

# POWER PERFORMANCE

## **Energy Assessment**

## **Type Testing & Technical Expertise**

## **Test Site Operation**

Efficiency and power output – these are the benchmarks of wind turbine value. Precision in measuring them – this is the value of windtest north-america.

**Our evaluations are the basis for minimizing costs, complying with regulations, meeting contractual obligations and maximizing profitability.**

As the North American subsidiary of windtest grevenbroich gmbh, a global expert in power performance evaluation, we apply decades of industry experience in evaluating, measuring and validating turbines to your project. Whether it involves prototypes, small wind turbines or utility-scale wind turbines, we'll independently design and execute an in-depth measurement plan that pinpoints their operational quality.

**Powerful performance.**

**By any measure, you'll have it with windtest north-america.**



## **WHY WINDTEST NORTH-AMERICA?**

### **Accredited Expertise**

We offer accredited services in accordance with ISO/IEC 17025 and adhere to the latest national and international standards. We also hold the FGW and MEASNET seals of conformity for measuring wind turbine power performance.

### **Experienced**

Our parent company, windtest grevenbroich gmbh, has been serving clients around the world for more than 25 years, and we've been engaged in North America for over 15. We've completed thousands of measurement and evaluation projects, including more than 250 power performance projects.

### **Engaged**

Our specialists are members of several national and international working committees like IEC and MEASNET, so we're always able to apply the latest processes and technology advancements to your project.



## Who We Serve

### Original Equipment Manufacturers

We'll test your prototypes so you can enhance designs and confidently assure customers their turbines will perform to contractual specifications.

### Developers, Investors & Lenders

Our reports provide valuable power curve data that allows you to calculate and project annual energy yield and cost-effectiveness with exceptional accuracy.

### Owners & Operators

You'll have exactly what you need to determine whether your turbines are measuring up to manufacturers' guarantees.

## Proven Process

We'll work closely with you through every phase of power performance evaluation – installation of precision testing equipment, comprehensive monitoring during the 3-to-6-month testing period, and data processing and evaluation. When we're finished, we'll provide you a detailed final report.

### Site Inspections

Turbine prototype evaluation requires a thorough site inspection to determine weather conditions, terrain and geographic or man-made features that might interfere with wind flow and, therefore, measurement accuracy.

### Site Calibrations

If there are obstacles to wind flow such as hills, tall buildings or other wind turbines nearby, a site calibration will be necessary. We'll develop a measurement plan, erect wind measuring masts, and install the most advanced sensors and technologies available, including SoDAR or LiDAR remote sensing systems in some cases. We measure air density, distance between obstacles and turbines, temperature, wind direction and wind speed to establish a valid measurement sector. During our analysis, we identify any corrections needed to offset deviations.

### Ongoing Assessments

Once the turbine or wind farm is operating, windtest north-america conducts periodic power performance assessments to ensure turbines are generating the correct amount of power as efficiently as possible.



## See How We Measure Up

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# ACOUSTICS

## **Energy Assessment**

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Wind turbines generate sound. It's a reality of wind energy development, generation and regulation.

**You need to make sure turbine sounds do not exceed acceptable levels. We'll help you make certain they won't.**

With windtest north-america, turbine manufacturers gain the basis for ensuring emissions are within contractually designated ranges. As an operator or owner, you'll have the information you need to protect neighbors from excessive immissions, comply with local rules and avoid the worst-case scenario, a turbine or wind farm shutdown.

We are the North American subsidiary of windtest grevenbroich gmbh, a global expert in turbine acoustic measurement and analysis, so you also get decades of industry experience behind your data.

**Sound operation and compliance.**

**By any measure, you'll be within acceptable ranges with windtest north-america.**



## **WHY WINDTEST NORTH-AMERICA?**

### **Accredited Expertise**

We offer accredited services in accordance with ISO/IEC 17025 and adhere to the latest national and international standards.

### **Experienced**

Our parent company, windtest grevenbroich gmbh, has been serving clients around the world for more than 25 years, and we've been engaged in North America for more than 15. We've completed thousands of measurement and evaluation projects, including 1,500 acoustics campaigns worldwide.

### **Engaged**

Our specialists are members of several national and international working committees like IEC and MEASNET, so we're always able to apply the latest processes and technology advancements to your project.

### **Fast**

In the right conditions, we can complete measurements at your site in just one day.



## Who We Serve

### Original Equipment Manufacturers

We provide the data you need to enhance your prototype designs and improve the acoustic behavior of your turbines.

### Developers, Investors & Lenders

The information we provide is credible, reliable and provides a sound basis for decision making.

### Owners & Operators

You need to know the turbines are measuring up to manufacturers' guarantees. With windtest north-america, you'll have the data you need to make that determination. We also can complete precise immission measurements so you know exactly what sound levels your neighbors are experiencing.

## Proven Process

We adapt our services to your precise needs, site conditions and turbines. We also work closely with you throughout every project, from consulting with local, state and national officials to interpreting weather forecasts, and from developing and executing a measurement plan to providing a comprehensive final report.

With windtest north-america, you'll have your results quickly. To measure the required wind speed range of 6-10 m/s, variable wind speeds in a four- to six-hour period are necessary. Under those ideal conditions, we can install measuring equipment, perform noise measurements and disassemble the equipment in one day. Measuring additional operating modes might require more time.



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# SITE ASSESSMENT

## **Energy Assessment**

### **Type Testing & Technical Expertise**

### **Test Site Operation**

Exactly how much power is your wind farm going to produce over the 20-year lifespan of the turbines? That's the bottom line for investors and lending institutions that can finance your project.

**You need precision, experience and reliability to provide the assurances they require. You need windtest north-america.**

We've calculated or verified projections for more than 100 developers through thousands of site assessments around the world. Over more than 25 years, our site assessment work has included 5,000 megawatts of installed capacity. We know how to gather the data you need – both through on-site measurements and from independent third-party sources – to calculate annual and lifetime energy outputs to the tightest margins.

That means you get the most accurate long-term projection possible, and your investors and lenders get the confidence they need to put financing on the table.

**Precision in yield reporting.**

**By any measure, you'll be ready to prove your project's value with windtest north-america.**



## **WHY WINDTEST NORTH-AMERICA?**

### **Accredited Expertise**

We offer accredited services in accordance with ISO/IEC 17025, and we adhere to the latest national and international standards.

### **Advanced**

We use the latest processes and technologies, including CFD software (O.F. Wind, WindSim) and proven software tools such as WAsP and WindPRO, in gathering and evaluating site-specific data.

### **Engaged**

Our specialists are members of several leading national and international working committees like IEC and the MEASNET Site Assessment Expert Group.

### **Experienced**

Twenty-five years. More than 100 developers and 800 sites. Thousands of megawatts of installed capacity. With windtest north-america, you always get the highest level of quality and site assessment expertise.



## Proven Process

We calculate the energy output you can expect with a specific turbine at a specific location over its average lifecycle of 20 years.

The windtest north-america assessment encompasses variables such as prevailing wind conditions and speeds, topography, ground levels (orography), surface roughness, obstacles on the site, weather conditions, information collected over many years by independent third-parties such as MERRA, NCAR and ConWx, wind farm design and the number of turbines to be installed.

To evaluate all of those parameters, we review your existing data and recommend a test program that includes advanced measurement masts on site. Ideally, measurements should be taken for 12 months. Less than a year can suffice in some circumstances, but only if we determine a shorter measurement period will not compromise our quality standards.

Once that step is complete, we begin calculating annual energy production and long-term output based on the turbines' projected generation capabilities.

In addition to annual and lifecycle energy production, our reports identify important parameters for investors and lenders such as occurrence probabilities, individual and total uncertainties and losses (grid, maintenance, ice, sound or bat related reductions, etc.).



### *See How We Measure Up*

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# GRID INTEGRATION AND POWER QUALITY

## Energy Assessment

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## Test Site Operation

Precise measurement and testing of all aspects of turbine performance, grid operation, stability and security are crucial to the success of your project.

**With our deep knowledge and experience, you'll have the answers you need to certify the quality of your project, shorten time to market and cut overall costs.**

We engage at multiple points in the process, from turbine manufacturers' R&D to on-site operation to the proper transfer of power onto the grid.

Does a turbine prototype meet grid codes established by governments and grid operators? Is the power acceptable in terms of harmonics, voltage stability, flickering and other essential elements of power quality? Will the grid operator be able to control output? How will the turbine respond to temporary voltage drops (LVRT and OVRT)?

We'll verify the answers to these questions, then report them in a way that will help you obtain certification and keep your project moving.

**Grid integration and power quality.**

**By any measure, you'll be in compliance with grid codes and prepared for any power output issues with windtest north-america.**



## WHY WINDTEST NORTH-AMERICA?

### Accredited Expertise

Most projects require measurement and testing by an organization with ISO/IEC 17025 accreditation. We have it.

### Experience

We've been working on power quality and grid integration with manufacturers, certifiers, developers, and on-site operators and managers for more than 25 years.

### Speed

Time to market is crucial; we'll help you keep it as short as possible.

### Flexibility & Responsiveness

We plan, install measurement hardware, collect data, evaluate it and report it to you. Sometimes new situations or requirements arise. Thanks to our specialists' abilities and our advanced technologies and equipment, we can adapt and respond quickly to your needs in each phase.



## Why windtest north-america?

### Technology and Equipment

We use the most advanced measurement and testing equipment, software and technologies in the industry. We also have several Fault Ride Through (FRT) containers and can quickly get one to your site.

### Consultative Partnership

We'll work closely with you through every step and provide accurate, precise information you can rely on. We're also a technical consultant, providing information and participating in discussions between OEMs, wind farm operators and grid operators.

### Customized Evaluations

We often customize measurements, tests and evaluations for special needs, like harmonic grid pre-load, harmonic power flow and flicker frequency analysis for R&D.



## Highly Qualified and Engaged

- windtest north-america is one of the few measurement organizations in the world that holds the MEASNET seal of conformity for grid integration and power quality measurement.
- Our specialists serve on national and international working committees like IEC61400 21 and the MEASNET Power Quality Expert Group.

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# LOAD MEASUREMENT

## **Energy Assessment**

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Every hour your wind turbine isn't load certified, installed and generating power is costing you and your customers money. With millions at stake for a new development, delays are costly and time to market is crucial.

**You can cut time and costs significantly while maintaining exceptional quality with windtest north-america.**

We've been assessing loads and stress for the wind energy industry for more than 25 years. New turbine prototypes and their main shafts, blades, rotors, tower sections, foundations... you name it, we can measure it to ensure your prototype simulations align with national and international requirements like IEC and MEASNET.

**Precise and reliable load measurement and evaluation.**

**By any measure, your turbine and its components will pass the test.**



## **WHY WINDTEST NORTH-AMERICA?**

### **Accredited Expertise**

We offer accredited services in accordance with ISO/IEC 17025. With windtest north-america, you always get the highest level of quality in your measurement programs.

### **Experienced**

windtest has completed more than 1,500 type testing projects worldwide. Since we know exactly what we're doing, there is less potential for delays.

### **Flexible & Responsive**

Sometimes new situations or requirements arise in the course of a project. Thanks to our specialists' abilities and our advanced technologies and equipment, we can adapt and respond quickly to your needs.

### **Engaged**

Our specialists are members of several national and international working committees like IEC and MEASNET, so we're always able to apply the latest processes and technology advancements to your project.



## Our Services

### Site Calibration

Our engineers evaluate the terrain where we will be performing wind tower measurements in accordance with IEC 61400-12-1. We then develop a measurement concept based on the local conditions, erect a wind measurement mast and select, configure and install measurement technologies.

### Prototype Measurement

We measure mechanical loads based on national and international guidelines such as IEC TS 61400-13, IEC 61400-22 or GL 2010, as well as IEC 61400-2 and AWEA guidelines for SWT.

### Safety and Function Testing

Our testing and measurement includes thorough evaluation of functional and safety criteria for specified operating states of the turbine.

### Components and Test Beds

We design and optimize component test beds with accredited measurement technology and automated evaluation routines.

## Customized Testing

We often develop and implement customized load testing programs that are beyond IEC requirements. It might be testing turbines and components in the field that are showing damage to find out what's causing it, or testing an existing turbine type to ensure it is suitable and safe for operation under more demanding site conditions. Regardless of the situation, windtest north-america can create a testing protocol to get you the data you need.

## Process and Timeline

Depending on suppliers and delivery times, windtest will install measuring equipment within two months of your order. Measurement periods are generally three to six months. We'll provide monthly interim reports during that time and a final report for you to present to the certifying body.



### See How We Measure Up

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