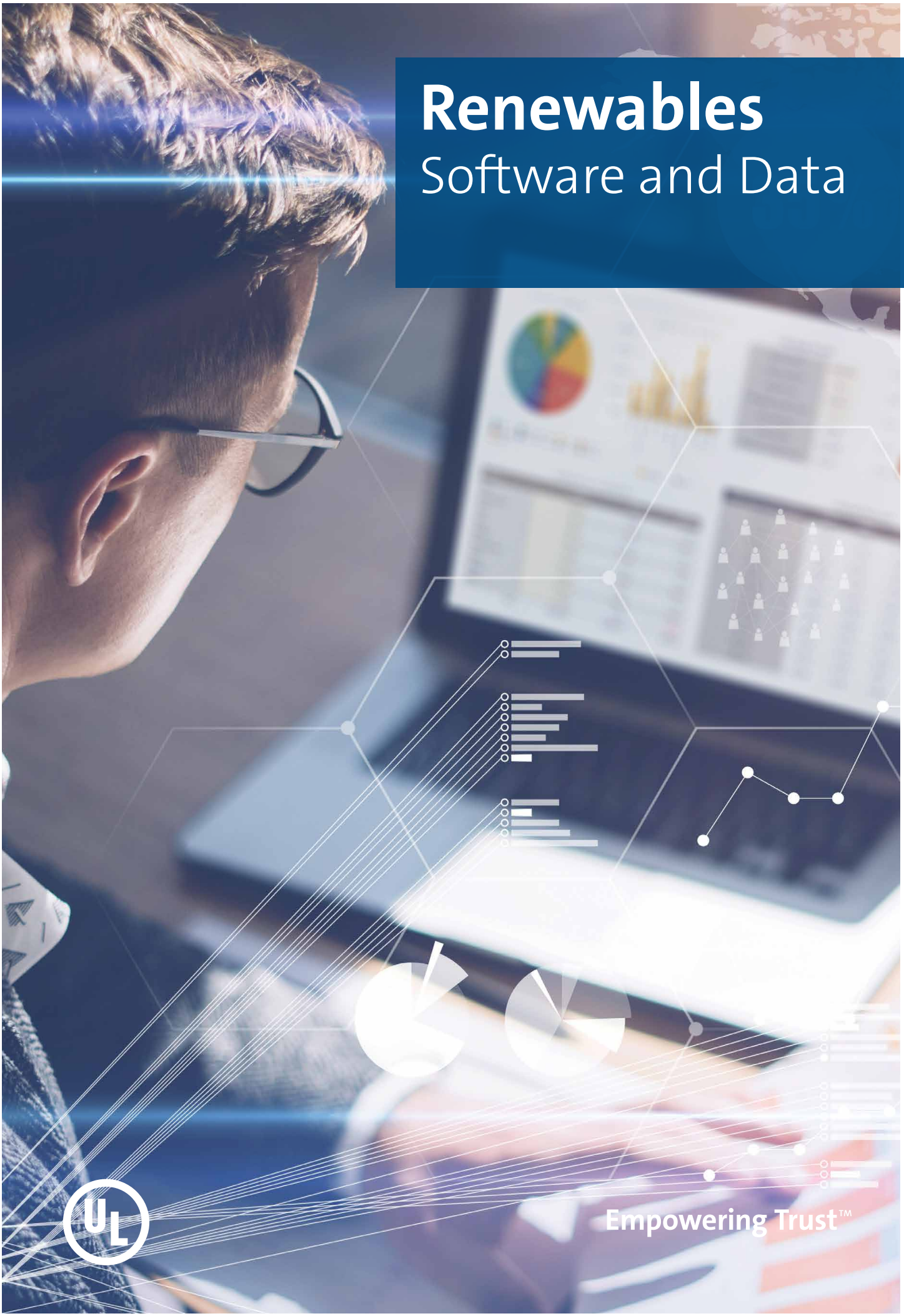


Renewables
Software and Data

Empowering Trust™

UL operates in more than

140
COUNTRIES

200,000+ MW
Total megawatts assessed

500+
RENEWABLE ENERGY EXPERTS

35+ *years of*
EXPERIENCE IN RENEWABLE ENERGY

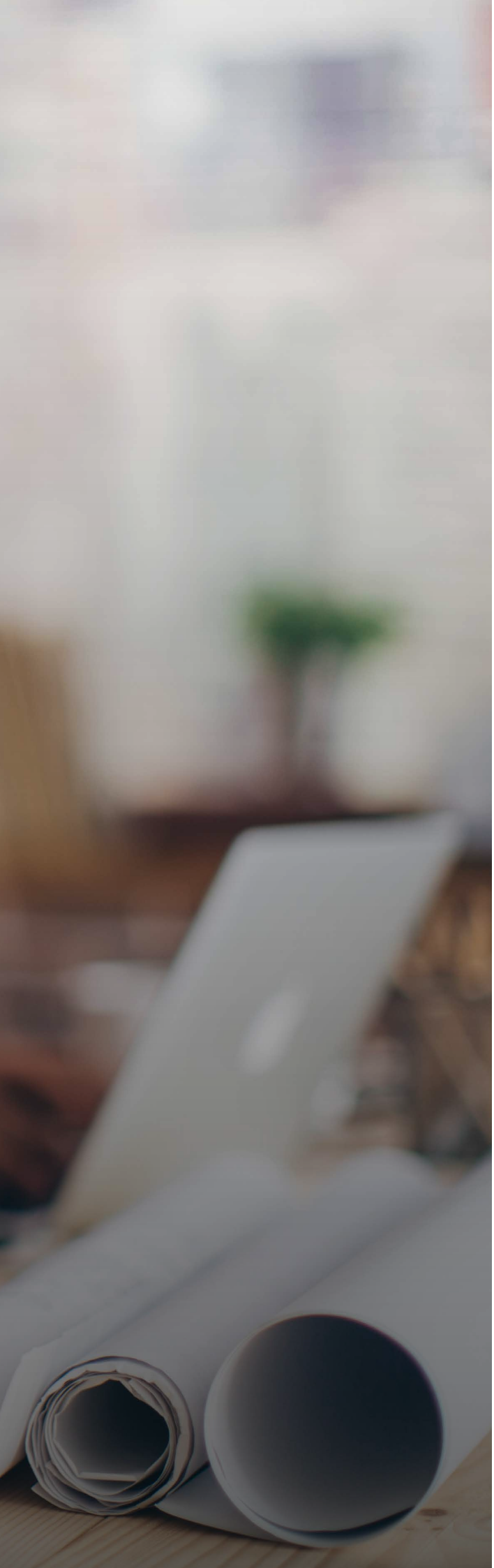
ADVISED 90%
OF THE WIND INDUSTRY'S TOP PROJECT DEVELOPERS AND PLANT OWNERS

INDEPENDENT/OWNER'S ENGINEER FOR

500+
WIND AND SOLAR PROJECTS SINCE 2012

Forecast provider for

70+ GIGAWATTS
OF INSTALLED RENEWABLE ENERGY PROJECTS



About Us

Leaders in Global Services for Renewable Energy

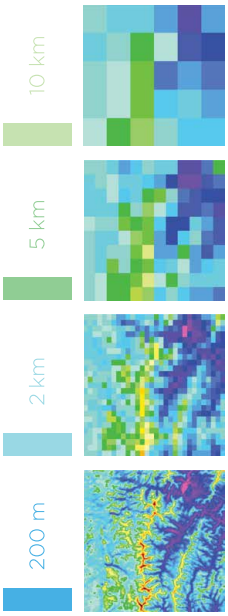
UL is a trusted independent advisory, testing, inspection and certification body for a broad range of industries. In the renewable energy space, UL works to help manufacturers, developers, owners, investors, lenders, utilities and policy makers navigate the risk and complexity associated with renewable resources. We have become a trusted advisor by providing access to proven science and expert engineering, and by offering innovative solutions to meet the unique challenges of the renewable energy industry. We pride ourselves on being accessible, flexible and keenly responsive to the needs of our clients.

UL now delivers an even more extensive portfolio of renewable energy services, through the acquisitions of AWS Truepower (2016) and DEWI (2012). With offices in over 140 countries, a team of over 500 experts and 35 years of experience, we advise on wind and solar projects as well as battery and energy storage technologies, helping our clients make them safer, compliant and perform to the highest standards. Our goal is to empower trust in renewable energy throughout the project lifecycle and across the supply chain.

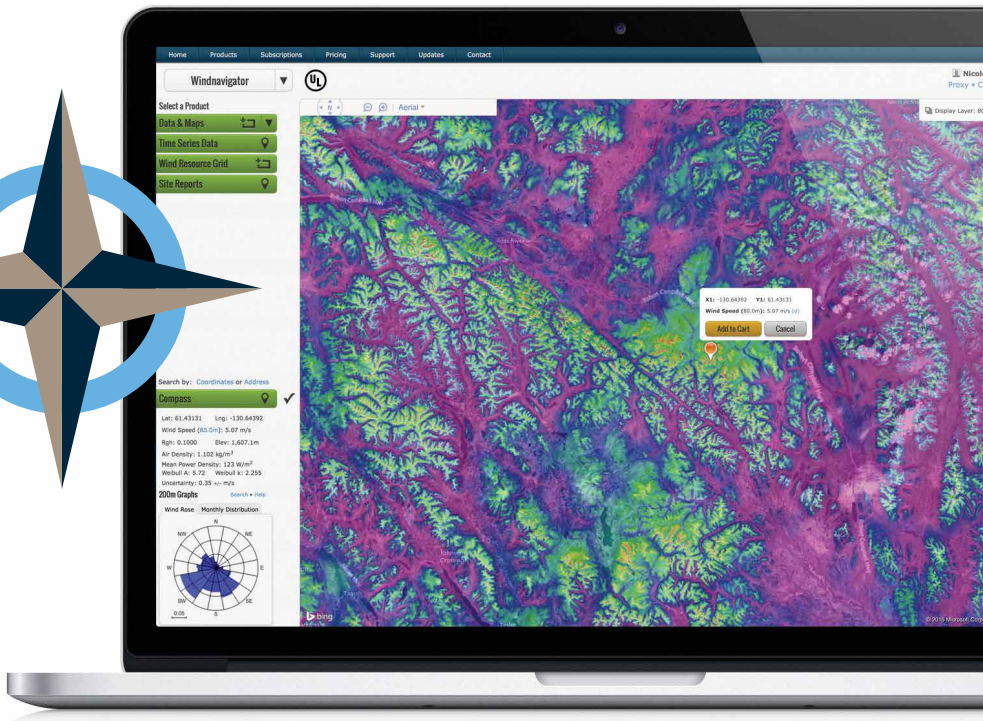
Why UL?

UL offers a range of software and data products that support the development, assessment, and operation of renewable energy projects. These products leverage the technical innovations and years of experience we've applied to the field of renewable energy, helping our clients to work more productively, effectively and independently. Our software and data support the entire wind project development process, from initial site prospecting to final design and energy estimation. We provide you with the tools your team needs to work on its own as well as the platforms to collaborate powerfully and efficiently with our experts.

Windnavigator



High resolution makes all the difference.



Windnavigator is an online dashboard designed to support preliminary stages of wind project development.

The Windnavigator Dashboard gives you the power to quickly obtain validated mean annual wind speed values, resource characteristics, maps and data layers, historical and long-term datasets, and resource and energy assessment reports. Users can accurately prospect greenfield sites, identify locations for a wind monitoring campaign and assess competing projects at custom hub heights of 10 m to 140 m in the online platform. Users have access to the compass tool which serves up click and point wind statistics, wind rose and monthly data.

Users benefit most by becoming Windnavigator Dashboard subscribers.

Subscription includes:

- Online access to the wind speed map
- Compass statistics
- Unlimited onshore and offshore global reanalysis data points
- (1) Complimentary typical year time series dataset
- (1) Complimentary 200 m WRG
- (1) Complimentary advanced report

Windnavigator API Value Bundle

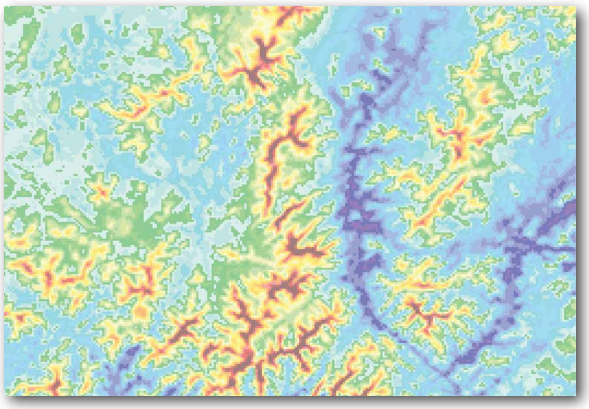
An API value bundle allows users to use the Windnavigator Dashboard as an API. The API allows you to input a long list of prospecting coordinates and receive immediate results and statistics in CSV format.

Available values include: wind speed, elevation, Weibull A and k, air density, max gust, predominant direction, wind rose, shear, air temperature and energy. The user can also select specific months for predominant direction, wind rose, and wind speed. A turbine library is provided for energy.

The Windnavigator Dashboard can also be customized to meet business, policy and planning objectives.

Windnavigator Data Products

Our data and maps are derived from simulations of historical atmospheric conditions performed by a numerical weather prediction (NWP) model. The model output is further downscaled with a microscale model accounting for local terrain and surface influences and adjusted using available high-quality wind measurements. This approach has been thoroughly validated and uncertainty statics are available upon request.



Wind Speed Maps

- Validated annual wind speeds available from 10 m to 140 m
- GeoTiff: wind speed, elevation and roughness at 200 m resolution
- ESRI shapefile: wind speed, wind power, Weibel A and k, frequency percentages, wind rose, monthly and diurnal data provided at 2 km resolution

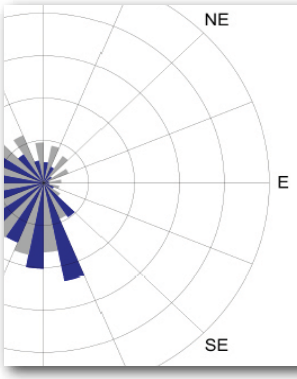
Wind Resource Grids (WRG)

- Site met towers, design preliminary turbine layouts and obtain preliminary energy estimates.
- Exports easily to most common wind flow and plant design software
- User-defined hub height between 10 m to 140 km
- Basic WRG: 200 m resolution, fixed 25 km x 25 km
- Advanced WRG: 50 m resolution, 50 km x 50 km up to 100 km x 100 km

19970101	0	-18.3	954.2	18	5.57	1.305	0.212	1.17
19970101	100	-19.2	953.5	26	5.33	1.308	0.195	1.03
19970101	200	-20.2	952.8	17	5.09	1.312	0.172	0.87
19970101	300	-20.4	954.5	19	4.61	1.316	0.17	0.78
19970101	400	-20.5	951.5	23	4.23	1.312	0.162	0.68
19970101	500	-20.6	952.8	37	3.52	1.314	0.175	0.61
19970101	600	-20.5	952.1	52	2.47	1.313	0.193	0.47
19970101	700	-20.4	954.1	55	1.6	1.315	0.205	0.32
19970101	800	-20.3	955.2	75	1.64	1.316	0.177	0.29
19970101	900	-20.2	953.9	64	1.05	1.314	0.165	0.17
19970101	1000	-20.1	952.6	77	1.61	1.311	0.104	0.16
19970101	1100	-19.8	951.7	119	2.76	1.309	0.106	0.29
19970101	1200	-19.2	952.7	141	4.16	1.307	0.076	0.31
19970101	1300	-18.7	953	152	5.42	1.305	0.084	0.45
19970101	1400	-18.2	953.3	164	6.68	1.303	0.084	0.55
19970101	1500	-17.4	949.7	163	7.04	1.294	0.106	0.7
19970101	1600	-16.1	949.4	162	6.26	1.287	0.136	0.85
19970101	1700	-14.6	948.2	162	6	1.278	0.166	0.99
19970101	1800	-13.1	947	168	5.89	1.269	0.18	1.05

Time Series

- Long-term time series used for MCP analysis where short-term data is available
- WRF time series at 3 km or 9 km resolution for 1 year up to 35 years and includes solar, turbulence intensity and humidity data to complete conditions analysis
- Global reanalysis data (MERRA, MERRA2, ERAI, ERA5, and CFSR)
- Onshore and offshore data available
- Typical year time series (short-term)
- Short-term data set using the UL MASS model and scaled to 200 m resolution to represent a 365-day sample from a 15-year period
- Easily imports into Openwind, Windographer and other plant design and resource assessment software



Sector	Freq	Pct Energy
N	4.5	2.4
NNE	3.8	2.0
NE	3.0	1.1
ENE	2.0	0.6
E	1.8	0.6
ESE	2.2	1.2
SE	4.6	4.9
SSE	8.2	11.8
S	8.6	10.1
SSW	7.8	7.6
SW	8.2	7.8
WSW	12.0	14.9
W	14.6	20.8

Site Reports

- Comprehensive resource summaries for a point
- Compare energy for up to 3 turbine models
- Extensive charts and graphs including wind rose, frequency, distribution and monthly diurnal data
- Based on 200 m resolution data
- Many additional features included

Windographer

Windographer software imports and analyzes wind resource data measured by met tower, sodar, or lidar. It quickly imports virtually every data format, allows rapid quality control and statistical analyses including MCP, and exports to all wind flow models.

Data Management

- Import NRG, Ammonit, Kintech, Campbell, Triton, AQSystem, ZephIR and Windcube
- Read calibration constants from raw data files and re-calibrate
- Reads from and write to SQL database
- Combine co-located anemometers, fill gaps, apply time shifts and create calculated data columns
- Extrapolate speed, direction, temperature and turbulence data to multiple heights
- “Document History” window displays complete list of modifications

Quality Control

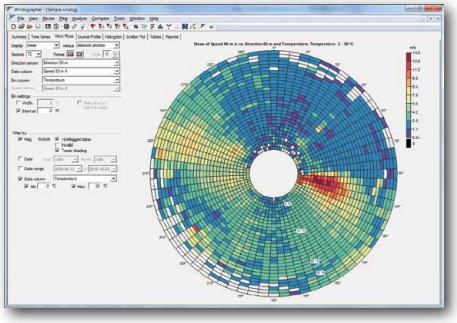
- Define your own flags
- Apply flags to data segments manually or automatically
- Use flags as filter criteria

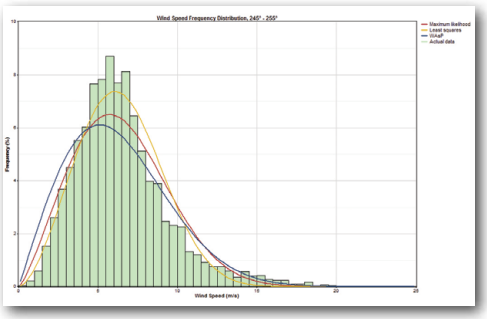
Measure - Correlate - Predict

- Download ERA5 and MERRA-2 long-term reference data for free
- Compare possible long-term reference data sets based on correlation and uncertainty
- Choose from several algorithms including linear least squares, variance ratio and matrix method
- Compare algorithms and settings in terms of their performance and their uncertainty
- Lengthen or scale the target data set to expected long-term conditions

Professional Output

- Export reports to PDF
- Export multiple-height time series data to Openwind
- Export to WAsP, WindFarmer, WindSim and Meteodyn WT
- Export graphs and tables to PNG or text files
- Enterprise edition imports/exports to any SQL database



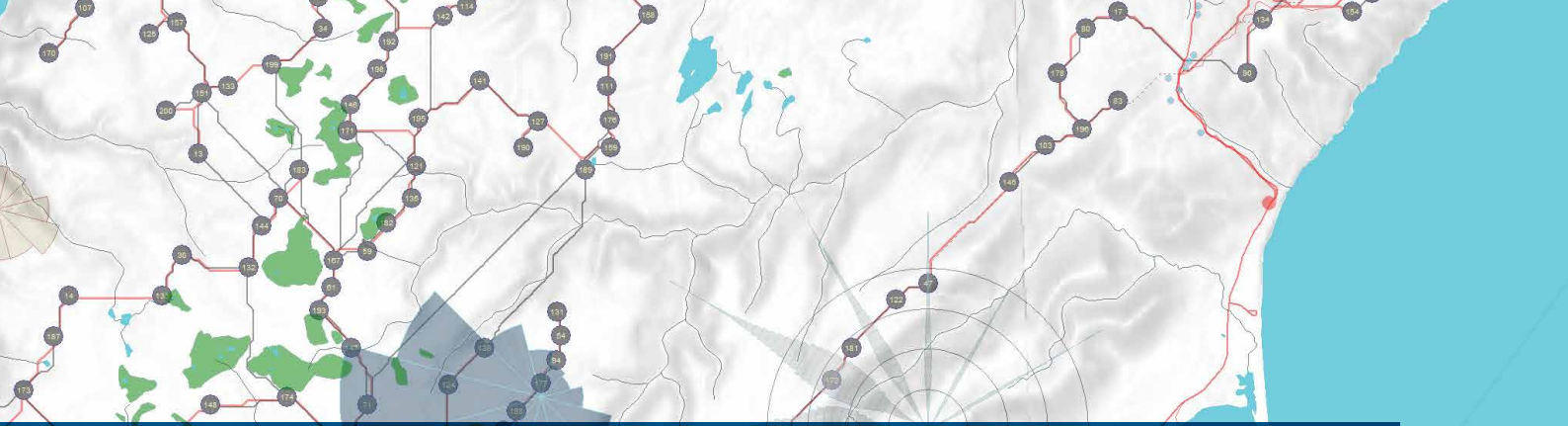


Windographer Monitor

Windographer Monitor is an automated data management service that monitors folders for raw wind resource data files, imports newly-arrived data and inserts that data into a database. The software and the database reside on the customer's server, allowing the user to control the folder scanning process, interact with the database and see the status of each monitored data set. Windographer Monitor can integrate with any SQL database that meets the specifications of Windographer Enterprise.

Windographer Database Creator

Windographer Database Creator is a utility program that creates a simple database (SQL Server, MySQL, or PostgreSQL) that has the structure to store wind resource data and all the metadata relevant to Windographer, including calibration data, flag data and data set history. It also immediately creates all the stored procedures the database needs to communicate with Windographer. You can expand the system over time adding tables and fields, or editing the stored procedures.



Openwind

Openwind is a wind farm design and optimization software used throughout a wind project's development to create optimal turbine layouts that maximize energy production, minimize energy losses, account for plant development costs and generate overall project efficiencies.

Maximize energy production

Cost of Energy Optimization

Optimize layouts and turbine positions to minimize the cost of energy, taking into account energy production, O&M costs and capital costs including turbine and plant development costs. Understand the impact each turbine has on the bottom line.

Arrive at the best layout by taking into account:

- Access road costs
- Collector system costs
- Waterways, pipelines, fence lines, wetlands and more
- Substation and grid connection locations
- Electrical losses
- Power purchase agreement length
- Operations and management costs
- Wind resource and wake losses

Gridded Turbine Layers

- Quickly create and modify gridded turbine layouts using the user-friendly GIS interface
- Design by hand using intuitive graphical tools
- Allow optimizer to determine downwind and cross-ing spacing, grid orientation and obliquity

Openwind Benefits

- Determine the best layout balancing energy output with construction costs using the Cost of Energy Optimization module
- Deep array wake modules are more accurate than leading competing modules and are essential for estimating wake losses for utility-scale wind farms
- Software that draws from over thirty years of con-sulting expertise assures confidence from financial institutions
- Compatibility with other wind software enables seamless file sharing and easy migration of existing procedures

Reduce and Quantify Uncertainty

- Model environmental and directional curtailments
- Accounts for measurement uncertainty, MCP uncertainty and modelling uncertainty
- Assign turbines to met masts, adjust WRGs and run energy estimates
- Let the software suggest additional sites for met masts to extend the monitoring campaign and minimize project uncertainty

Multiple Design Turbine Layout Option

- Analyze multiple turbine layout options for cost effectiveness including different hub heights and turbine types

Minimize energy loss

Deep Array Wake Models (DAWM) and Standard Wake Models

Leading-edge wake models consider the dynamic interactions between turbines and atmospheric boundary layer as well as allowing wakes to vary with turbulence intensity and stability.

Openwind offers users 5 different customizable wake models to choose from including:

- Modified Park
- N. O. Jensen (variety of wake combination schemes)
- Eddy Viscosity
- Deep Array Wake Models (Park & Eddy Viscosity versions)

Time Series Energy Capture

(12x24s, annual or long-term time series at hourly or 10 minute intervals)

- Run energy capture calculations that take into account time-varying temperature, air density, and turbulence intensity
- Model realistic availability using Markov chain models, which can vary with season
- Model high wind hysteresis, low- and high-temperature shutdown losses
- Diurnally varying wake losses
- Icing losses based on met data
- Parasitic consumption, blade heating and electrical losses
- Effects of bat curtailment and NRO modes
- Output results for entire project or individual turbines

Directional Curtailment, Inflow Angle, Turbulence

Model effects of directional curtailment by specifying curtailment strategy in detail or by setting criteria for automatic sector management.

Non-Ideal Performance Losses

Use multi-height met mast data to assess the effects of non-standard shear using the rotor equivalent wind speed and adjust power curves for different ranges of turbulence intensity.

Environmental Management

- Noise Modeling
  - ISO 9613-2
  - Harmonoise
  - CNOSSOS-EU (NMPB 2008)
- Vary atmospheric attenuation based on ISO 9613-1
- Automatically generate NRO strategies based on noise constraints
- Turbine Scheduling (Noise, Bat, Shadow-Flicker Curtailments)
- Visual Impact Modeling (variety of ZVI measurements)
- Shadow Flicker
  - Take account of wind time-series data
  - Take account of sunshine hours

Suitability

- Effective turbulence intensity and terrain complexity
  - Implements IEC 61400-1 editions 2, 3, 3 amendment 1 and draft edition 4
  - Allows customization of those elements open to interpretation
  - Facilitates easy comparison of turbines to their appropriate IEC curve or custom curves
  - Automatically generate wind sector management strategy to meet IEC requirement
  - Optimize layouts while taking account of likely wind sector management losses
  - Set suitability limits for turbine layouts based on the appropriate IEC standard
- GIS and GPS Integration
- Validated energy capture
- Comprehensive import/export capabilities

"Compared to competition, Openwind is greatly adaptable, tweakable, detailed, useful and GIS compatible. It could surpass other software applications (such as WindPRO, WAsP, Meteodyn, WindSim, WindFarmer, etc) in many respects using different built in Openwind features. I would like to emphasize the fast and effective customer support."

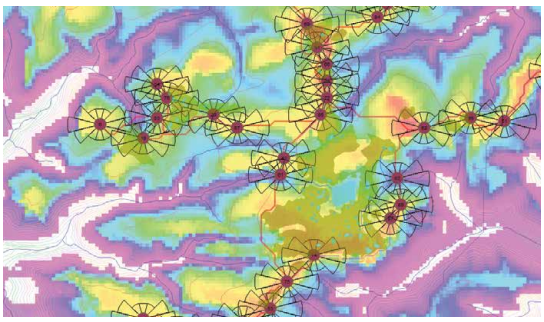
— Kornel Rozsavolgyi, Orion Renewable Energy Group

How to save millions on a wind development project

Determining balance-of-plant (roads, collectors and crossings) can be expensive, but so can ignoring such costs, or evaluating them too late in the process.

Q: How can I minimize cost of energy?

A: *Use Openwind to minimize the cost of energy including balance-of-plant costs - while keeping production as high as possible.*



Texas Case Study*

Openwind's cost of energy optimization tool allows developers to account for balance-of-plant costs much earlier in the development process, and to weigh them directly against energy production, leading to the optimal design.

To minimize cost of energy, Openwind considers:

- Existing roads and new roads
- Terrain steepness
- Water bodies and courses
- Fence lines
- Railroads
- Pipelines
- Substation location and cost
- System voltage
- Cable types and costs
- Financial forecasting
- Many other parameters

Openwind accounts for construction costs that can affect the value of your project. Early and regular communication with construction teams can help in the design cycle and benefit many participating parties.

To demonstrate Openwind's capabilities, we joined with EDF Renewable Energy, Mortenson, and Stanford University in a research study on a recently built Texas plant. The study showed that the cost of energy optimization model could have:

- Reduced road costs by 15%
- Reduced collection system costs by 7.8%
- Reduce total plant costs by 6.2%
- Compared to as-built, this would have lowered the overall cost of energy by a substantial $1.3/MWh

Key to Success:
Increase collaboration with construction, operations, and financing teams to continually refine the cost of energy model and improve the balance of plant design.

*J. Kassebaum, "Improving Wind Turbine Layouts: Balancing Energy Production and Construction Costs to Minimize the Total Cost of Energy," AWEA Resource Assessment Workshop, Orlando, Florida, 10 December 2014.

Access all three industry-leading tools with the Wind Developer Suite

The Wind Developer Suite is an all-inclusive bundle to support the entire wind project development process, from initial site prospecting to final design and energy estimation. We provide you with the tools your team needs to work on its own, as well as a platform to collaborate powerfully and efficiently with our experts. This package includes:

- Windnavigator Dashboard subscription
- Windographer Enterprise software
- Openwind Enterprise sofware
- Ten (10) software training hours per year

To learn more about the value of this package contact our sales team: renewableenergyservices@ul.com.

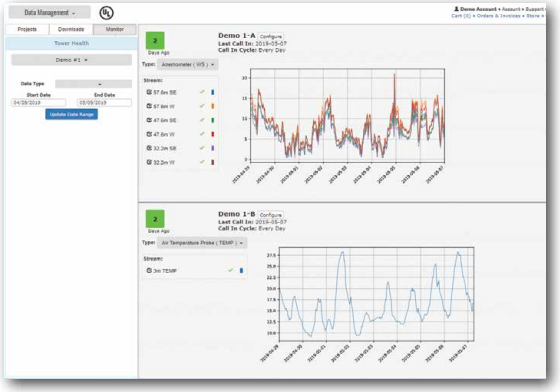
Data Management Dashboard

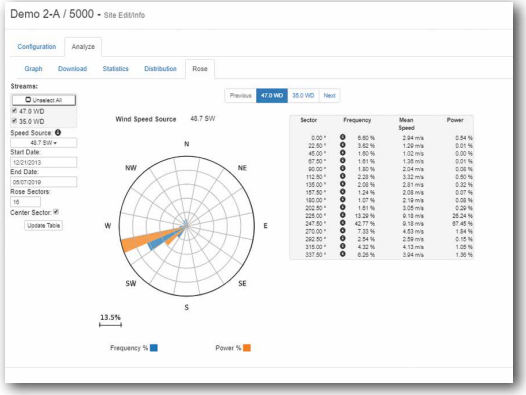
Manage all of your meteorological towers and/or solar monitoring stations in a secure online environment.

The Data Management Dashboard is a platform designed for wind and/or solar project developers to collect, monitor and analyze data from their meteorological (met) towers and/or solar monitoring stations. Whether it's a single met tower or a fleet, you can view and access information about your entire program including tower (mast) statistics, monthly reports, raw data, instrumentation activity and faults, and screened and compiled data through the convenient and secure online interface. When using our Data Management Dashboard, you can expect:

- To be alerted of any issues with tower / station instrumentation for quick recovery
- Data security and quality control from UL
- Access to all tower/station data — past and present tower/station data
- To receive monthly reports summarizing data
- To download raw, compiled or screened versions of data
- To view and download resource statistics, plots and data files from any device with an internet connection
- A high level of service from our expert meteorologists who are familiar with data for future analysis

We help ensure that wind and solar resource measurement programs have high data recovery and provide reliable long-term estimates, which result in lower uncertainty in energy estimates when exploring financing opportunities.





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