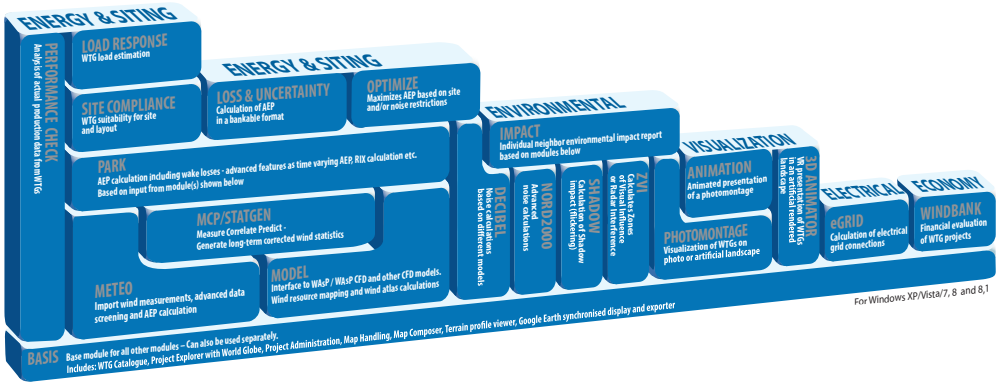
windPRO

windPRO Software

MODULE DESCRIPTION

EMD International A/S
www.emd.dk

windPRO
Basic



BASIS

The BASIS module in windPRO is necessary for the use of any of the other calculation modules. It contains the following key elements:

Project Management

Project Management - a tool for the effective administration of your projects with full overview of the projects on the Project Explorer globe.

WTG Catalogue

This catalogue is the most comprehensive wind turbine catalogue in the world with data on more than 1,000 different types of WTGs. The data is constantly being updated and can be supplemented with your own turbine definitions.

Map Management System

The Map Management System is a tool for linking scanned maps or maps from the Internet or other digital sources to windPRO, making them available for project work and the input of data, which is done directly on top of such digital background maps.

Project design / Input Data

With BASIS the user can prepare a windPRO project ready to calculate.

Tools

Special tools for many purposes such as advanced digitisation of height contour line data based on software recognition of the color differences on the background map; tools for trimming and adjusting digital data; terrain profile presentation including WTGs and measurement masts; quick profile tool for checking site elevation data; map composer for creating maps for reports with specified resolution and with customable legends.

Organized data

Layer structure to organize the input data efficiently as well as result layer structures for viewing and comparing (with user formula input) spatial result data.

On-line data services

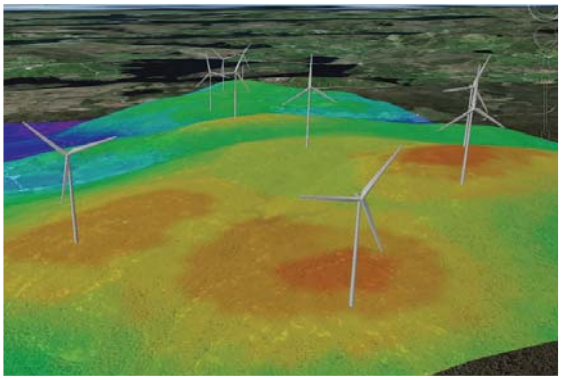
On-line data services with free access to elevation data covering nearly the whole world (SRTM + other data sources), roughness data from different sources, satellite images (worldwide) and other maps for use as background maps. WMS server maps and Google overlay maps are supported.

Data handling tools

Data handling tools and features for easy import / export of e.g. shape files and GPS data.

Google Earth

Synchronized display with Google Earth to present your wind farm project with photo-realistic turbines and enabling the use of Google Earth for precise geo-referencing of houses or other objects. Photomontages can be exported as "fly in" photos in Google Earth and other information such as wind resource maps can be shown as transparent draping. Import of Google Earth KMZ files into windPRO is also possible.



Energy & Siting

METEO

The METEO module has three functions:

- Import, analysis and presentation of measured wind data (screening of wind data).
- Import of long-term reference data from our extensive world-wide ON-LINE database with both meteorological measurements and MESO scale model data (access requires license to the MCP module).
- Calculation of the energy yield of a WTG based on measured on-site wind data (without applying a flow model, like WAsP).

The data screening facilities of METEO are widely recognized. It is possible to read almost any kind of wind data files (export from any logger), arrange them in time series or summary frequency tables and obtain the Weibull parameters and to visually inspect the time series, produce gunshot graphs, directional distributions, diurnal graphs etc. Time series for multiple heights can be compared with each other in all diagrams and selected data can be disabled (flagged) both through selection filters and visually in the time series plots. In XY presentations of any signal versus any signal, data can be flagged above or below a flag line and double click on an outlier shows where this is seen in the time series. The many features make it easy to identify and eliminate errors in the measurements.

The screened wind data can be used in the calculation of wind statistics (a set of wind data cleaned for local terrain influence) with the MODEL module and the WAsP software. The module includes special wind profile analysis features with tools allowing the user to specify day/night and seasonal variations and directly compare measurements with WAsP calculations as well as comprehensive shear analysis tools with easy cut and paste to Microsoft Excel or other spreadsheet programs.

The METEO module also includes the METEO ANALYZER tool for graphical comparison of data from different masts or other sources, substitution of data between different measurement heights and masts, graphical comparison of wind data from different masts and cross-prediction of wind data based on data from several masts and/or heights with different models. In the METEO ANALYZER it is possible to prepare for subsequent time varying calculations for each WTG in the PARK module either based on measured wind data transformed through WAsP or using a WTI (wind time variation file).

MODEL

The MODEL module contains a collection of tools used for wind flow models to do the vertical and horizontal ex-trapolations on a site. The core models supported are the WAsP and WAsP-CFD models.

The MODEL tools are often used in combination with other modules like PARK, MCP and SITE COMPLIANCE. A popular MODEL tool is the Resource Map Calculator. EMD's own ATLAS model can also be used with this module. Depending on the model used, different objects and information are required.

STATGEN - Creation of wind statistic (WAsP or WAsP-CFD):
This will require a terrain description of roughness, elevation and possibly local obstacles prepared in relevant objects. These are assembled in a site data object and sent to WAsP or WAsP-CFD together with wind measurement data from a Meteo object or a MCP calculation.

WAsP Interface - Calculation of AEP (Annual Energy Production) (WAsP or WAsP-CFD):
For this the same terrain input is used as above with the addition of a wind statistic (Wind Atlas). The calculation can be made for a single point using a range of wind turbine types and hub heights to create a basis for choosing the right turbine type for the site.

RESOURCE - Calculation of wind resource map (WAsP or WAsP-CFD):
The same terrain description and (multiple) wind statistics can be used to calculate a wind resource map. An irregular shaped area for the map can be defined with a WTG area object. The resulting resource map can be presented on the working map and used as wind model for a PARK calculation or for energy optimization of the wind farm layout with OPTIMIZE.

ATLAS - Calculation with ATLAS model:
ATLAS is a simple model suitable for non-complex terrain. The ATLAS model is typically used for small-scale projects, where the AEP calculation process must be simple, fast and cost efficient. The ATLAS requires a pre-made wind statistics. The ATLAS model is integrated in windPRO, so no additional software is needed. ATLAS can either be calculated for a single turbine or used as input for a PARK calculation.

Mesoscale Time Series

→ Subscribe to the **EMD ConWx mesoscale data** set to have instant access to **20-year+ time series** in a 3 km / hourly resolution for **Europe** or use the **EMD-WRF Mesoscale On-demand Calculation Service** to create high-quality **20-year+ time series** in a 3 km / hourly resolution **anywhere in the world** at very attractive prices.

MCP MODULE

The MCP (Measure-Correlate-Predict) module is for long-term correction of measured wind data on site and based on the correlation with long-term reference data. The module includes the four most common MCP methods: Linear Regression, Matrix, Weibull Scale and Wind Index.

Within the module, users can download both worldwide MERRA wind data sets from 1979 to present with a grid resolution of 1/2° latitude / 2/3° longitude, CFSR wind data sets from 1979 to present in a grid resolution of 1/2° latitude/longitude, NCEP/NCAR wind data sets from 1948 to present with a grid resolution of 2.5° latitude/longitude, NARR data (North America, 32 km resolution), Blended Coastal Winds Data (offshore wind data up to 100 km from land), from 1987 to present with a resolution of 0.25° latitude/longitude, QSCAT data (offshore, variable resolution until 2009), METAR data (5,000 airports worldwide) and SYNOP data (7,000 synoptical stations worldwide). These data can be imported directly into a METEO object and used as long term reference data.

The "end result" from the MCP analysis is a wind statistic generated with WAsP based on a terrain description and the long term corrected site data. This can be used directly in a PARK calculation or for a wind resource map calculation. For non-WAsP use or further analyses, the long term corrected site data can be exported as time series. A very strong feature of the MCP module is the graphic comparison between local measurements and concurrent predictions based on long term reference and calculated transfer function from any of the four methods.

PARK

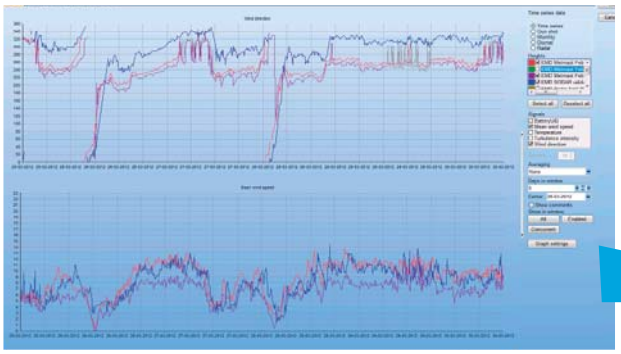
The PARK module is a very flexible tool for calculating the AEP of one or more wind farms. WTGs can be entered as both existing and new WTGs and treated separately in the printout, while all are included in the calculation. Even the loss of energy at existing WTGs caused by the new WTGs is calculated automatically in one process, if required. With the windPRO layer structure, several different layouts can quickly be tested against each other. The PARK module contains several different wake loss models and facilities for advanced turbulence and RIX calculations.

The PARK module includes reports with 24-12 tables and duration curves based on time series with wind variations. Detailed results with calculated time varying production for each turbine for analyses with the PERFORMANCE CHECK module or Excel extract. The calculated production including transformation of the wind measurements to each WTG position and wake loss calculation for each time step offers a new dimension for analyzing actual versus calculated production figures. Finally, the PARK model can calculate data for park power curve verification, etc.

LOSS & UNCERTAINTY

The LOSS & UNCERTAINTY module is used in addition to a PARK calculation for reaching a bankable level with probability of exceedance levels between P50 and P99 for the annual energy production (AEP). The LOSS & UNCERTAINTY module offers an efficient and structured way of addressing the loss and uncertainty issues.

In a wind farm project several important losses have to be considered and their resulting reduction calculated; the module helps the user through this ›



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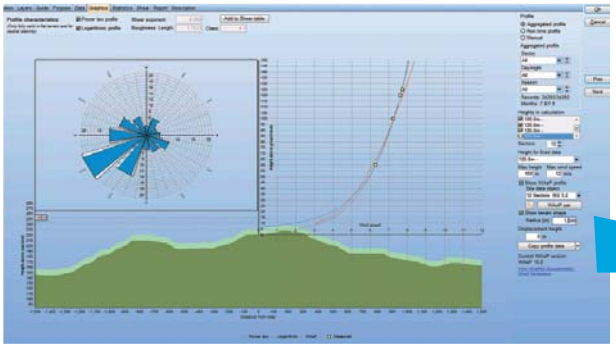
1 - METEO Module



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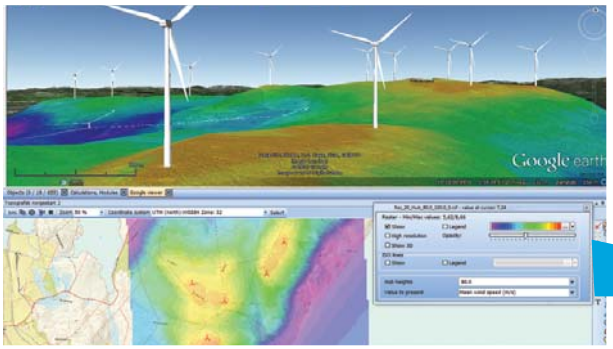
2 - MODEL Module



3

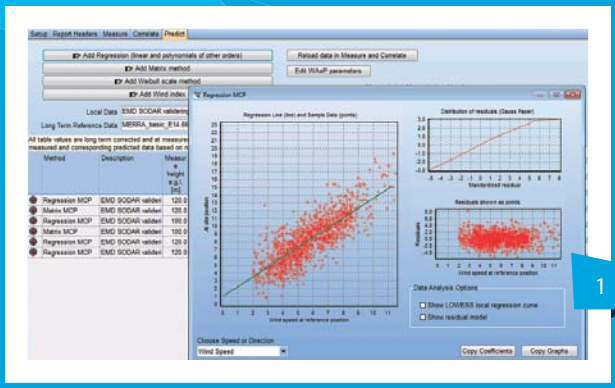
3 - RESOURCE Illustration

windPRO

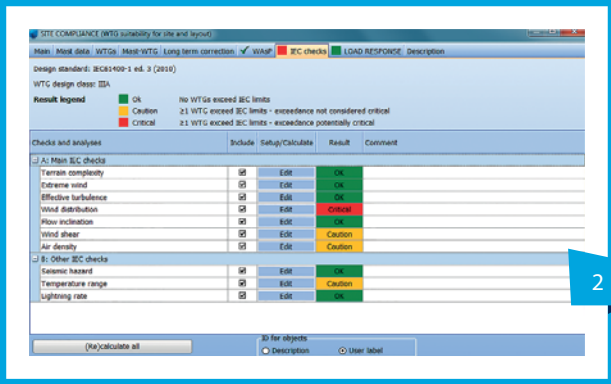
THE WORLD'S MOST WIDELY USED SOFTWARE PACKAGE FOR PLANNING AND DESIGN OF WIND FARM PROJECTS

Used by more than **2,200** companies and institutions, including all of the world's leading turbine manufacturers, project developers, engineering companies, utilities, planning authorities and research institutions.

“windPRO is a fully integrated modular based



1 - MCP Module



2 - SITE COMPLIANCE Module

process with a full list of all potential losses. The losses are grouped and organized according to the recommendations made by an international group of experts. Several types of losses can be calculated within the module e.g. high wind hysteresis, wind sector management and fully customizable curtailment settings. Bias due to RIX correction is easy calculated for each turbine position. In the module all the important uncertainty components are grouped according to their origin. The uncertainty components resulting from horizontal and vertical extrapolation may be calculated using a setup based on EMD’s vast international project experience. Uncertainty due to the power curve may also be calculated according to the IEC61400-12 standard.

SITE COMPLIANCE

Together the SITE COMPLIANCE and LOAD RESPONSE modules in the LOADS group allow a complete site suitability assessment of a wind turbine design class for a site and layout. LOAD RESPONSE is licensed as a separate module, but is fully integrated in SITE COMPLIANCE to provide the user a smooth and efficient work flow from wind measurements to load assessment.

The SITE COMPLIANCE module offers calculation of the seven main checks required in the IEC61400-1 ed. 3 (2010) standard: terrain complexity, extreme wind, effective turbulence, wind distribution, wind shear, inflow angle and air density. Check results are compared against the limits for the chosen IEC design class e.g. IIIA. The module also include the supplementary IEC checks: hours outside normal and extreme temperature ranges, Seismic hazard and annual lightning rate.

A full assessment of the IEC checks may be performed with site measurements and a WAsP license. SITE COMPLIANCE also includes a seamless and user-friendly integration of the flow models WAsP Engineering and WAsP-CFD, which enables additional calculation options for several of the main checks. IEC design classes (e.g. IIIA or IIB) may be individually set for each wind turbine in a layout and a flexible user-input is offered for customized ‘Class S’ models. The module is user-friendly yet allowing elaborate calculation alternatives for advanced users to compare, test and validate results and their sensitivity to key assumptions.

When one or more of the Main IEC checks are exceeded the IEC61400-1 ed. 3 (2010) standard requires a load calculation to assess the chosen turbine models ‘structural integrity’ for the site and layout. This requirement means to assess that on-site loads do not exceed design loads for all turbine components at all turbine positions. LOAD RESPONSE implements this requirement via an advanced response surface methodology based on large amounts of pre-run load assessments to allow very fast and accurate load assessments. The resulting loads are presented as ‘load indices’, i.e. actual loads normalized to design loads, for each main component.

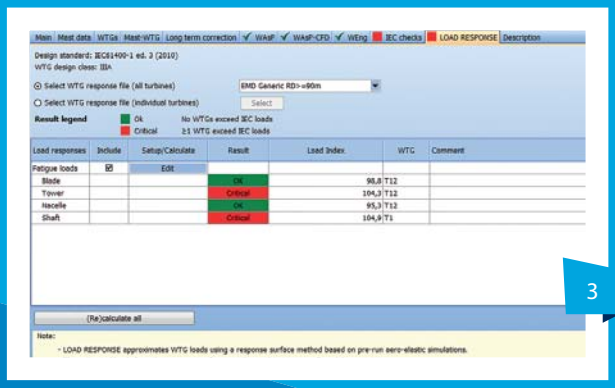
LOAD RESPONSE

LOAD RESPONSE comes with two generic wind turbine response models for small (<90m) and large (≥90m) rotor diameters. These generic models represent well most turbines on the market, and are validated against commercial turbine models and allow consultants and developers to assess loads even at very early project stages.

Turbine manufacturers can easily add their own turbine response models for in-house use, based on their own aero-elastic simulations and post-processing. Implemented manufacturer specific response models are protected by high security via encryption and license control, and the manufacturers decides with whom to share the implemented response files.

SITE COMPLIANCE and LOAD RESPONSE are both certified by TÜV SÜD for consistency with the requirements in the IEC61400-1 ed. 3 (2010).

software package, based on nearly 30 years of experience."



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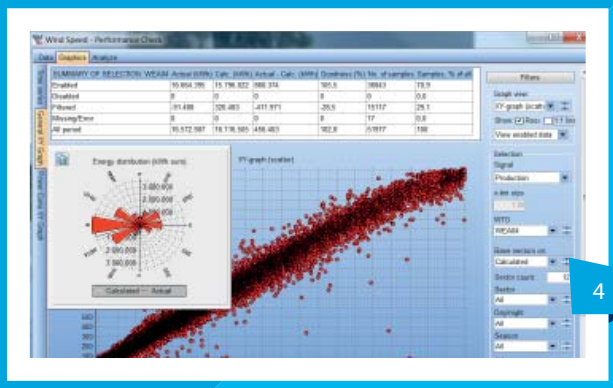
3 - LOAD MODULE Module



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4 - PERFORMANCE CHECK Module

OPTIMIZE

The OPTIMIZE module operates with three different methods which can be used for the optimization, either independently or in combination:

A: Regular pattern: Park design with strict requirements to a geometrical layout (straight parallel lines with equal distances between the WTGs e.g. off-shore, but also arc layouts can be handled). The software tests a large number of parameters automatically (e.g. angles, distances, row offset etc). Boundaries can be digitized to keep the layout within a limited area. The layout with highest energy yield is "the result", but each calculation step can be exported to a spreadsheet and processed to find the most cost efficient layout. E.g. for offshore optimization, the water depths for the turbines in each calculation step are part of the export.

B: Random pattern: Automatic optimization of a WTG layout with highest energy production within specified wind farm areas. Restricted areas can be defined manually or loaded from a shape file. The optimization process can automatically ensure required distances to neighbors.

C: Noise optimization: Given a fixed layout, The OPTIMIZE module will optimize the operation modes for each turbine in the wind farm to comply with noise requirements.

PERFORMANCE CHECK

The PERFORMANCE CHECK module has two modes:

1) Calculation of WCP (Wind energy index Corrected Production) – or long term expected production based on actual monthly production and wind energy index or:

2) Detailed performance check where actual production versus calculated is analyzed on e.g. a ten minute basis, which makes it possible to group data by day/night, direction sector, season, temperature etc. to establish whether there are specific problems related to turbine operation or model calculations that might be fixed. This part also holds a power curve validation, where more complex topics like air density correction are intelligently handled. The module offers very comprehensive "basic tools" such as a flexible importer of turbine production data and other important data for the analysis such as turbine wind, pitch angle, rpm, etc. A comprehensive wind energy index tool is also included, handling import of public wind energy indexes as well as an index generator where input is based on measured or meso-scale wind data.

SITE COMPLIANCE & LOAD RESPONSE MODULES CERTIFIED BY:

Software evaluation
TÜV SÜD
Site suitability
IEC 61400-1 ed.3

Environment

DECIBEL

The DECIBEL module makes noise calculations an easy task. Existing and new wind turbines can both be included, and it is possible to define noise receptors (Noise Sensitive Areas) as spot locations as well as areas described by polygons. It is also possible to enter the initial background noise level without turbines if known, and then calculate the additional noise generated by the wind turbines. Most of the country-specific calculation models and noise limits are implemented. With interactive noise lines continuously updated when moving turbines on the map, a suitable layout can quickly and efficiently be found on sites with noise restrictions.

NORD2000

The NORD2000 module includes a calculation engine for advanced noise calculations. It calculates the noise propagation from a wind turbine to a receptor (neighbor) given the specific terrain, wind speed, direction and climatic conditions. Typical calculations are either a point calculation that calculates for a specific set of conditions (e.g. for testing noise measurements) or for a range of wind speeds/directions to find the worst case of noise impact. In advanced use wind directional dependent noise reduction modes can be calculated, which can save several percentages of losses due to noise reduced operation.

ZVI (Zones of Visual Influence)

The ZVI module enables users to analyze the long distance visual effect of WTGs and to evaluate how several groups of WTGs affect the visual impact in a region. In a ZVI calculation, the user can optionally include forests, villages and other blocking elements in the calculations. The module includes features for calculating the cumulative impact of several wind farms within a specified region and it includes optional distance reduced impact. In addition, the ZVI module also includes features for radar calculations allowing the user to create a planning map of non-visibility of WTGs for radars or calculate the clearance height between the line of sight and the turbine.

IMPACT

The IMPACT module combines DECIBEL, SHADOW, ZVI and PHOTOMONTAGE to a one-page calculation result for each individual neighbor. This module can be used for informing neighbors close to a proposed wind farm of the individual environmental impacts they may experience from the project. This precise information can often avoid unnecessary opposition and protests among neighbors to a new project.

EIA documentation accepted worldwide by local planning authorities

SHADOW

The SHADOW module makes it possible to calculate the annual hours of shadow flicker impact generated by one or more WTGs at either specified recipients or for a given area. As part of the calculation, the module checks for non-visual contact between recipients and WTGs through a pre-calculation of zones of visual influence within the area. A worst-case calculation based on maximum possible impact or a real-case value (weather-statistic based) calculations can be performed. Calculation output such as a shadow flicker calendar for each recipient is included. Shadow flicker calendars for each turbine can also be calculated and the results can be exported directly to and implemented in the control system of the WTGs.

Visualization

PHOTOMONTAGE

The PHOTOMONTAGE module is used to create a realistic visualization of a WTG project in a landscape photo (normal or panoramic view), wireframe or based on Google Street View images before it is installed. The properties of the photo used (focal length, date/time, coordinates) are loaded automatically if available within the digital photo file. Special features such as the horizon line or various control points make it easy to calibrate the camera model and get a precise result.

ANIMATION

After creating a photomontage, the animated visualization is a few clicks away with this module. On the computer screen, the rotor blades rotate at the proper speed and even flashing aviation lighting can be added. The file can be saved in GIF, AVI, MPG or Flash formats for publication on the internet. With ANIMATION it is easy to get a realistic impression of the dynamic appearance of the wind turbines in a wind farm project.

3D-ANIMATOR

The 3D-ANIMATOR module is used for virtual reality (VR) modeling of any given wind turbine project and any 3D objects (e.g. power masts, houses, forest). The artificial landscape is rendered based on the elevation data. This surface is then draped with a texture surface, (i.e. a map, an aerial photo or any texture) that will provide a realistic presentation of the landscape.

After rendering, you can freely move through the model with rotating turbines. Movement can be controlled from the keypad, mouse or joystick. The VR-project, together with an external viewer, can also be distributed electronically, so that anybody can take a virtual tour through the wind farm area.

Grid

eGRID

The eGRID module is used for the design and calculation of WTG grid integration. It calculates the following:

- Annual losses in cables and transformers based on the local wind climate
- Design check of the cables and transformers (load as a percentage of capacity)
- Steady state voltage variations based on two freely-definable load situations or auto-defined
- Short circuit power and current
- Voltage fluctuations (long-term flicker)
- Voltage variations caused by switching effects
- Verification of the calculated values with demands given e.g. by the utility
- List of cables and components used for cost calculations, including both cable length and excavation length, taking topography and gradients into account.

Economy

WINDBANK

The WINDBANK module makes it easy to calculate the financial or economic feasibility of the wind turbine/-farm investment in question. The flexible nature of the module enables the user to tailor the calculations according to the specific conditions in various countries. The strength of this module is that the data handling and key figure reports are specifically designed for wind energy projects.

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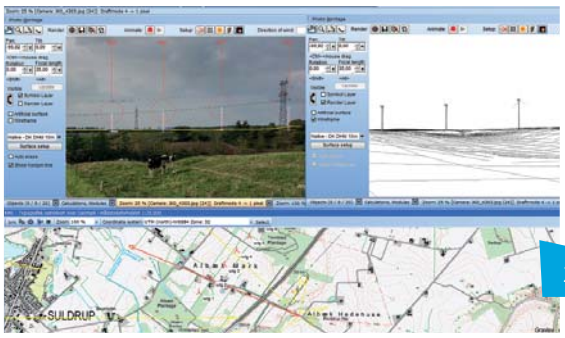
1 - Project PHOTOMONTAGE



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2 - PHOTOMONTAGE Module

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windPRO

windPRO is a fully integrated modular based software package, based on nearly 30 years of experience, offering you both outstanding interactive graphics and superious documentation.

Recognized and accepted by turbine manufacturers, developers, utitilities as well as local planning authorities worldwide.

www.windPRO.com

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