# WIND KNOWLEDGE

IS WIND POWER

YOUR PARTNER IN WIND ASSESSMENT
Maximize production and wind farm performance while minimizing risk, downtime and maintenance cost.

*wind*sim

Software | Consulting | Training

WindSim pioneered the use of CFD (Computational Fluid Dynamics) technology to optimize wind turbine placement, and offers CFD software, training, independent technical and engineering services to the wind industry. Headquartered in Norway, and with a global presence in over 30 countries, WindSim has for a long time been the thought leader and expert on CFD within the wind industry.
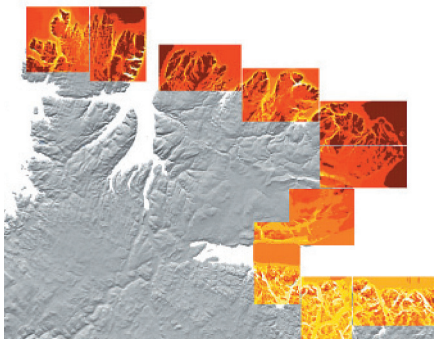
THROUGH THE YEARS | HISTORY

In 1998 Arne Gravdahl (PhD), the founder of WindSim, took on the exciting task of establishing the Norwegian Wind Atlas in cooperation with the Norwegian Meteorological institute. Simulating the local wind field conditions along the complex Norwegian coastline was a challenging task, where the use of CFD was a requirement to achieve the accurate simulations needed.

Studies showed that CFD captured the terrain effects on wind conditions much more realistically than traditional linear technologies. To accommodate these demands The WindSim methodology was developed. The first version of WindSim software was launched in 2003. Since then, the focus has been on continuous improvement and development with Arne Gravdahl's vision in mind: To be the most successful Wind Farm Design Tool in the industry.

MAXIMIZE PRODUCTION | MINIMIZE LOADS

WindSim core business is based on value-adding CFD products and services for the wind industry. WindSim's advanced simulations deliver value for every type of terrain—from the simplest to the roughest—maximizing energy production while minimizing the loads on installed equipment. WindSim can be used across a variety of length scales ranging from detailed micro-siting up to larger mesoscale wind resource assessments.

CFD | THE VALUE OF COMPUTATIONAL FLUID DYNAMICS

Many comparisons have been carried out between CFD and the traditional linear tools in wind energy asesssment. It is widely proven that linear tools very often give less accurate wind speed estimations compared to CFD tools, especially in complex terrain. Identifying areas with high wind speeds is vital to maximizing energy production. A 10% increase in wind speed can give a 30% increase in Annual Eneregy Production. The fundamental equations of fluid flow consist of a set of non-linear partial differential equations, the so-called Navier-Stokes equations. These equations are known to be difficult to solve due to their non-linear nature. Nevertheless, in numerous flow situations—and in various industries over many years—CFD reproduces the measured flow patterns, and is therefore considered a proven method. CFD can take all the different effects of turbulence, variable density, topography and vegetation into account using fundamental equations.

THE VALUE OF WINDSIM FOR WIND PROJECTS

- Maximize production and wind farm performance while minimizing risk, downtime and maintenance cost.
- Using WindSim from early concept evaluation, through engineering to operation, secures overall capital and operating cost effectiveness.
- Minimize risk and ensure efficient, predictable, and safe operations.
- Successful design and operation of wind farms rely on detailed understanding of the wind field. WindSim provides solutions through accurate modeling of true dynamics.

Normalized wind speed at 5 meters height. Measurements are given by black boxes. The solid orange line shows the WindSim results. The other lines are results from other methods.

For further detail on the Bolund case, please visit: http://windsim.com/library/the-bolund-experiment.aspx

WINDSIM | POWERFUL WIND FARM DESIGN TOOL

WindSim is a powerful Wind Farm Design Tool (WFDT) based on CFD, and has been the thought leader in the application of CFD techniques for the worldwide wind energy industry for more than ten years. The software is used for the design of wind farms both onshore and offshore, maximizing Annual Energy Production while taking site and terrain constraints into account. The software combines advanced numeric processing with compelling 3D visualization in a user-friendly interface. In order to evaluate the strengths and the shortcomings of the different wind characterization methods we need a large number of validation cases.

R&D | RESEARCH & DEVELOPMENT

Our commitment is to work with the leading people and companies in the industry to continuously develop and improve WindSim—delivering the technology that meets the needs of the future.

WindSim proudly participated in the Bolund experiment, a validation case undertaken by Risø DTU. The CFD methods—including WindSim—showed the lowest errors among the various methods used.

Acknowledging the responsibility to meet tomorrow's wind industry challenges – we involve both research and operational environments in breaking new barriers. New technology is developed, made available, and supported through worldwide cooperation and organization.

Business Areas	Advanced Measurements	Wind Analysis	Wind Resource Assessment	Micro-Siting and Wind Farm Design	Meso-Micro scale coupling	Forecasting and Planning
Products	WindSim Software					
				Park Optimizer		
	Multiple Core Utilization (MCU)					
	Remote Sensing Correction Tool			Remote Sensing Correction Tool		
						Forecasting
Services	WindSim Consulting					

HOW DOES IT WORK? | TECHNICAL BASICS

WindSim is based on a 3D Reynolds Averaged Navier Stokes (RANS) solver. Solving the non-linear transport equations for mass, momentum and energy makes WindSim a suitable tool for simulations in both complex terrain, and in situations with complex local climatology.

Assessment of wind resource is carried out through both observational and numerical means. Observational data are usually collected for one or several points within a wind farm development site but these observations cannot account for the terrain-induced variations in the local wind fields between or around the observation points. By combining the observations with WindSim's advanced CFD flow modeling you can create a full 3D model of the wind fields including mean wind speed, turbulence, wind shear and inflow angles. This allows for more informed decisions about turbine layout and more accurate estimates of Annual Energy Production.

HOW TO? | BEST PRACTICE

WindSim software has a user-friendly modular structure that makes it easy to use and interpret. First you start off with the terrain module; this generates a 3D model of the area around your wind farm based on elevation and roughness data. You can model forested areas and physical objects such as buildings, to include the influence these have on the wind field. The next step is the Wind Fields module, where the wind database is generated. This module simulates how the terrain and other factors affect local wind conditions. In the Objects module you decide on placement of turbines and measurement points. This is done in a fully interactive 3D interface, which makes it easy to get a visual layout of the wind farm from different angles.

The overview of flow variables you get in the Result Module, here you can inspect all of the variables like wind speed, direction shifts, turbulent intensity and wind shear. The wind resource map forms the basis for the energy optimization, and is established by weighting the wind database against measurements. The final step is the Energy module where you can calculate the Annual Energy Production for each turbine in the wind farm, as well as compare alternative park layouts and wake losses.

ADD-ON MODULES
Park Optimizer

The Park Optimizer Module uses WindSim CFD results plus new optimization algorithms to automate the design of IEC-compliant wind farm layouts. You can include costs and revenues to maximize the wind farm profitability with respect to optimum number of turbines and optimum location of turbines to maximize production and minimize loads.

Multiple Core Utilization

WindSim can run several simulations at the same time, or split calculations of one sector onto multiple cores or CPUs. This module allows more control and flexibility in utilizing all available computing resources and ultimately allows you to run your simulations significantly faster.
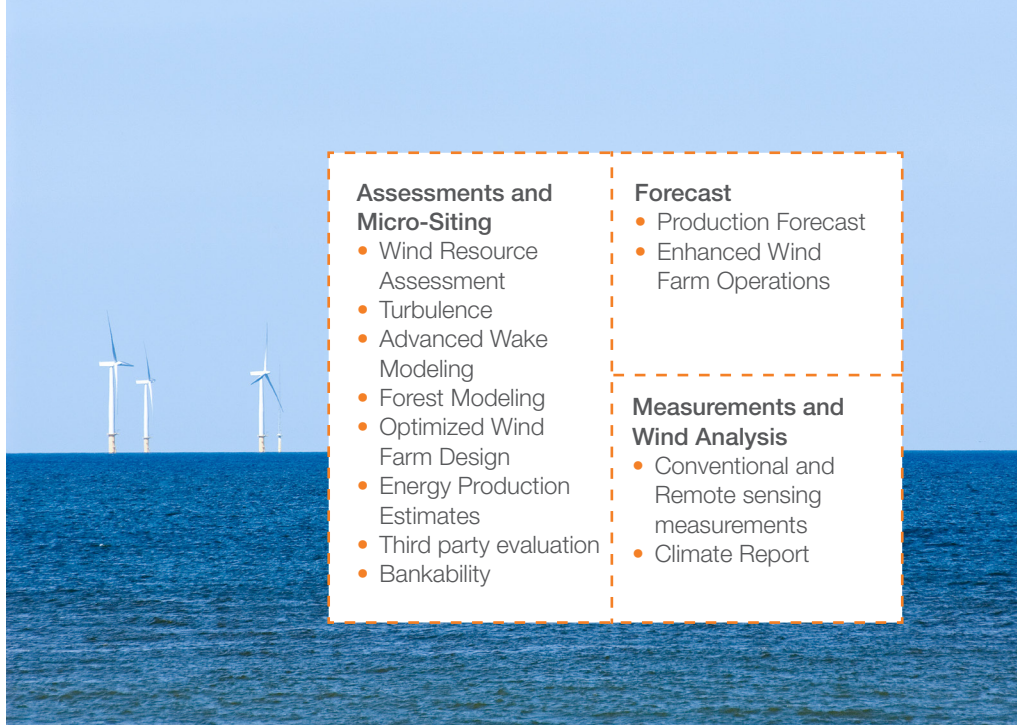
Remote Sensing Correction

Today horizontal wind speed measurements from LIDAR are derived assuming homogeneous wind fields over the LIDAR, and this assumption can lead to large errors where there is complex terrain. WindSim has developed and tested a method which corrects the raw LIDAR data according to the wind fields at each site and thus yields more accurate measurements.

Forecasting

This is an interface for automatically downloading wind forecast data from numerical weather prediction models and downscaling it through the use of Neural Network post-processing and CFD simulations. The end result is an accurate, high resolution production forecast for selected times in which the user can include wake effects and see energy production for each individual turbine.
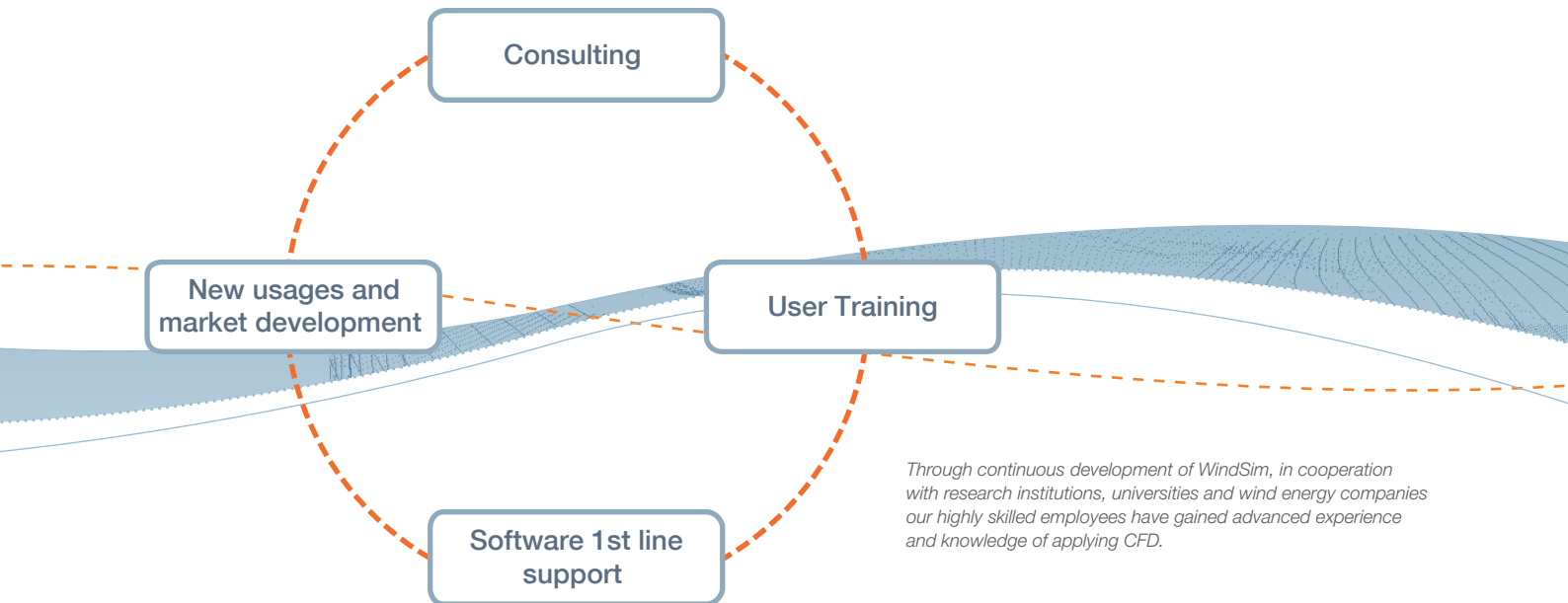
Assessments and Micro-Siting
- Wind Resource Assessment
- Turbulence
- Advanced Wake Modeling
- Forest Modeling
- Optimized Wind Farm Design
- Energy Production Estimates
- Third party evaluation
- Bankability

Forecast
- Production Forecast
- Enhanced Wind Farm Operations

Measurements and Wind Analysis
- Conventional and Remote sensing measurements
- Climate Report

WINDSIM | CONSULTING

Accurate solutions from one of the most experienced teams in the wind industry. The quality of a CFD analysis depends strongly on the experience of the engineer, and our team is one of the most experienced CFD consulting groups in the industry. This is how we are able to provide our clients with quality assured results and analysis they can trust. The WindSim Consulting Team adds value to CFD users as well as organizations needing additional CFD expertise.

- Consulting
- New usages and market development
- User Training
- Software 1st line support

Through continuous development of WindSim, in cooperation with research institutions, universities and wind energy companies our highly skilled employees have gained advanced experience and knowledge of applying CFD.

WINDSIM | TRAINING

CFD simulations do require a certain level of skills in order to run correctly, and over the years we have experienced the effect the user has on the end result when using CFD.

WindSim CFD experts offer training courses worldwide on a consistent and frequent basis. The objective of the training courses is to equip you with the necessary skills to run your simulations and projects using WindSim as accurately as possible.

THE BASICS

The course focuses on the advantages–but also the challenges–of applying CFD techniques to wind energy projects.

ADVANCED USAGE AND CONCEPTS

You will work along other savvy WindSim users while guided by skilled instructors who will help you sharpen and expand your WindSim skills.
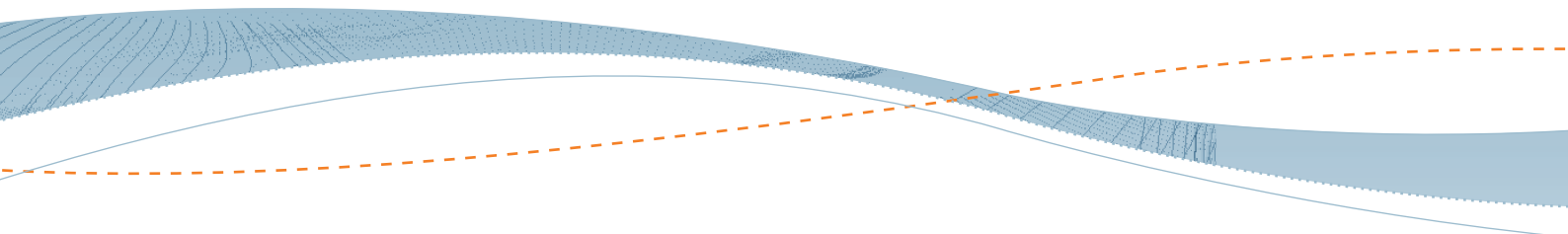
ON-SITE-WORKSHOP

Customized training offered at location of customer—level of difficulty, project and length of course is determined by the need of the customer.
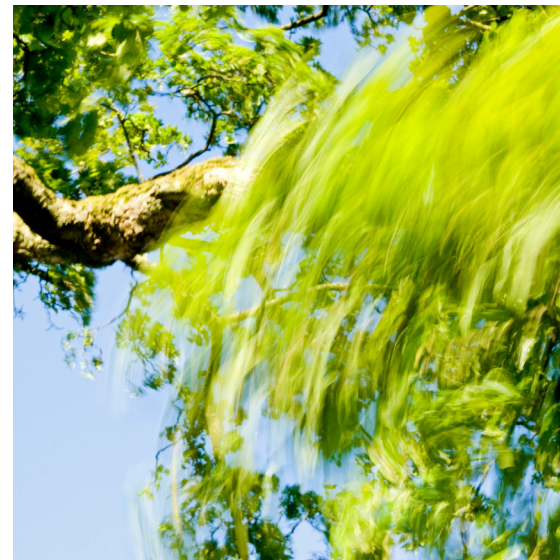
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