

Renewables

Asset Management Qualifications



Empowering Trust™

About us

Leaders in Global Services for Renewable Energy

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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.

UL OPERATES IN
MORE THAN

140

COUNTRIES



35+

YEARS OF
RENEWABLE
ENERGY
EXPERIENCE

200,000+ MW
TOTAL MEGAWATTS ASSESSED

500+ RENEWABLE
ENERGY EXPERTS



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



We help renewable energy customers with:



PROJECT DEVELOPMENT SUPPORT

Navigate project complexities in the earliest stages of development.

- Site Screening and Feasibility
- Turnkey Measurement Services (Met Masts and Remote Sensing)
- Resource Assessment
- Plant Design and Energy Assessment
- Technology Selection and Suitability
- Infrastructure and Balance of Plant
- Permitting Support and Environmental Assessment



SOFTWARE AND DATA

Leverage the knowledge and expertise of our experts and enable your team to work independently.

- Windographer
- Openwind
- Windnavigator
- Wind Data Management
- Resource Maps
- Time Series Datasets
- Site Specific Reports



ASSET MANAGEMENT

Manage expectations of operational plants and improve performance, including safe and reliable operations of wind projects beyond the original design life.

- Operational Energy Assessments
- Performance Analysis
- Plant Performance Optimization
- Remote Sensing / Lidar for Turbine Diagnostics
- Turbine Inspections
- Root Cause Analysis
- Lifetime Extension / Remaining Useful Life
- Loads Simulations
- Components Evaluation



GRID SOLUTIONS

Understand renewable energy variability and the impact of weather-driven events:

- Real-Time Renewable Forecasting
- Grid Management and Planning Services
- Atmospheric Modeling and Applied Research



ENERGY STORAGE SOLUTIONS

Address safety concerns for large battery systems for wind and solar integrators and OEMs.

- Testing and Certification
- Performance Testing
- Custom Research



DUE DILIGENCE

Mitigate the risks associated with renewable energy project investment:

- Independent Engineering
- Technical Advisory
- Pre-Construction, Operational and Repowering Projects
- Custom Support for Investors, M&A, Tax Equity
- Turbine Technology, Civil and Electrical Design Review
- Contracts Review
- Environmental Permitting Review
- Financial Model Review
- Construction Monitoring
- Owner's Engineer



CERTIFICATION

Confirm compliance and provide assurance and confidence in wind technology.

- Certification of Turbines and Components
- Project Certification
- Grid Code Compliance
- Assessment of Construction and Foundations



TESTING AND INSPECTION

Verify the safety, reliability, performance and compliance of wind turbines and components.

- Validation and Type Testing
- Mechanical Loads
- Power Performance Testing
- Electrical Characteristics
- Low Voltage Ride Through Testing



CYBERSECURITY

Help validate and substantiate security claims, meet regulatory requirements and mitigate risks of cyber incidents.

- Training
- Custom Security Testing
- Penetration Testing
- Code Review
- Risk Analysis
- Gap Analysis



RESEARCH AND ADVANCED STUDIES

Research in electrical safety, renewable resource characterization, plant design, energy estimation and real-time forecasting.

- Custom Research
- Market Studies

Asset Management Services



Growing investments in renewable power plants, aging fleets, and the desire for safe operations while maximizing asset value all drive companies to UL's asset management services. We help you evaluate and optimize your projects' operations and maintenance, contracts, health and safety and remaining useful life. Our goal is to help you maximize energy production, reduce downtime and O&M costs, help ensure project safety, and support key decisions around asset life and repowering.

Asset management services can include:

Operational Energy Assessments

- Operational Energy Production Reports
- Repower Energy Production Report
- Lost Energy Production Report
- Portfolio Operational Energy Assessments
- Portfolio Benefit Analysis
- Annual Portfolio Benchmarking

Plant Diagnostic Services

- Monthly Performance Reports
- Plant Diagnostic & Optimization Report
- Custom Wind Anomaly Index

Turbine diagnostic Services

- Power Generation & Variance Report
- Event Log Analysis Report
- Performance Diagnostic & Optimization Report
- Methods Consulting
- Lidar-Based Services
 - Lidar-Based Yaw Misalignment Detection (YMD)
 - Lidar-Based Operational Power Curve
 - Lidar-Based Nacelle Transfer Function

Inspections

- Accreditation (IAS, ISO17020)
- Factory / Harbor / Transport
- Wind Farm (at any point in lifecycle)
- Manufacturing / Commissioning
- End of Warranty
- End of Life
- Root Cause Analysis

Lifetime Extension Services

- Remaining Useful Life (RUL)
- OPEX and CAPEX Forecast Beyond Design Life
- Analysis Permits & Administrative Frame
- Operational Strategies to Extend Life
- Loads Simulations
- Components Evaluation



Operational Energy Assessments

As an industry leader in operational assessments, we have developed and refined high quality methodologies for providing long term energy forecasts for operational wind and solar plants. By using operational data, we can estimate future energy production more accurately than by using standard pre-construction methods alone. For investors, we provide bankable energy production reports based on operational data. These assessments provide a clear indication of normal operation and long-term energy projections with lower uncertainty than pre-construction assessments.

Operational Energy Assessments

Operational Wind and Solar Energy Production Reports (OEPRs)

As an industry leader in operational assessments, we have developed and refined sophisticated methodologies for providing energy assessments based on actual production data from the operating wind farm. By using operational data, we can assess the long-term energy production more accurately than by using standard pre-construction methods alone. OEPR's fulfill all requirements of bankable energy production reports and provide a clear indication of normal operation and long-term energy projections with lower uncertainty than pre-construction assessments.

Repower Energy Production Report

Wind plants are typically designed for a 20-year lifespan. A full repower involves the complete dismantling and replacement of the existing wind turbines at the site. A partial repower may involve a replacement of the blades with longer ones, or possibly a more significant upgrade of major components, such as drive trains, but is likely to leave the foundations, towers and site infrastructure intact. UL takes a comprehensive approach to repowering, assessing the current plant from both an operational and theoretical perspective. These complementary viewpoints are merged to create a custom analysis that more accurately predicts the future repowered energy than theoretical models alone.

Lost Energy Production Report

An independent estimate of lost production is critical for contractual reimbursement of lost revenue as part of business interruption insurance claims or reimbursable curtailment. UL has state-of-the-art modeling capabilities to comprehensively assess lost production during periods of curtailment, outages or other force majeure events that impact the entire facility, even for periods where there is little to no data collected on site.

Portfolio Operational Energy Assessments

Owning a portfolio of wind and solar projects allows owners to balance local resource fluctuations and reduce the volatility of the revenue stream. In a portfolio the effect is enhanced with increasing geographic, resource, and technology diversity. UL has developed tools to perform Portfolio Energy Reports focusing on the effect of reduced uncertainties of operating portfolios against individual operating wind or solar projects. Portfolio assessments are used in numerous transactions and refinancing of portfolios, leveraging the reduced uncertainties for financial benefit.

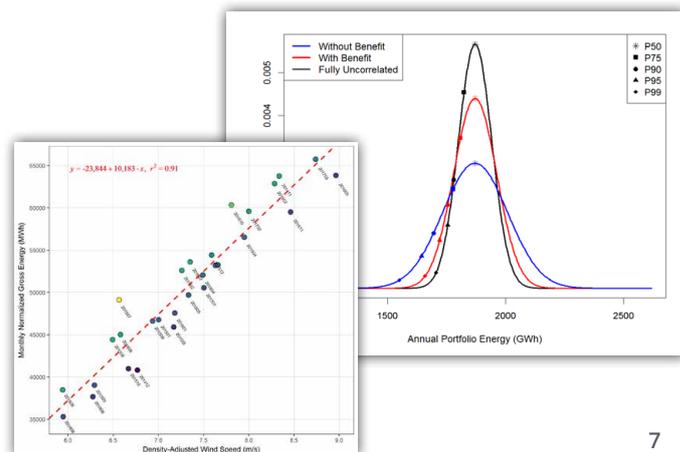
Portfolio Benchmarking

UL is the 'go to' company for operational assessments for many owners and investors. Using a streamlined process, we can also assess entire portfolios of renewable energy plants on a one-time, annual, quarterly or monthly basis. This benchmarking process provides a solid understanding of changes in performance over time, adjusted to account for changes in the underlying wind/solar resources, and flags performance problems.

Portfolio Benefit Analysis

By evaluating a portfolio as a whole, the result is that the error distribution for the combined output of the projects is often narrower than the summed error distributions of the individual projects. This is known as the portfolio benefit, which may translate into lower risk to the net income for the portfolio owner. To determine the portfolio benefit, it is necessary to estimate the correlations of the various sources of uncertainty and then to combine the results to arrive at an estimate of the likely deviations of the aggregated output. Perfectly correlated project uncertainties yield no benefit, while perfectly uncorrelated project uncertainties would yield the maximum benefit.

PORTFOLIO BENEFIT ANALYSIS





Plant Diagnostic Services

Wind and solar plants generate massive amounts of data, which if utilized properly can provide significant insight for potential improvement of operational performance. Plant operators benefit from advanced metric and performance monitoring to identify unexpected developments and behaviors in the wind farm. UL provides this periodic performance reporting from an independent perspective.

Plant Diagnostic Services

Plant Diagnostic and Optimization Report (PDOR)

The main drivers for underperformance issues occurring at a wind or solar project can be detected with the analysis of the SCADA data. The PDOR includes an in-depth analysis and comprehensive visualization of key sensor measurements and operating parameters reported in the SCADA data. To identify issues in asset performance or reliability, comparative analysis of individual asset operation and performance within a plant or against expectations are evaluated using anomaly detection, outlier detection and trend analysis. By identifying such developments in early stages, it is possible to apply low cost corrective actions that significantly reduce maintenance costs and turbine downtime. The PDOR also includes a comprehensive overview, summarizing the findings and specific recommendations for each of the problems detected in order to address them. Typical SCADA signals which are evaluated can include:

- Electrical (voltages, currents, active and reactive power)
- Mechanical (nacelle position, yaw error, blade pitch angle, generator and rotor speed)
- Thermal (gearbox, bearings, oil, generator or ambient)
- Performance (Tip-speed-ratio, Coefficient of power, derating)

Monthly Performance Reports (MPRs)

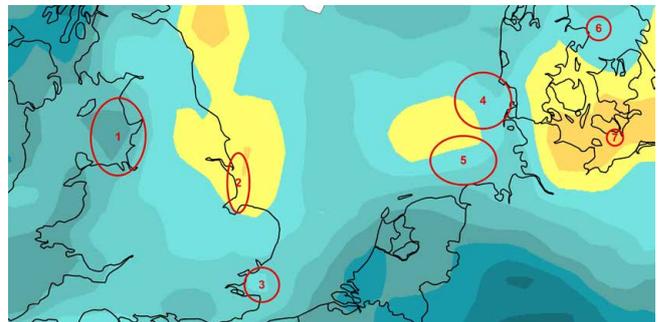
MPRs target the delivery of independent information about the performance of the wind farm and the development of key performance indicators (KPIs) throughout the life of the wind farm or solar plant. The reports deliver insights on production and availability of the wind farm and reasons for loss of power generation, and identify wind turbines with abnormal behavior. MPRs are independent from analyses provided by turbine manufacturers and operators, thereby giving owners and investors reliable third-party advice for the assessment of the investment and a solid basis for decision making. The report contains as a standard:

- Power generation & comparison to expected production;
- Availability assessment (energy- and time-based)
- Detailed assessment of downtime and lost energy
- Wind resource based on the nacelle anemometer
- Identification of outliers in behavior of performance as pre-indicator
- Performance KPIs by turbine
- Correlation between wind turbine production and its development along the operation of the wind farm.

MPR's are based on the 10-minute (or higher resolution) SCADA data and alarm logs of all turbines. The report can be extended and customized by inclusion of further data sources such as met masts, revenue meters, service records, work orders, and balance of plant (BOP) registers according to the specific needs of each customer.

Plant-Level Monthly Wind Speed and Anomaly Time Series

Knowing the performance of the wind can help you understand the performance of your wind farm. To understand the wind at specific sites we offer plant-level, historical, monthly-average wind resource information derived from maps and global reanalysis data, on a one-time or subscription basis, updated within 7 days of the end of each month. These custom datasets are based on a combination of three reanalysis data sources: ERA-Interim, MERRA, and CFSR, which allows for rapid, reliable updates of wind conditions around the globe. Anomalies are defined as the percent deviation in speed relative to the historical average speed for the given calendar month, quarter, or year.



Wind Anomaly Map of Project Sites

This product can be used in a number of applications, including:

- A reference for Measure-Correlate-Predict for operating wind plants, to extrapolate short-term performance to long-term conditions.
- Tracking performance of wind plants against expectations and identifying deviations against pre-construction budgets.
- Assessing portfolio diversity benefits for multiple wind projects in different regions.
- Studies of wind climate trends and variability.



Turbine Diagnostic Services

Operations and maintenance costs can be high due to failing wind turbine components such as gearboxes and blades. SCADA systems installed at each turbine contain information about various turbine parameters, and errors encountered by the system. Data mining the historical SCADA data gives us a robust approach to monitoring turbine performance, identifying patterns and predicting failures. This data is key to understanding plant performance, managing expectations of operational plants and identifying opportunities for performance optimization, saving time and money.

Turbine Diagnostic Services

Power Generation and Variance Report (PGVR)

A wide variety of factors can negatively impact renewable energy project performance. To understand how a plant is performing, we evaluate variance of the actual operational energy production from the pre-construction energy production estimates. The PGVR provides a comprehensive, independent overview of a renewable project performance against expectations. A variance analysis of major aspects of project performance includes:

- available resource
- availability (contractual and commercial)
- curtailment
- performance
- electrical losses
- environmental losses

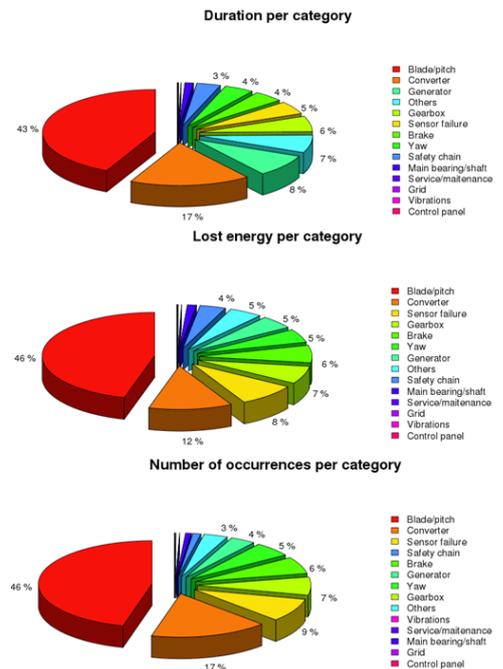
Additionally, the PGVR provides an asset-level evaluation with the goal of identifying and highlighting both the magnitude and possible causes for deviations from expected performance. A ranked view of priority assets and possible causes for underperformance provides operators with actionable intelligence which can be translated to increased revenue.

Event Log Analysis Report (ELAR)

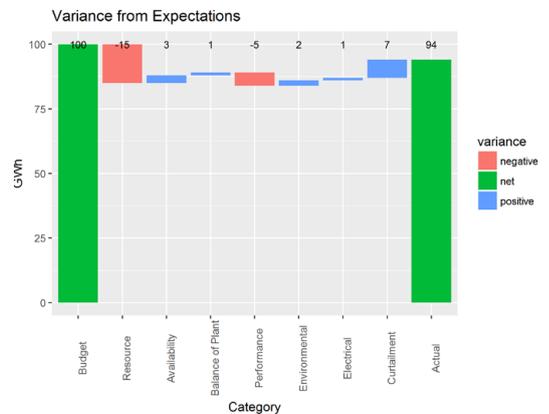
The ELAR provides a detailed asset-level analysis of the production impacts of downtime at a wind or solar project, identifying the amount of lost energy and, as far as possible, lost revenue for each type of downtime. The report identifies the most relevant downtime causes and can enable an operator to prioritize remediation activities. The ELAR is an introductory diagnostic of project performance and health status based on the statistical data mining of sensor alarms registered by the SCADA system for each asset in the project. It has been proven to be a solid basis and complement to end-of-warranty inspections. The analysis provides:

- Downtime and loss of energy by downtime type including its monetary impact;
- Frequency of alarms per component or turbine;
- Duration of O&M interventions;
- Time between alarm activation and intervention; and
- Evolution of alarm logs.

Lost Energy by Category



Variance Analysis Results



Turbine Diagnostics Services cont'd

Methods Consulting

As an industry leader in operational assessments, UL can assist owner/operators with establishing in-house procedures to deal with any aspect of turbine or PV system operation. UL has an established track record with clients which can:

- identify the best methods to estimate possible power and energy loss due to curtailment
- for wind plants, create test plans for wake optimization which can be installed by operators
- develop test plans – either side-by-side or before-after – to estimate the impact of power uprates (e.g., vortex generators) or control system changes by the turbine manufacturers.

Methods consulting services can range from drafting procedures for in-house use to reviewing and commenting on procedures developed by owners or third parties who are implementing performance modifications.

Lidar-Based Services

Lidar technology has become increasingly important in performance assessments of wind projects. The lidar device is mounted on the rooftop of the nacelle and accurately aligned with it. By measuring wind speed and wind direction upwind of the rotor, the assessment provides higher reliability on the data than the normal nacelle anemometer. As industry leaders in operational assessments, UL has invested in its own lidars and developed the experience, knowledge, and tools to use them for the assessment of wind project performance.

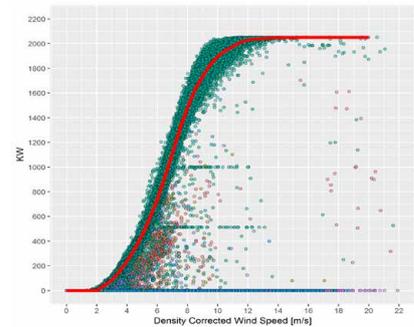
Applications of the nacelle mounted lidar for wind farm performance assessments include:

Lidar-Based Yaw Misalignment Detection (YMD)

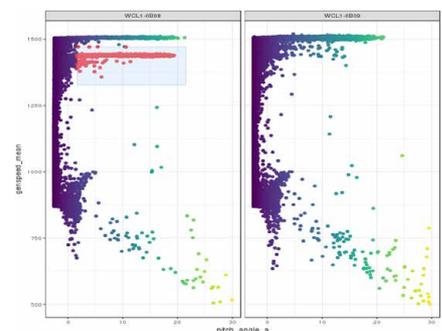
Yaw misalignment is a frequent cause of turbine underperformance in the operation of a wind project. In the short term, yaw misalignment causes production losses. In the long term, it can cause undesired loads that lead to higher maintenance and repair costs and/or a reduction in the wind turbine's or components' life time. The detection of yaw misalignment with nacelle mounted lidar is accomplished by measuring the relative wind direction compared to the yaw position. The report identifies the average yaw misalignment angle which can then be used for correction of the yaw direction.

The measurement campaign takes usually between two to three weeks, depending on the effective wind during the measurement campaign period.

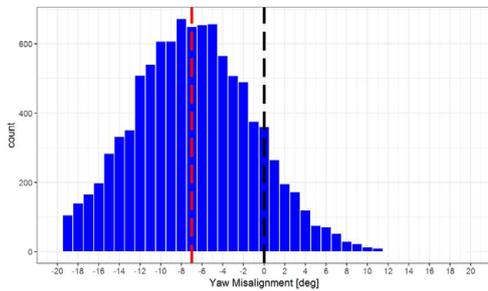
Density Corrected Wind Speed



Plant Performance Anomalies



Yaw Misalignment



Lidar-Based Operational Power Curve

As the nacelle-mounted lidar measures the free wind speed in front of the rotor, one of its main applications is to calculate the power curve of the wind turbine with higher accuracy than is possible with the nacelle anemometer. In combination with the correction of the yaw misalignment, the power curve assessment can be used to identify the impact of yaw misalignment correction on the energy production.

Lidar-Based Nacelle Transfer Function

An additional application of nacelle-based lidar is the calculation of the nacelle transfer function to improve accuracy of the performance assessments against uncorrected nacelle anemometer measurements taken from the SCADA data.





Inspections

Ensuring safe and efficient operations, UL offers independent technical inspections on wind turbines and components during the whole project life cycle. We provide services that allow project developers, wind project owners or investors to combine technical safety with a reliable and profitable management plan for the long-term operation of the wind farm.



Wind Turbine Inspections & Root Cause Analysis

Wind Turbine Inspections

Wind turbine inspections are important, and often required, at various stages of the wind project lifecycle to help ensure reliability, safety, and performance. We offer inspection services for onshore and offshore wind turbines and their components and provide completely independent and objective information to accurately characterize their current condition, identify technical issues, and document all findings and recommendations in an accredited report. Combining more than 27 years of experience in wind turbine technology and a very well-documented, accredited process, we are the best partner to help ensure your inspections comply with the highest standards and are accepted by all parties.

Inspections can be performed at the following locations:

- Factories, including the manufacturing quality control process
- Origin and destination ports and hubs
- Transportation means for main components
- Onsite during the project construction and operation

Inspections can be performed at different stages of a project's lifecycle, including:

- At any point in the supply chain to verify the quality of components
- After COD to establish a punch list before signing an approval certificate
- Before the end-of-warranty to help ensure that warranty claims and contractual obligations of the manufacturer are fulfilled before the deadlines
- During the life of the wind project, recommended every 2 to 4 years
- At the end of a wind project's design life to determine remaining useful life

Wind turbine inspections include inspection of their main components including:

- Endoscopic inspection on gearboxes, bearings, main shafts, pitch systems
- Vibration measurement and diagnosis for the drive train, shaft alignment
- Inspection of blade and/or blade lightning protection system from the ground, uptower, or with drones
- Insulation test on generator
- Additional reviews including oil and grease analysis, ultrasounds, penetrating liquids, and more

Root Cause Analysis (RCA) and Damage Assessment

When turbines are damaged, our qualified inspectors, and structural and mechanical experts conduct a root cause analysis (RCA) to determine the reasons. It is of critical importance to evaluate the pervasiveness of the causes across the complete wind project, and clearly define measures to mitigate the consequences. Our RCA processes are based upon proven methodologies (including IEC 62740), which start from a gathering of all facts surrounding the incident and methodically reaching a conclusion.

Accreditation (IAS, ISO17020)

UL Renewables is accredited by IAS (under AA-759) according to ISO/IEC 17020:2012 as "Inspection Agency - Type A (Third-Party) Inspection Body."

The accreditation of our compliance with standards provides the recognition that our policies, practices and procedures are consistent with the standard in terms of quality, independence, transparency and conformity, and that we have the necessary expertise in the provided services.





Lifetime Extension Services

Extending the operation of a wind turbine equates to increased revenue, which is gaining significant importance in the established wind installation markets. LTE also incorporates potential challenges that may lead to higher O&M costs and an increased risk of structural failures, which are more likely associated with additional cost, also considering the corresponding safety risks. Lifetime extension of wind projects will continue to be an important topic in future years as lifetime extension services maximize the profitability of aging wind farms.

Turbine Life Assessment

With the vast and growing number of wind turbines operating globally, extending the life of wind projects, and in turn their cash flow, will be an important priority for wind asset owners. Turbine life assessment and extension services help owners make intelligent, informed decisions concerning operations, maintenance, and repair, as well as repowering, with the ultimate goals of supporting safety and maximizing the value of operating wind assets.

Remaining Useful Life (RUL) Analysis

A turbine is not an isolated system with a pre-determined life: it is a set of components, each of which has its own statistical life, expressed as a probability of failure over various time frames, which is sensitive to site conditions and to how the turbine has been operated.

Turbines are designed for specific IEC wind class conditions based on average wind speed, extreme gusts, and turbulence, and typically for a 20-year expected lifespan. Actual wind conditions are, in many cases, less aggressive than design conditions, and there is enough margin on the design that the turbine can safely operate well beyond its intended life.

UL 4143 Standard

Underwriters Laboratories has drafted standard UL 4143, a methodology for the Life Time Extension of Wind Turbines as an ANSI approved standard. The ANSI designation on the published UL 4143 standard indicates its acceptance as the US National Standard for the lifetime extension of wind turbines.

RUL ANALYTICAL PROCESS



Turbine Life Assessment cont'd

The question is, how much longer can they operate safely and profitably? If a turbine is going to be operated beyond its 20-year design life, it should be assessed for its potential for lifetime extension. The RUL can be determined by a combination of analytical calculations and wind turbine inspections based on:

- On-site wind conditions (wind distribution, turbulence intensity, wind shear, inflow angle)
- Operating practices and conditions and O&M (e.g., availability, curtailments, emergency stops, preventive/corrective actions)
- Wind turbine design and properties (geometries, materials, stiffness, WT control model)

The main focus of the analysis is to determine the accumulated turbine component fatigue compared to design limits. The structural integrity of the turbines is also verified, and load simulations are performed to assess the safety and viability of extending turbine life. Load simulations include:

- Verification site suitability
- WT modelling and validation
- Damage equivalent loads (Markov Matrices)
- Wind seeds generation (Kaimal models)

The results of the analysis include a probabilistic assessment of the remaining useful life of the major structural components (i.e. tower, bedplate, hub, etc.), estimates for replacement or remediation costs, and recommendations for energy assumptions and forecasts for OPEX and CAPEX costs.

Components Evaluation

The RUL of a wind turbine is actually defined by the RUL of its individual components. The RUL for each critical component is derived by comparing the component load at the wind turbine's location to the design load. At a minimum, the following components are inspected:

- All-over turbine condition
- Damage to:
 - Tower and foundation
 - Blades
 - Nacelle and hub
 - Bolt connections
 - Yaw system
 - Hydraulic systems
 - Electrical systems
 - Gear box
- Wind turbine operation
- Safety and control systems
- Test of all operating states
- Personnel safety
- Maintenance logs
- SCADA data for verification





Representative Case Studies

LOCATION: Canada

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.

LOCATION: California, United States

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 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.

570+
MW

LOCATION: Brazil, China, India, South Africa

Seven-Project Operational Wind Portfolio

Provided technical advisory services to support the buyer's assessment and valuation for the potential acquisition of a wind portfolio consisting of seven operational projects. The technical scope included:

- Operational energy production reports
- Review of historical operations
- Review of IE report
- Site visits for visual inspection
- O&M review including OPEX costs

LOCATION: Brazil

Monthly Performance Reports for a Brazilian Wind Project

UL has been providing monthly reports to a wind complex of more than 400 MW of installed capacity in Brazil, assessing plant production and availability from an independent perspective, identifying turbine damage at early stages and detecting underperformance issues. Thanks to the periodic analysis of SCADA data and other plant information as BOPs or Work Orders, we were able to increase turbine efficiency, improve O&M and decrease operating costs.

LOCATION: Brazil

Energy Assessments and SCADA Data Analyses for Brazil Wind Project

Post-construction energy assessments with actual plant data were provided for a Brazilian wind complex of more than 70 MW, followed by an in-depth SCADA data analysis to diagnose existing underperformance issues and identify symptoms of damage in the main components of the wind turbines.

LOCATION: Causapsca, Sainte-Marguerite-Marie & Sainte Florence, Quebec, Canada

Event Log Analyses for M&A Transactions Assessment

An in-depth analyses of all the alarms and events registered by turbines during the last year of plant operations was performed in order to evaluate turbine performance and health status for this 250 MW wind farm in this country. A detailed assessment of the main causes of downtime and energy losses and the identification of problematic turbines and components was performed in order to assess the M&A transaction and make recommendations.

22
MW

LOCATION: France

Lidar-Based Measurement of Yaw Misalignment for Wind Project in France

Our company installed a nacelle-mounted lidar system to measure the degree of yaw misalignment for this 22 MW project in France. We identified a considerable optimization potential of the energy yield by correcting the yaw misalignment in the wind farm project, realizing an increased AEP of 1.8%

LOCATION: Mexico

End-of-Warranty Inspection on a Wind Project in Baja California

Including General Inspection, Drive Train Inspection (Gearbox and Hydraulic actuators oil analyses, Gearbox video-endoscopy, vibration analysis), Blade Inspections, Switch-Gear Inspections (functional test, gas SF6 levels), Yaw Systems Inspections and Generator Inspections. The work included an accredited acoustic test to comply with local regulations. The extensive work was executed in record time with very high level of satisfaction from our customer.

230
MW

LOCATION: United Kingdom

Remaining Useful Life Calculation for 17 Wind Farms

The lifetime extension potential for this entire portfolio was analyzed as part of the due diligence including performance assessment, contractual evaluations and technology reviews. The final report was redacted in English and Chinese and was considered crucial to the transaction by the buyer.

LOCATION: Spain

Remaining Useful Life Calculation for 21 Wind Farms

The project comprised analytical probabilistic calculations for the main load stations (components) for all the wind farms as well as accredited wind turbine inspections for selective sampled turbines for all wind farms. The probabilistic calculations were based on comprehensive uncertainty calculations and sensitivity factors per load station. The complete studies contained a projection for OPEX and CAPEX beyond the 20 years to help ensure meeting the P50 life-values.

739
MW

LOCATION: Republic of Ireland, Northern Ireland

Thirty-Six Project Operating/Construction/Pipeline Wind Portfolio

Provided Performance Assessment within a M&A transaction to support the buyer's assessment and valuation for portfolio acquisition. The performance related scope included as follows:

- Curtailment
- Resource assessment and energy production
- Portfolio analysis

136.8
MW

LOCATION: Global Portfolio

Eleven-Project Global Wind and Solar Portfolio

Provided portfolio benefit analysis to support an investor in the valuation and review of portfolio consisting of eleven wind and solar assets in North America, South America, Europe, Asia and Australia. Scope included:

- Energy Review
- Estimation of uncertainty
- Portfolio effect analysis

69
MW

LOCATION: United States

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.



Key Office Locations



AFRICA

Johannesburg, SOUTH AFRICA

ASIA PACIFIC

Beijing, CHINA

Suzhou, CHINA

Bangalore, INDIA

Ise, JAPAN

Tokyo, JAPAN

Seoul, KOREA

EUROPE

Lyon, FRANCE

Bremen, GERMANY

Cuxhaven, GERMANY

Hamburg, GERMANY

Oldenburg, GERMANY

Wilhelmshaven, GERMANY

Milan, ITALY

Ansoain (Navarra), SPAIN

Barcelona, SPAIN

Izmir, TURKEY

London, UNITED KINGDOM

LATIN AMERICA

Buenos Aires, ARGENTINA

São José dos Campos, BRAZIL

Rio de Janeiro, BRAZIL

Bogotá, COLOMBIA

Mexico City, MEXICO

NORTH AMERICA

Albany, New York, UNITED STATES

Northbrook, Illinois, UNITED STATES

San Diego, California, UNITED STATES

San Jose, California, UNITED STATES



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