WIND PROJECT SERVICES
ABOUT US

Leaders in Global Services for Renewable Energy

UL works to help renewable energy 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, helping them build projects that reduce humanity’s global carbon footprint and generate healthy financial returns.

UL now delivers an even more extensive portfolio of renewable energy services, through the acquisition of AWS Truepower (2016) and DEWI (2012). 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.

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Country locations of UL renewable energy customers

200,000+
Total megawatts (MW) assessed

500+
Renewable energy experts

80+
Advised Lenders to finance and build renewable energy projects globally

55+
Years of combined experience in renewable energy

450 Projects
Investor/Lender’s engineer on over 450 wind and solar projects since 2012

60+GW
Forecast provider for 60+GW of installed renewable energy projects
Supporting Projects Throughout Their Lifecycle

Access to the top industry experts and tools is critical for project success. Our staff of engineers, meteorologists, and environmental specialists provide clients with comprehensive consulting services, independent engineering, technical advisory, and data and software solutions that span the entire project lifecycle. We work with clients as technical advisors, and we provide resource data, online services, and advanced software to support their teams. Our goal is to empower our customers to succeed.

Feasibility
- Market Potential
- Site Prospecting & Wind Maps
- Site Feasibility & Assessment
- Wind Resource Potential
- Early-Stage Energy Estimates
- Field Assessment
- Early-Stage Plant Design
- Grid Integration Studies
- Regional Build-Out Scenarios
- Thermal Screening
- Environmental & Permitting Risks

Development
- Measurement Campaign Design
- Met Tower Installation
- Remote Sensing Systems (SODAR & LiDAR)
- Data Collection & QC
- Resource, Energy and Uncertainty Assessment
- Advanced Wind Flow Modeling & Visualization
- Turbine Selection & Suitability
- Turbine Layout & Cost Optimization
- Preliminary Road & Collection System Design & Costing
- O&M Strategy Development
- O&M Contractor Qualification & Selection
- EPC Qualification & Selection
- Contract Negotiations
- Financial Model Development
- Permitting Support
- Transmission Analysis
- Owner’s Engineer
Preconstruction & Financing

- Bankable Energy Production Reports
- Independent Engineer Reports for Financing
- Owner’s Engineer
- Contract Review
- Civil & Electrical Review
- Turbine Technology Review
- Financial Model Review
- Review of Project Contractors & Capabilities
- Schedule & Construction Risk Review
- Curtailment Forecast
- Environmental Review
- Permitting Review

Construction

- Construction Forecasting
- Construction Monitoring
- Progress Report Review
- Site Visits
- Schedule and Quality Review
- Drawdown Verification
- Substantial Completion Verification
- Factory Inspections

Operations

- Operational Energy Assessment
- SCADA Data Review & Reporting
- Power Performance Measurement
- Plant Performance Analysis and Optimization
- Monthly Resource & Energy Reporting
- Real-Time Forecasting
- O&M Review & Optimization
- End-of-Warranty Inspection
- Curtailment Analysis
Whether you are a developer or investor looking for new opportunities, or a policy maker or power company wanting to know how best to incorporate renewables into your growth plans, we have the tools and expertise to help you succeed. We deliver reliable and detailed information about resources, siting opportunities and constraints, development potential, plant and technology characteristics, generation expansion scenarios, economic benefits and impacts, and many other factors.

Services:

- Market Potential
- Site Prospecting & Wind Maps
- Site Feasibility & Assessment
- Wind Resource Potential
- Early-Stage Energy Estimates
- Field Assessment
- Early-Stage Plant Design
- Grid Integration Studies
- Regional Build-Out Scenarios
- Thermal Screening
- Environmental & Permitting Risks
The world’s only global, high-resolution (200 m) wind resource maps and data available for site prospecting.

Over 5000 preliminary wind assessment reports and 7000 datasets and maps delivered in over 80 countries since 2012.

Over 30 wind-grid integration studies performed on four continents.

**Simulated Wind Energy to Support Economic Assessment of Renewable Energy**

Identified 1400 GW of potential onshore and over 175 GW of potential offshore wind project sites meeting specified development criteria for the Electric Power Research Institute (EPRI). Used atmospheric models and wind resource maps to synthesize hourly generation data for every site, and aggregated the data by capacity factor and state. The data allowed EPRI to model a wide range of future economic-energy scenarios critical for decision making by the United States power industry.

**Identifying Project Locations in India**

Assessed the wind energy potential of regions in India for a confidential developer to identify promising sites for further assessment and possible project development. Applied advanced computer models and practical resource assessment experience to produce high-resolution wind power and speed maps at hub height, digital elevation model, land cover, and gross capacity factor.

**Site Screening for Wind & Solar Development Opportunities in Latin America for Celsia**

Identified attractive wind and solar development opportunities in seven Latin American countries for Celsia. Assessed wind resource, capacity factor, and production availability as well as electrical line data and topography. Utilized and gave Celsia access to our Windnavigator® maps and data sets, typical year time series data, and reports. Conducted a three-day workshop at Celsia’s headquarters.
DEVELOPMENT

Over 30 years we have created a wide range of high-quality products and services to support the development of successful wind projects. We work with your team in the way that makes most sense for you – either as expert advisors or by providing resource data, online services, and advanced software. Either way, we help you achieve your goals.

Services:

- Measurement Campaign Design
- Met Tower Installation
- Remote Sensing Systems
- (SODAR & LIDAR)
- Data Collection & QC
- Resource & Energy Assessment
- Advanced Wind Flow Modeling & Visualization
- Turbine Selection & Suitability
- Turbine Layout & Cost
- Optimization
- Preliminary Road & Collection System Design & Costing
- O&M Strategy Development
- O&M Contractor Qualification
- & Selection
- EPC Qualification & Selection
- Contract Negotiations
- Financial Model Development
- Permitting Support
- Transmission Analysis
- Owner’s Engineer
Advanced Wind Modeling to Assess Complex Wind Regime in Brazil

When Casa dos Ventos (CDV) needed a more accurate and comprehensive understanding of the wind resource at their large project site in Chapada, Brazil, they turned to us to apply our expertise in resource assessment, atmospheric science, and advanced wind flow models. CDV was developing 720 MW of projects within the 60x60 km area. Due to the complexity of the wind regime on this subtropical plateau, CDV had already installed about 35 meteorological towers. Even with this massive effort, they had significant questions about where to install turbines to maximize production, which could not be answered with conventional methods.

AWS Truepower, a UL company provided high-resolution atmospheric modeling, expert interpretation and data analysis, and site visits to assess the wind resource. This helped CDV site additional towers where they offered the most value, and significantly reduced the uncertainty in energy production estimates. Subsequently we conducted a series of training sessions that reviewed our methodology and approach as well as the findings at CDV headquarters in Sao Paulo, Brazil. CDV used these results to achieve success in a wind energy auction in August 2013.

Project Consultant for 3000 MW Wind Project in Wyoming

In 2008, Power Company of Wyoming LLC (PCW) approached AWS Truepower, a UL company to consult for them on a proposed wind project in Wyoming, known as the Chokecherry and Sierra Madre Wind Energy Project (CCSM). Our assessment began with the creation of wind maps and conceptual turbine layouts to determine feasibility. Next we designed and executed a wind measurement campaign. This was a significant task due to the project size and the complexity of the terrain with the project boundary. Over 30 meteorological towers were sited and sodar was placed in over 25 locations. One hundred twenty-five years’ worth of data was collected and analyzed. The data was used with advanced wind flow modeling to better understand complex wind phenomena at the site. All of this information was crucial in planning 1,000 turbines layouts, and it continues to inform turbine selection for this high-capacity-factor site.

We continue to support the CCSM project. Several energy studies have been performed, including energy production reports, hourly time-series data to determine load coincedence, and studies showing whether micrositing adjustments altered energy production and if so, to what degree. Once built, the CCSM project will be one of the largest wind farms in the world.
Considering Balance of Plant Costs in Designing Wind Turbine Layouts

Designing the balance of plant (BOP: roads and electrical collection system) for a wind project is time consuming and expensive, and often occurs near the end of the development process when the plant layout is difficult to adjust. This can lead to missed opportunities for cost savings that could make a wind project more price-competitive.

Faced with this challenge, EDF Renewable Energy joined with AWS Truepower, a UL company, Mortensen, and Stanford University in a research study to demonstrate the capability of Openwind to reduce balance of plant costs and overall cost of energy in two EDF wind projects. We made modifications to Openwind to improve its BOP design and costing algorithms, and incorporated Mortensen’s site-specific material and construction cost estimates.

For a recently built Texas plant, it was shown that through the use of Openwind’s cost-of-energy optimization model, road costs could have been reduced by 15%, collection system costs by 7.8%, and total plant cost by 6.2%, compared to as-built. This would have lower the cost of energy by a substantial $1.3/MWh. We also used this validated approach to inform the design of a project in New Mexico which is currently under construction.

Openwind’s cost of energy optimization tool allows developers to account for BOP costs much earlier in the development process, and to weigh them directly against energy production, producing a more competitive project design.
Our suite of software and data products supports the entire wind farm 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.

**Windnavigator**

Windnavigator® is a web platform that allows you to view and access our high-resolution wind resource maps and data anywhere you have an Internet connection. Our clients use Windnavigator to prospect new wind development sites, browse global wind maps, query mean annual wind speeds at custom hub heights, and acquire wind statistics including Weibull values, wind roses and monthly diurnal distributions.

**Windographer**

Windographer™ is the industry-leading software for analyzing wind resource data measured by met towers, SODAR, and LiDAR. It quickly imports virtually every data format commonly encountered in the wind power industry, allows rapid quality control and statistical analyses including MCP, and exports to all wind flow models common to the wind power industry.

**Openwind**

Openwind® software allows professional wind developers to design, analyze and optimize a wind project. Using an intuitive GIS interface, users can optimize for cost of energy, assess deep array wake impacts, define and analyze strategies for managed shutdown of turbines, uncertainty, and perform other advanced tasks.
PRECONSTRUCTION & FINANCING

We help make the critical financial close of a wind project as smooth and successful as possible. Our technical and commercial expertise, along with our understanding of the intricacies of project finance, make us the ideal partner for developers looking to raise capital. Our team of engineers and technical advisors will help you prepare your project for financing, mitigate risk, and help ensure it is technically sound and ready for construction. The approach we employ for our Independent Engineering (IE) reports has been thoroughly vetted with some of the world’s top lead arrangers and lenders, so we know exactly what they are looking for, helping ensure a timely transaction.

Services:

- Independent Engineer Reports for Financing
- Owner’s Engineer
- Contract Review
- Civil & Electrical Review
- Turbine Technology Review
- Financial Model Review
- Review of Project Contractors & Capabilities
- Schedule & Construction Risk Review
- Curtailment Forecast
- Environmental Review
- Permitting Review
Bankable energy assessments throughout company history:

<table>
<thead>
<tr>
<th>Region</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>80,000</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>55,000</td>
</tr>
<tr>
<td></td>
<td>25,000</td>
</tr>
</tbody>
</table>

Independent Engineer for Ventika Wind Project in Nuevo Leon, Mexico

The Ventika Wind Project is divided into two adjacent wind farms, Ventika I and Ventika II. Each plant has a name plate capacity of 126 MW, for a total of 252 MW, and it was the largest wind project in Mexico at the time of financing. AWS Truepower, a UL company acted as the energy consultant and engineer in the debt financing for the project, and are continuing to perform construction monitoring on behalf of the lenders and project sponsors. The wind farms are expected to be complete and on line in April 2016. The developers are Cemex and Fisterra Energy while Banco Santander led financing efforts, along with Nadbank, Banobras, Nafin & Bancomext. These wind farms will produce energy for Instituto Tecnológico de Monterrey, Femsa, Deacero, and Cemex.

Bankable Energy Assessments for Several Wind Projects in Texas

Our typical project developer client seeks independent energy assessments multiple times through their development process. A confidential client sought our support for bankable energy assessment studies in Texas spanning the course of several years. The early results were needed to move the project through the client’s internal approval process. Two years later, when they were seeking to secure project finance, we refined the analysis with the benefit of additional on-site data and improved inputs to the energy modeling process. Due to the nature of the project and site conditions, we conducted a more detailed analysis of the wake affects to further improve the accuracy of the energy projections. The project has since been financed and is operational.
Contour Global hired AWS Truepower, a UL company to provide full technical due diligence for the wind portfolio they were looking to acquire in Austria. At Contour Global’s request, our technical team reviewed the existing energy production reports for projects in development as well as all operating assets. We were asked to perform an analysis of the portfolio’s operational data and prepare energy production reports. As part of this comprehensive analysis, our staff traveled to a number of project sites to inspect the balance of plant and review the potential risks associated with the operations and maintenance (O&M), as well as other key aspects on the projects. We also estimated future O&M costs, and provided CAPEX and OPEX (capital and operational expenditures) to the client. The resulting analysis and reports contributed to Contour Global’s decision to acquire the 207 MW portfolio.

Independent Engineer for 150 MW Project in Mexico

Acted as Independent Engineer to support the financing of a confidential 150+ MW wind project in Mexico. Services included resource and energy assessment, design and technology review, contract review, operations and maintenance review, environmental and permitting review, and review of the financial model. Conducted several site visits for support of both the energy and the design reviews. Financing was approved in 2014, and we conducted construction monitoring until commercial operation in 2015.

Technical Due Diligence to Support the Acquisition of a Portfolio in Austria

LOCATION
MEXICO 150+ MW

LOCATION
Austria 207 MW
Energy Yield Assessments to Support Ecoren Energy’s Wind Development Activities in India

AWS Truepower, a UL company supported the development of several wind farms throughout India, including Andhra Pradesh and Madhya Pradesh for Ecoren Energy India. For these projects, our wind experts evaluated the proposed energy yield for a twenty-year period. Utilizing meteorological data from Ecoren’s meteorological stations and our regional expertise, we conducted an assessment of the long-term wind resource. Ecoren has completed development on several of these projects and several more are underway.

Energy Consultant and Independent Engineer for Wind Project in Quebec, Canada

The Vents du Kempt project retained AWS Truepower, a UL company to act as the Independent Engineer and energy consultant for financing prior to construction. Vents du Kempt is a 101.05 MW wind plant located in the towns of Causapscal, Sainte-Marguerite-Marie and Sainte Florence, Quebec, which utilizes 43 Enercon E92 wind turbines. Our firm provided the Independent Engineering report prior to debt financing, which was provided by co-arrangers The Manufacturers Life Insurance Company and KfW IPEX-Bank GmbH as well as Caisse de Dépôt et Placement du Québec. We continued work on the project and provided construction monitoring through to commercial operation, which was reached in December of 2014. The project is jointly owned by Eolectric Club, L.P. (51%) and Fiera Axium Infrastructure Canada, L.P. (49%).
CONSTRUCTION

When your project moves into construction, we can help ensure that the construction process unfolds smoothly, on schedule and within budget. Whether you are looking for a desktop or onsite review of methods, documentation, schedule, or work quality, we can provide you with an independent progress assessment. In addition, our construction forecasting service can help you mitigate and manage weather delays. We can also review the technical aspects of construction and confirm compliance with the commercial closing requirements as defined by the credit or financing agreement and project documents.

Services:

- Construction Forecasting
- Construction Monitoring
- Progress Report Review
- Site Visits
- Schedule and Quality Review
- Drawdown Verification
- Substantial Completion Verification
- Factory Inspections
Wind Forecasting Service to Facilitate Construction Activities

RES America Construction, Inc., contracted AWS Truepower, a UL company to provide construction forecasts for a 150 MW wind farm located in Oklahoma. For a 3-month period, delivered twice-daily forecasts with a 72-hour (three-day) time horizon. Forecast parameters included wind speed, direction, and gust; temperature, precipitation, visibility, cloud cover, fog, and freezing rain, all for a height of 80 m above ground. Thanks in part to this service, construction was completed on time and the wind farm went into full operations in October 2014.

Construction Monitoring to Support Lenders

Upon the Notice to Proceed with Construction in 2014 (after financing supported by our Independent Engineering report), we were engaged to conduct construction monitoring for this confidential 150+ MW wind project, located in Mexico. The monitoring included monthly site visits, drawdown verification, change order review, and completion certification, and was conducted on behalf of the lenders on the project.
OPERATIONS

While renewable energy brings with it inherent variability in plant production, good economic performance of a project is not a matter of chance. We are committed to developing innovative methods to help understand plant performance, manage expectations of operational plants, and identify opportunities for performance improvement. We also provide ongoing operational support through real-time forecasts for individual and fleet operators.

Services:

• Operational Energy Assessment
• SCADA Data Review & Reporting
• Power Performance Measurement
• Plant Performance Analysis and Optimization
• Monthly Resource & Energy Reporting
• Real-Time Forecasting
• O&M Review & Optimization
• End-of-Warranty Inspection
• Curtailment Analysis
### Performance Analysis for Large Wind Developer in Canada

A confidential client wanted to obtain an in-depth evaluation of the performance of two wind farms in Canada and asked us to perform the analysis. In the first phase, based on the plants’ SCADA data, we categorized wind turbine performance, identified and quantified sources of lost energy, and created a list of action items ranked by priority to correct and improve performance. One key finding was that the turbines were often in transitional states. Since then, the client has asked us to evaluate two additional projects in the same way.

### Operational Assessment to Aid in Sale of One of the Largest Wind Projects in the United States

In 2014, Terra-Gen Power announced that it would divest from the 947 MW Alta Wind project in Tehachapi Pass, California, USA, and sell it to NRG Yield. To support this transaction, AWS Truepower, a UL company conducted an operational assessment to project future energy generation for Alta I-V. Relying on years of 10-minute SCADA data, we performed an in-depth investigation into plant operational issues, wake losses, and windiness corrections. Results showed that the initial energy production estimates had been too high. Our experts worked with Terra-Gen to determine a realistic best estimate of long-term energy yield. The sale was completed in August 2014.

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<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>189 MW</td>
</tr>
<tr>
<td>California, USA</td>
<td>947 MW</td>
</tr>
</tbody>
</table>

Number of data points processed in a typical performance analysis: 500 Million
Power Performance Measurement for Wind Project in Nebraska

More and more often for new plants, power performance tests are conducted to verify that the turbines are performing as they should. Such tests can even be a requirement for project financing and performance warranties. For a confidential client with a project in Nebraska, we tested three GE 1.5 MW wind turbines in accordance with IEC specifications. Initially, we completed a terrain and obstacle analysis, which led to a site calibration. Then we installed and commissioned the power measurement equipment on the three selected turbines and monitored their performance for three months. The conclusions were delivered in a comprehensive report to the client.

Operational Energy Production Assessment for Project Financing

Performed a detailed investigation of the performance of a wind project for a confidential client after a year of operation. Using SCADA data, benchmarking, and evaluating the project’s operational reports, we provided the project owner with a better understanding of operational loss factors and identified areas of recoverable energy production for future operations. The results were used for project financing and considered in a portfolio benefit assessment.
GRID-CONNECTED RENEWABLE ENERGY MANAGEMENT

As more and larger grid-connected renewable energy projects are built, power companies and grid operators and regulators increasingly recognize the need for accurate, timely forecasts of renewable generation, as well as for long-range analyses of the impacts of fluctuating renewables on grid reliability, cost, and operations.

We are the preeminent renewable energy forecasting provider for Independent System Operators (ISOs) in North America. We are also leading experts in grid integration, having participated in over two dozen major studies in the United States and Canada, Latin America, Asia, and Europe.

Services:

• Real-Time Renewable Forecasting
• Grid Management & Planning Services
• Atmospheric Modeling & Applied Research
### Renewable Energy Forecasting Service for NYISO

AWS Truepower, a UL company was selected by the New York Independent System Operator (NYISO) to provide generation forecasts for all existing and future wind plants in the New York Control Area to more effectively manage New York State's electricity market and grid operations. The current suite of services for the NYISO includes forecasts with a 15-minute time interval extending out to 8 hours delivered every 15 minutes, as well as a forecast for the next two calendar days delivered twice per day. As of Fall 2016, the NYISO wind forecasting service consists of over 1,900 MW installed capacity across 20 sites.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York, United States</td>
<td>1900 MW</td>
</tr>
</tbody>
</table>

### Renewable Energy Forecasting Service for CAISO

AWS Truepower, a UL company won competitive solicitations to provide forecasting services to the California Independent System Operator (CAISO), including 5-minutes- to days-ahead generation forecasts for all wind and solar plants in the CAISO Balancing Area and adjacent markets, totaling over 10 GW installed capacity. Since 2014, we have provided CAISO with meteorological support for load forecasting by monitoring and advising on meteorological features that could have an impact on electrical load variations within the CAISO balancing area.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Capacity (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>California, United States</td>
<td>10 GW</td>
</tr>
</tbody>
</table>

### Simulated Wind Power & Load Forecasts to Support Power Flow Studies

We provided simulated wind generation data for the Atlantic Energy Gateway to model the savings of regional collaboration in power systems operations. Identified up to 2.4 gigawatts (GW) of potential onshore wind projects in New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. Synthesized three years of wind plant output data on a 5-minute resolution, as well as next-hour and next-day synthetic wind power and load forecasts, in support of power flow studies.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Capacity (GW)</th>
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<tbody>
<tr>
<td>Canada</td>
<td>2.4 GW</td>
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</table>

Forecast provider for over 60 GW of installed renewable energy projects.
MERGERS, ACQUISITIONS, & INVESTMENTS

From a small equity stake in a single project to the acquisition of a global project portfolio, different investments require different levels of review. We work with you to determine the best path for your due diligence, and strive to identify all critical risks. Depending on your risk appetite, the type of investment, and your team’s expertise, we work to tailor project evaluation strategies specifically for you.

Services:

- Operational Energy Assessment
- O&M Assessment
- Commercial Contracts
- Off-Taker Agreement
- Curtailment
- Revenue Generation
- Future Up-Wind Build-Out Analysis
- Portfolio Effect Review
- Financial Modeling
- Turbine Technology Assessment & Track Record
- Maintenance Program Review
- Environmental Compliance
Investor/Lender’s Engineer on over 450 wind & solar projects since 2012.

Assessed over 300 wind projects for investment or acquisition.

Lender’s engineer for approximately 50% of all lenders active in wind and project finance.

LOCATION
Ireland and Northern Ireland

Brookfield Bord Gáis Acquisition

The Brookfield hired AWS Truepower, a UL company to support the acquisition of the Bord Gáis Éireann wind portfolio located in Ireland and Northern Ireland. At the time of acquisition, the portfolio consisted of 321 MW of operating wind projects, 137 MW in construction, and approximately 300 MW in development.

We supported Brookfield by evaluating forecasts of energy production and O&M costs, providing a portfolio analysis and technical review of major contracts, and conducting site visits. Following completion of the acquisition, we were retained as the Lender’s Independent Engineer to support the leverage of a nine-operating-project portfolio. Following this financial close, we were again retained as Lender’s IE to support construction financing of three projects totaling 136.8 MW. In this engagement, we provided a single, comprehensive IE report with the following scope: energy production assessments, review of site conditions, design, turbine technology, major agreements, environmental and permitting, and financial model, as well as responding to lender questions. We then executed an agreement with the finance parties as the Lender’s Technical Advisor in support of the construction monitoring for all three projects, which includes quarterly construction report review, draw down verifications, and verification of COD.

LOCATION
Oklahoma and Texas, United States

Technical Advisor in the Evaluation of Tax Equity Financed Wind Projects

A major investor hired AWS Truepower, a UL company to act as their technical advisor in the evaluation of tax-equity financing of numerous wind projects, with varying owners and geographic locations. The scope of services included a review of the work performed by the third-party independent engineers in energy production, electrical curtailment, and the preconstruction independent engineer and monthly construction monitoring. We commented on the thoroughness and completeness of the IE reports and identified risks and concerns in the report that required additional information. The energy production reports for the projects were also reviewed, and we provided commentary on the reasonableness of the assumptions and losses. Electrical curtailment reports were reviewed, and resulted in our own independent opinion regarding future curtailment losses.
TECHNICAL ACHIEVEMENTS & ADVANCED STUDIES

We pioneer solutions that overcome technical barriers. AWS Truepower, a UL company is at the forefront of research in resource characterization, plant design, energy estimation and real-time forecasting. Look for more examples of our work in the Knowledge Center of our website.
Study: Verifying Preconstruction Energy & Uncertainty Estimates

We were among the first to identify and close the gap between preconstruction wind energy estimates and actual production when we published our first back-cast study in 2009. In 2012, we updated the study and implemented further improvements in our methods. This same transparency and drive for accuracy applies to all of our technical services.

Offshore Wind: Moderating Impacts of Winter Natural Gas Price Spikes

Offshore wind has a strong coincidence with electricity demand profiles and produces maximum capacity factors during the winter. Our study demonstrating this powerful benefit was the winner of the 2014 AWEA Technology Award.

Global Maps for Wind Site Prospecting

We were the first private company to apply mesoscale and microscale models to high-resolution, regional wind resource mapping. Today our detailed global maps remain the industry’s leading site-prospecting tool. Through Windnavigator, these maps and associated wind roses and other data are available to our customers.

Wind Flow Modeling Uncertainty

The uncertainty of wind resource and energy production estimates is a critical element in wind project financing. We developed a sophisticated uncertainty model, now in the Openwind software, that allows users to optimize the design of their monitoring campaign to minimize the uncertainty in future energy production.

Environmental Losses

No stranger to severe environments, Our company is at the forefront of research on associated energy losses in wind plant operations. Using 10-minute SCADA data from 18 projects in sub-Arctic sites, we developed an icing-loss model that depends on turbine type and weather conditions.

The Authoritative Reference on Wind Resource Assessment

OFFSHORE

Our efforts have helped facilitate the growth of offshore wind markets globally. We have been active in the design and implementation of bankable wind resource and energy assessments and broad meteorological and ocean (metocean) studies to define reliable project design conditions. We integrate proven measurement and analytical methods with innovative observation techniques on fixed, floating and remote platforms. We leverage direct and remote sensing technologies for wind, wave, current, and atmospheric boundary layer characterization. Our pioneering wind and wake modeling capabilities, turbine technology assessments, and other technical evaluations quantify uncertainty and mitigate a project’s technical risk.

Services:

• Operational Energy Assessment
• O&M Assessment
• Commercial Contracts
• Off-Taker Agreement
• Curtailment
• Revenue Generation
• Future Up-Wind Build-Out Analysis
• Portfolio Effect Review
• Financial Modeling
• Turbine Technology Assessment & Track Record
• Maintenance Program Review
• Environmental Compliance
Involved in 80% of the offshore wind projects in North America since 2000.

Recognized expert for developing metocean needs and priorities for the United States offshore wind industry.

First to deploy an offshore metocean monitoring system for offshore wind in the United States.

**LOCATION**
Three miles southeast of Block Island, United States. 30 GW

**Project Meteorologist and Technical Advisor to Deepwater Wind**

Project meteorologist and technical advisor for the first US offshore project to get full financing. Supported the metocean design input analysis for the project. Responsible for the wind resource monitoring program design and implementation, project meteorology, wind turbine assessment, project layout development, and energy production estimates.

**LOCATION**
Six miles from shore, United States

**Development Support for Cape Wind’s Horseshoe Shoal Project**

We have been instrumental in the technical support of the Cape Wind project from its inception. For the last fifteen years we have provided Cape Wind with services to support project feasibility, development, and pre-construction and financing activities. We conducted project meteorology, wind resource modeling, wind turbine layouts, energy production estimates, data analysis from offshore met masts, as well as visual assessments. The final energy production report was used to move the project to financing, including several recent iterations with varying turbine layout scenarios.
LOCATION
3 miles Southeast of Block Island, USA

Project Meteorologist and Technical Advisor to Deepwater Wind

The United States Department of Energy along with the National Renewable Energy Laboratory (NREL) contracted AWS Truepower to develop high-resolution (200 m) offshore wind maps of United States waters to facilitate wind energy siting and planning at the national, state, and project levels. The work has supported national policy development and the technical definition of build out potential. It has also supported the evaluation of selected BOEM Wind Resource Areas by NREL and others. The offshore wind mapping is inclusive of the Atlantic and Pacific coasts (including Hawaii), the Gulf of Mexico, and the Great Lakes. All mapping results, which include a variety of wind resource statistics at multiple heights, were independently validated by NREL.
OFFICE LOCATIONS

NORTH AMERICA
Albany, UNITED STATES
San Diego, UNITED STATES

EUROPE, MIDDLE EAST & AFRICA
Lyon, FRANCE
Bremen, GERMANY
Cuxhaven, GERMANY
Hamburg, GERMANY
Oldenburg, GERMANY
Johannesburg, SOUTH AFRICA
İzmir, TURKEY
London, UNITED KINGDOM

GREATER ASIA
Beijing, CHINA
Bangalore, INDIA
Tokyo, JAPAN
Seoul, KOREA

IBERIAN PENINSULA AND LATIN AMERICA
Buenos Aires, ARGENTINA
São José dos Campos, BRAZIL
Rio de Janeiro, BRAZIL
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