Objectives

The aim of the project is to develop accurate models that substantially outperform current state-of-the-art methods, for onshore and offshore wind power forecasting, exploiting both statistical and physical prediction methods. Emphasis is given to the integration of high-resolution meteorological forecasts. For the offshore case, marine meteorology will be considered as well as information by satellite-radar images. An integrated software tool, 'ANEMOS', will be developed to host the various models. This system will be installed by several utilities for on-line operation at onshore and offshore wind farms for prediction at a local, regional and national scale. The applications include different terrain types and wind climates, on- and off-shore cases, and interconnected or island grids. The on-line operation by the utilities will allow validation of the models and an analysis of the value of the models to a competitive integration of wind energy in the developing liberalised electricity markets in the EU.

Expected Results

The project provides an advanced technology for wind power forecasting applicable on a large scale: at a single wind farm, regional or national level and for both interconnected and island systems. A next generation forecasting software, ANEMOS, is developed to integrate the various models. The tool is enhanced by advanced Information & Communication Technology functionality and can operate both in stand alone or remote mode, or be interfaced with standard Energy Management Systems. The software will be installed for on-line operation at a number of onshore and offshore wind farms. Finally, the benefits from wind prediction will be evaluated during on-line operation, while guidelines will be produced for the optimal use of wind forecasting systems.

The output of the ANEMOS project will facilitate wind power integration at two levels. First, at an operational level, it will allow better management of wind farms. Second, it will promote an increase in the installed capacity of wind farms because an accurate power prediction capability reduces the risk to wind farm developers, who are then more willing to undertake new wind farm installations, especially in a liberalised electricity market environment.

In order to achieve the challenging targets of the project, a Consortium from seven countries has been set-up integrating major actors from complementary areas including research institutes, universities, industrial companies, utilities, transmission system operators, meteorological institutes and energy agencies.

Consortium

- F **ARMINES–Centre d'Energétique**
  Ecole Nationale Supérieure des Mines de Paris
  (Project Coordinator)
- F **ARIA Technologies S.A.**
- UK **CCLRC Rutherford Appleton Laboratory**
- E **CENER**
- E **CIEMAT**
- DK **DTU-IMM: Informatics and Mathematical Modelling of the Technical University of Denmark**
- F **Electricité de France**
- DK **ELSAM A/S**
- E **Energia Hidroeléctrica de Navarra, S.A.**
- IRL **ESB National Grid**
- D **EWE AG**
- EL **IASA – University of Athens**
- E **IDAE**
- EL **Institute of Communication & Computer Systems - National Technical University of Athens**
- F **MeteoFrance**
- D **OVERSPEED GmbH & Co. KG**
- EL **Public Power Corporation S.A.**
- E **Red Eléctrica de España**
- DK **Risø National Laboratory**
- E **Universidad Carlos III de Madrid**
- D **University of Oldenburg**

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Development of a **Next Generation** Wind Power **Forecasting** System for the **Large-Scale Integration** of **Onshore** & **Offshore** Wind Farms

WIND POWER FORECASTING
ANEMOS

Background

Accurate forecasting of wind power production up to two days in advance is recognised as a major contribution for reliable large-scale wind power integration.

Especially in a liberalised electricity market, prediction tools enhance the position of wind energy compared to other forms of dispatchable generation.

The ANEMOS project aims to develop advanced forecasting models that will significantly outperform current methods.

Emphasis is given to challenging situations such as complex terrain, extreme weather conditions, as well as to offshore prediction for which no specific tools currently exist. The prediction models are implemented in a software platform and installed for online operation at onshore and offshore wind farms by the end-users participating in the project.

The project demonstrates the economic and technical benefits from accurate wind prediction at different levels: national, regional or at single wind farm level and for time horizons ranging from minutes up to several days ahead. The forecasting techniques developed in the project take account of the diversity of wind farm characteristics found across the European Union.

Duration : 01.10.2002 – 31.03.2006
Total Cost: EUR 4.3 mio
EC Contribution: EUR 2.5 mio

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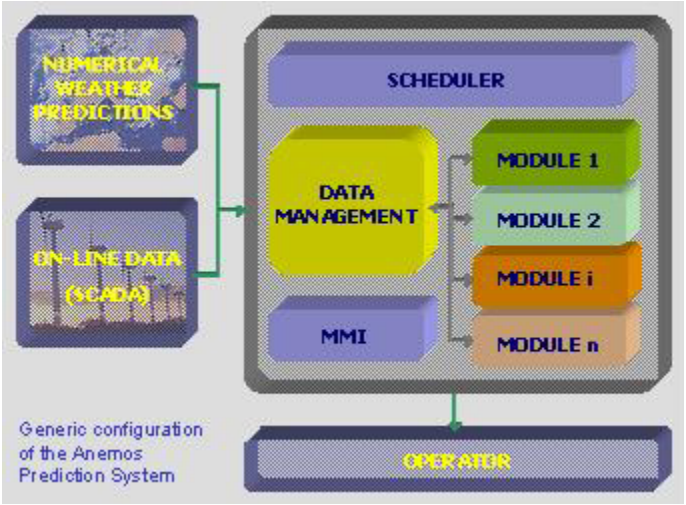

Generic configuration of the Anemos Prediction System

The Project

The project is structured into 9 work-packages, which address the technical objectives:

- **WP-1:** Data collection & evaluation of needs
- **WP-2:** Off-line evaluation of prediction techniques
- **WP-3:** Development of statistical models
- **WP-4:** Development of physical models
- **WP-5:** Off-shore prediction
- **WP-6:** Anemos prediction platform development
- **WP-7:** Installation for on-line operation
- **WP-8:** Evaluation of on-line operation
- **WP-9:** Overall assessment and dissemination

In the initial stage (WP-1), the prediction requirements are defined in collaboration with end-users (utilities, transmission/distribution system operators, independent power producers a.o). A detailed review of the current short-term prediction technology is performed.

The project develops prediction models based on both a physical and statistical approaches. Research on physical models (WP-4) gives emphasis to techniques for use in complex terrain and the development of prediction tools based on CFD techniques, advanced model output statistics or high-resolution meteorological information.

Statistical models (for example based on artificial intelligence) are developed for downscaling, power curve representation, and upscaling for prediction at regional or national level (WP-3). A benchmarking process is set up (WP-2) to evaluate the performance of the developed models and to compare them with existing ones using a number of representative case studies. The synergy between statistical and physical approaches is examined to identify promising areas for further improvement of forecasting accuracy. The performance of purely meteorological forecasts, but also long-term wind predictability up to 7 days ahead, are evaluated in detail.

Appropriate physical and statistical prediction models are also developed for offshore wind farms (WP-5) taking into account advances in marine meteorology such as interaction between wind and waves and coastal effects. The benefits of the use of satellite radar images for modelling local weather patterns are investigated.

The models will be integrated in an advanced prediction platform (WP-6), which will be installed for on-line operation at various onshore and offshore sites (WP-7). An evaluation period of at least one year (WP-8) will follow to assess the performance of the developed system and the benefits from its operation.