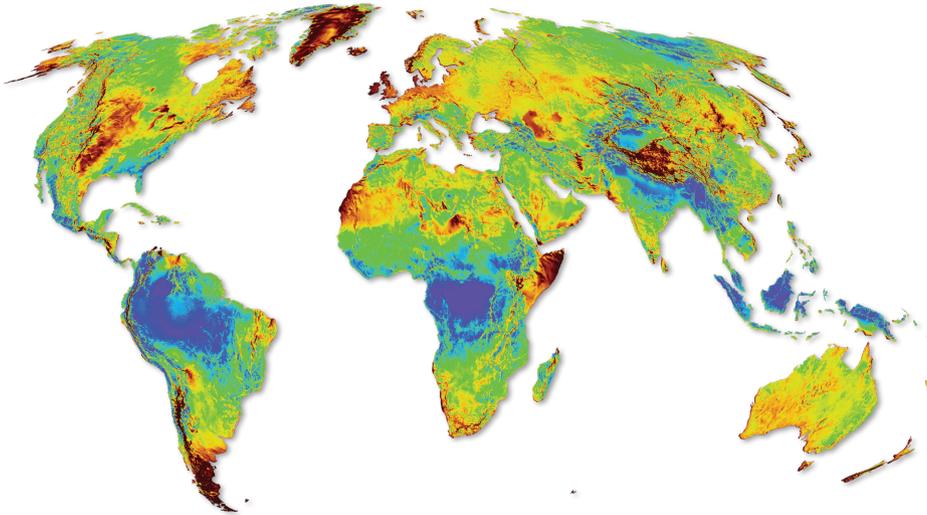


# Wind Energy Assessment & Forecasting



*Experts in weather, climate, and renewable energy risk, Vaisala 3TIER® Services enable profitable decisions so our clients can act with confidence across the development, financial, and operational spectrums.*

## Project Feasibility

### Prospecting & Resource Assessment

The “fuel” of a wind project is the most critical factor driving its commercial success or failure. Whether you are doing initial site prospecting or due diligence for financing, uncertainty about the available wind resource drives your decision process. We help you mitigate the risk of resource uncertainty every step of the way - even at your most challenging sites.

## Energy Marketing

### Forecasting for Power Scheduling & Trading

Efficient wind plant operations, energy integration, and power trading require quick decisions with substantial exposure to risk. These decisions impact production, operational costs, and ultimately project profitability. As one of the largest wind power forecasters in the world, we deliver the accuracy and context you need to manage risk and optimize operations at a single project or across an entire region.

## Asset Management

### Performance Reconciliation, Reforecasting & Due Diligence

We help developers, utilities, and financiers make informed decisions in a challenging energy market with fluctuating price and volumetric risk. Our project reforecasting services use advanced wind deviation analysis to help maximize the profitability of operating projects. Seasonal forecasting combines science and information technology to help build economic value for the long-term.



# Wind Energy Project Feasibility

## Prospecting & Resource Assessment

### Risk Mitigation Process

We provide a full suite of services to help you manage the risk of wind resource variability.

Early Stage		Late Stage	
<b>Prospecting</b> Identify the best areas for closer evaluation quickly and inexpensively.	<b>Project Design</b> Optimize your project design and objectively prioritize your portfolio.	<b>Financing</b> Maximize certainty in your project's long-term performance to secure financing.	<b>Post-Construction</b> Optimize your project's performance and make sound acquisition decisions.
<b>Tools:</b> <ul style="list-style-type: none"> <li>• Long-term time series from multiple sources</li> <li>• 5 km resolution maps and mean data</li> <li>• GIS data layers</li> <li>• API access to data services</li> </ul>	<b>Tools:</b> <ul style="list-style-type: none"> <li>• High resolution wind maps and long-term hourly wind and power data</li> <li>• Optimized met tower and turbine placements based on available resources</li> <li>• Initial risk assessment and recommendations for project design improvements</li> </ul>	<b>Tools:</b> <ul style="list-style-type: none"> <li>• Comprehensive loss analysis with our Energy Risk Framework</li> <li>• Multi-staged observational data quality control process</li> <li>• Incorporation of proprietary time-varying wake model for project turbines and future external projects</li> </ul>	<b>Tools:</b> <ul style="list-style-type: none"> <li>• Integrate power production data into the analysis</li> <li>• Reconcile recent performance against long-term climate data</li> <li>• Independent project assessments using unique methodologies</li> </ul>

### Quickly Explore Wind Resources Around the World

Now you can avoid problem sites and separate successful projects from marginal ones earlier in the process. We offer a 5 km wind prospecting tool that includes a download tool with several long-term time series to select from and have delivered directly to you within 24 hours.

### Maximize Accuracy With State-of-the-Art Science

In a process unique in the industry, we use on-site measurements to correct our long-term mesoscale model simulations of project climatology with sophisticated statistical techniques. We combine our advanced wind energy assessment methods with a holistic analysis of project risk.

Time-varying wake losses, observational data integrity, high stability conditions, shear variability, and more

are assessed on a project specific basis through our energy risk framework. The result is significantly reduced uncertainty about future project performance and the bankable production estimates required to secure project financing.

### Experienced and Trusted

We are a trusted assessment partner for hundreds of developers, engineering firms, and financiers, including many of the largest and most successful energy companies in the world. We have performed wind energy assessments on all 6 continents, many in challenging locations, and our experience includes over 40 GW of proposed and operating wind projects.

Whether you are just getting started on developing a project or you are preparing to get financing, we are an experienced energy assessment provider that can partner with you throughout the entire process.



# Wind Energy Marketing

## Forecasting for Power Scheduling and Trading

### Primary Uses

- Making informed energy purchasing, trading, and marketing decisions
- Managing long-term financial agreements
- Maximizing renewable integration and reducing curtailments
- Reducing imbalance penalties
- Improving construction, energy, and maintenance scheduling

### Guaranteed Industry-Leading Accuracy

We provide the most accurate wind energy forecast available. From an individual site to an entire region, we utilize the latest forecast capabilities: weather and climate science, advanced statistical methods, real-time data integration, historical data mining, and an ensemble of weather forecast models to provide an industry-leading energy forecast. Understanding uncertainty requires transparency. We provide real-time verification and a situational awareness tool to understand forecast performance over any time horizon.

### Cutting-Edge Forecast Science

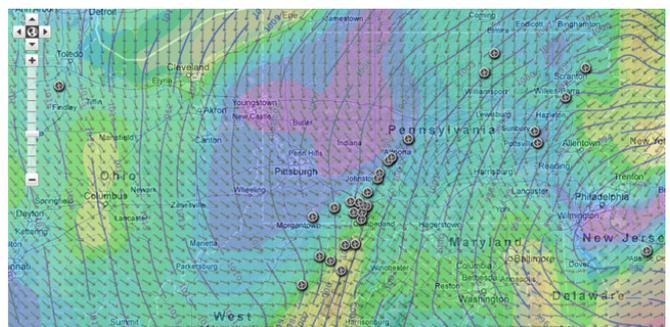
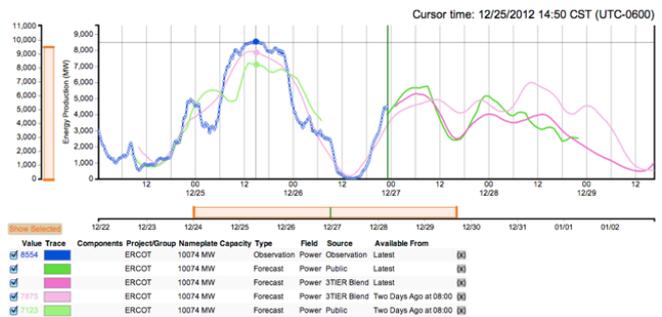
Science never stands still at Vaisala. Our approach combines state-of-the-art numerical weather prediction models with advanced non-linear statistical techniques that incorporate an ensemble of modeled and observational data. New and existing techniques are continuously under evaluation for inclusion and refinement to maintain and improve forecast quality.

### Extensive Forecasting Experience

With over a decade of utility-scale wind energy forecast experience and clients located all over the globe, 3TIER Services currently forecasts over 130 GW of installed wind capacity worldwide. We have earned our reputation forecasting for merchant non-PPA wind projects, which have the highest degree of financial exposure, and we forecast for more of these projects than anyone else in North America.

### Immediate and Customized Forecast Access

We provide an API and online access to wind energy forecasts and histories. You can use these tools to build seamless workflows that integrate 3TIER Services directly into your EMS, RMS, and other core systems. The online interface can also be configured to provide access to the specific information necessary for the task at hand.



### Premium Wind Forecasting

We provide accurate wind energy forecasts updated at the frequency of your observations for any wind farm in the world. Industry-leading accuracy enables improved plant operations, maximized power production, improved energy marketing, reduced imbalance charges, and effective trading in intraday and day-ahead energy markets.

### Regional Wind Forecasting

We provide regional wind energy forecasts for the major energy trading markets in North America and Europe. For traders interested in a subset of the region, 3TIER Services provides the ability to drill-down to a specific country, group, or even an individual wind farm. The forecast and supporting tools are designed to provide energy traders, analysts, schedulers, and asset managers the critical information they need to reduce risk and make fast day-ahead and intraday trading decisions with confidence.

### Situational Awareness

Quickly understand the spatial context and degree of certainty for wind energy forecasts at a single site or across an entire region. Within an innovative map interface, view hub-height wind forecasts from all of the major global weather models for any location on Earth. Quickly assess your degree of confidence in the forecast by comparing them to each other as well as how they have changed over time.

# Wind Energy Asset Management

## Performance Reconciliation Post-Construction

### Primary Uses

- Structuring long-term energy agreements, trades, and hedges
- Performing financial and portfolio analysis
- Reconciling energy performance and deviation
- Optimizing and integrating assets
- Planning for climate anomalies

### Project Forensic Studies

Recognizing and resolving underperformance issues as early as possible helps maximize energy production, optimize operations, and proactively restructure financial obligations. When performance guarantees are not being met, we can perform a full forensic evaluation of the project. 3TIER Services can also isolate issues related to wind variability from equipment performance so you can identify the systemic causes of underperformance.

### Performance Reconciliation

Spot problems early by putting recent and future wind performance in context and reconciling expected energy production with actual production. This allows you to understand the risks and implications of resource variability at potential or existing projects across your entire portfolio. 3TIER Services use mesoscale models and the best available observations to model weather patterns and climate anomalies that impact wind energy output to deliver timely information.



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