASEM-GreenIPPnetwork.net.
This *Newsletter* has been produced with the financial assistance of the European Community. The views expressed herein are those of the authors and can therefore in no way be taken to reflect the official opinion of the European Commission.

Third Regional Workshop

ASEM Green IPP Network Fourth Regional Workshop

Experiences of Green Independent Power Producers

Approaches in the international context

25 September 2003, Amsterdam, The Netherlands

The third regional workshop of the ASEM Green IPP Network was successfully held on 25 September 2003 in Amsterdam, The Netherlands. The main objectives of this workshop were to:

- give an overview of the national approaches towards the introduction of renewable energy in SEA,
- give an overview and more detailed information on project structures and financial options which exist to introduce renewable energy in the region of South East Asia,
- share experiences of Green IPPs in Southeast Asia in specific projects.

The market for renewable energy in South East Asia is full of new opportunities. The electricity market structures are changing while at the same time, governments are establishing or strengthening their renewable energy policy, both for environmental reasons and to improve the energy trading position. Further, the international concern for climate change is generating new financing opportunities for world-wide investments in renewable energy. Private parties will play a crucial role in renewable energy implementation, from manufacture and supply to project development, investment, and exploitation.

The workshop was targeted at all those interested in international investments in renewable energy. Experts on renewable energy and international energy investment, both within the European and Asian market presented their experiences. The topics discussed covered three aspects, namely policies and market context, project organisation and new financing opportunities, and technology and resources. The workshop was divided into an opening session; a session on policies and market context for green IPPs, a session on project organisation and financing structures, a session on the Green IPP experiences and a closing session.

For further information, please visit our website. ❖

Fourth regional workshop ... *Continued from page 1*

Session 4 provided an open discussion between resource speakers and participants. This session marked the end of the meeting and followed by the closing remarks.

Please visit our website for more details . ❖

European experiences with wind resource assessment - An overview

- by Kaj Jorgensen
Risoe National Laboratory, Denmark

Introduction

For obvious reasons it is vital for any wind energy project to be based on reliable wind resource predictions. This is of significance both to make valid predictions of the payback on the wind power investments and to ensure the best integration into the power supply system. Hence, wind resource assessments may assist both in providing a sound basis for decisions on investments into wind energy (pre-investment) and in improving the operation of the power supply system to make the most of the wind energy (post-investment). The latter aspect is important from a systems approach, and at the same time such knowledge may enable the wind power operators obtaining better selling prices in deregulated power markets.

On the other hand, the needs with respect to the quality of the wind power predictions have to be offset against the opportunities in practice. First, there are restrictions on the time that may be spent on the exercise and usually restrictions that are not even close to the requirements to be able to extrapolate from the measurements with any degree of certainty. Secondly, costs are placing further constraints on the options.

Thus, basing the resource assessment on wind measurements carried out specifically for the project, is generally not a viable option. On the other hand, existing data may be available, even though these will usually need some for of adaptation to the specific sites in question.

Overview of approaches

On this background, a range of different methods exists that may be applied for the resource assessments. These methods vary from the most simplistic and uncertain, but low-cost, approaches on the one hand to highly sophisticated, but costly, on the other. Indeed, the different approaches may be combined to some extent at different stages of the project development.

Many approaches use the “regional wind climate” - that is wind data modified by removing impacts of local conditions - as point of departure. In other words, the regional wind climate illustrates geographical and temporal variations in wind statistics reduced to standard conditions, excluding the impact of roughness and near-by obstacles among others. To translate the regional wind climate into wind predictions for specific sites and hub heights, most approaches apply various types of microscale modelling. In the past, computing requirements have been prohibitive for the application of models of medium and large-scale weather events - mesoscale modelling - for this purpose. The computer development is rapidly reducing this obstacle and the coming years may see mesoscale modelling applied for wind resource predictions, either on its own or in combination with microscale modelling.

Among the most sophisticated approaches, are methods based on global databases containing data on wind, temperature and pressure in a global grid. For instance, the European Centre for Medium-range Weather Forecasting project has such a database. Potentially, such global databases are highly interesting, but for the time being their resolution is low.

Regional wind climate and microscale modelling - the Wind Atlas and the WAsP model

Risoe National Laboratory developed the Wind Atlas method for Denmark in the early 1980s and today this is the most widely used wind registration scheme in the world, having been applied in more than 90 countries. In the first step, the method establishes a generalised regional wind climate based on inputs regarding sheltering obstacles, roughness of the terrain and height contour lines. Secondly, a wind characterisation is generated of the specific site in point.

The Wind Atlas usually is generated by means of the microscale model Wind Analysis and Application Programme, WAsP, but other options exist. WAsP was developed by Risoe in 1993 as a computer tool for the practical application the wind atlas tool. {}

Short-term predictions

The objective of short-term prediction of the wind is to provide a better basis for the integration of fluctuating wind power supplies into the power supply system by predicted the wind power output 1-2 days in advance. This is particularly important in countries with high wind penetration levels, such as Denmark.

Short-term prediction usually based on the output from Numerical Weather Prediction models, operated by meteorological services. These typically provide 48 hours forecasts with runs every 6 to 12 hours. The NWP output is then combined with key features of the wind turbine or wind farm to generate predictions of

the power output. In addition off-line or on-line data of measurements of its output are used for updating of the model parameters (by means of regression or autoregression).

Such short-term prediction models for wind power have been developed since the mid-1980s. Examples of models currently in use, include Prediktor, WPPT (Wind Power Prediction Tool) and MORE-CARE but a considerable number of others exist and also there is a constant rapid development in this field. In addition to improving the validity of the predictions within the 1-2 days' range of the present models, attempts are being made to increase the range of the forecasts (e.g. to 5 days). These improvements are being facilitated by the increase in opportunities offered by the ongoing computer development.

Conclusions

Wind resource predictions, both prior to investments and after, are of crucial importance to the success of wind energy projects. The methods in this field are in a state of rapid development, not least supported by the general computer development. Besides the general need for further improvement of the validity of the methods, there is a need for a range of approaches at different levels. In particular, methods for the early stage choice of the most suitable sites for wind power would be useful.

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Calendar of Events

FEBRUARY 2004

The 7th Annual Asia Power Conference
10-13 February 2004, The Grand Hyatt, Singapore
Organized by Terrapinn
E-mail: aisha.aboosali@terrapinn.com

MARCH 2004

Power-Gen Renewable Energy
March 1-3, 2004, Flamingo Hotel, Las Vegas, Nevada
Organized by Pennwell Corp.
URL: http://pgre04.events.pennnet.com/

Technology Partnership for New and Renewable Energy (NRE) *– An EC-ASEAN Energy Facility Programme to Promote Indigenous NRE Power Supply*
4 – 5 March 2004, New World Hotel Saigon, Ho Chi Minh City, Vietnam
Organized by RIET, Singapore
URL: http://www.riet.org/NRE

European Conference on Green Power Marketing
18 - 19 March 2004, Lausanne, Switzerland
Organized by the European Green Power Marketing
URL: www.greenpowermarketing.org

Global Wind Power 2004 - Conference and Exhibition
28 – 31 March 2004, Chicago, Illinois
Email: sminer@awea.org
URL: http://www.awea.org/global04.html

APRIL 2004

REAsia 2004
7 - 9 April 2004, Beijing, China
Email: vivian@gracefair.com
URL: http://www.gracefair.com/

MAY 2004

World Renewable Energy Forum 2004
30 – 31 May, Bonn, Germany
Organized by World Council for Renewable Energy
URL: http://www.wcre.org/

In the News

Shell to open 5-MW solar power station in Germany

Shell Solar and German solar firm GEOSOL will open the world's biggest solar power station south of Leipzig in Germany. The 5-MW power station, which will be opened in July 2004, is estimated to reduce CO2 emissions by 3,700 tonnes per year. The power will be fed directly into the grid and will be sufficient to meet the electricity demand of about 1,800 households.
Source: Point Carbon (via www.pointcarbon.com), 21 January 2004