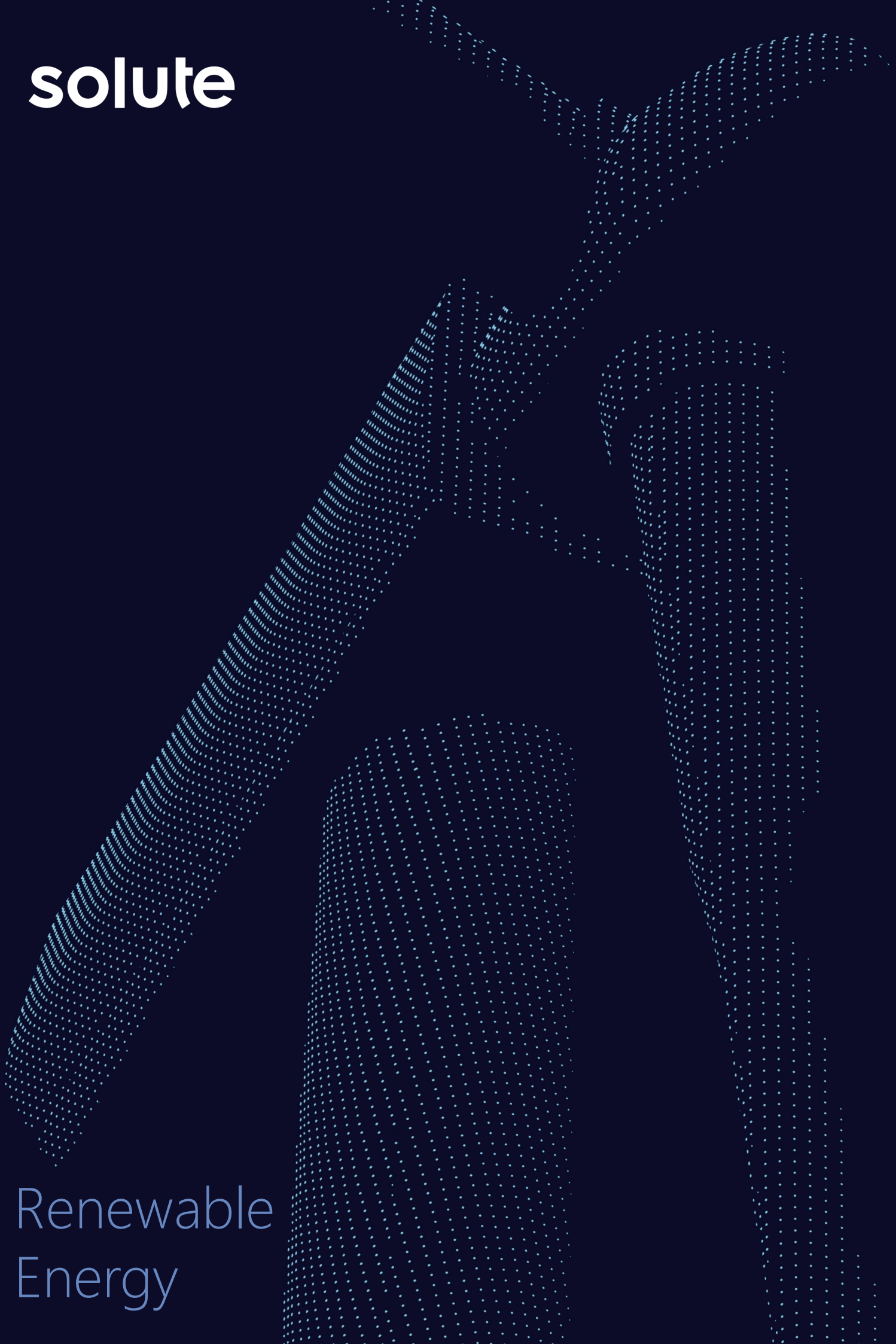
solute



Renewable Energy

"In the past the man has been first; in the future the system must be first. This in no sense, however, implies that great men are not needed. On the contrary, the first object of any good system must be that of developing first-class men."

Frederick Winslow Taylor

About SOLUTE

Since its foundation, SOLUTE has been closely bound to wind energy, sharing the success of the big companies and taking part in the second revolution of the wind energy industry at a national scale.

The constant growth of the industry has increased the demand of services, and that is why new developments that require the newest technology exist, as well as older assets which need operational support.

SOLUTE participates in that evolution, providing a solid experience in relation to the evaluation of the existing problems and offering a comprehensive solution based on engineering services within the industry. This solution offered by SOLUTE encompasses all the lifetime stages of a wind energy project: from the energy potential analysis of a location for a possible wind farm, to service errors reports or life extension projects, also including the complete design process of a wind farm, aeroelastic loads analysis, controllers design and fatigue tests, among others.

SOLUTE has been an active part in the wind energy generational change, through its participation in several lifetime extension projects for wind energy plants located in Spain, as well as the development of the latter wind turbine models by its R&D area.

Thus, we constitute a model in different projects for both national and international companies, and that is why wind farms manufacturers, promotors and operators rely on SOLUTE as a specialized and high-quality engineering company that helps them to complete every project successfully.

Wind farm development

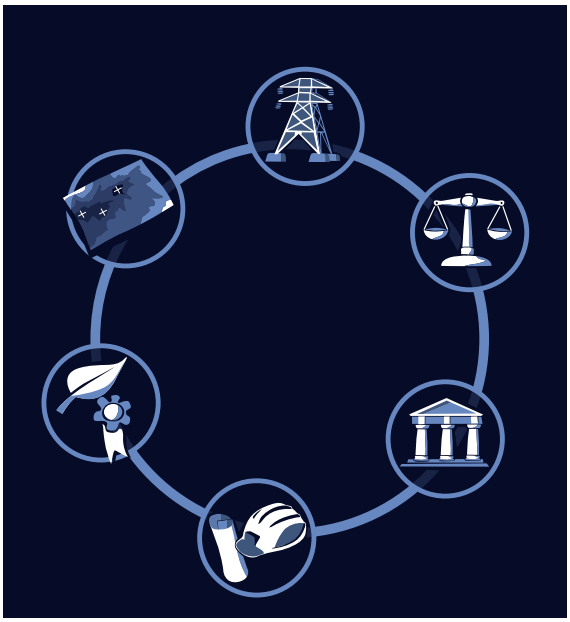
SOLUTE offers complete plant design engineering services, providing its experience in project management, coordination and analysis with different ranges, that allows the company to take charge of any stage or task within them.

Measurement campaigns management through the installation of SODAR, LIDAR and meteorological masts, attending to MEASNET certification criteria.

Wind resource calculation by means of the **location physical modeling**, the analysis of the wind data for each mast, the class and subclass evaluation in the measurement points, the wind energy mapping of the location, the layout preparation and the energy calculation through uncertainty analysis.

Usage of FUROW for the plant layout optimization, through the continuous recalculation of the energy generated by the plant over different distributions.

Complete plant infrastructure: internal access roads layout, platforms, foundations, connection to existing roads, electric grid, electric substations and electrical network connection. **Optimization** through the balance between economic-financial studies and design criteria. Usage of the Civil-3D software tools for the design and FUROW for energy optimization. Detail design through a representation system. **Usage of BIM** for the design management, cost calculation, etc.



Edition of the wind farm technical documentation for public tenders and private development over different types of projects:

Preliminary studies for tender

- Wind resource studies
- Civil and electric preliminary designs
- CAPEX estimation

Basics projects for processing

- Restriction studies: environmental, aerial or sea navigation in the case of offshore plants, distribution lines, patrimony, archeology, etc.
- Micrositing and layout review depending on affections
- Machinery selection and production recalculation
- Basic civil and electrical design
- Layout optimization according to CAPEX vs. production
- Decommissioning plan, drawings, measurements and budget

Building and detail projects

- Review of inquiries to different organisms during the processing period
- Final layout definition
- Detail electric and civil design
- Foundation design and calculation based on load calculations
- Drawings, reports, budget and calculation annex
- Final budget
- Safety and health project

Wind resource evaluation through Furow

FUROW is a software that collects all modules and functionalities required to perform a wind farm promotion since the beginning of a wind resource measurement campaign through several sources. Self-developed by SOLUTE and certified by Tüv-Sud, its objective is to evaluate wind energy resource, carrying out meteorological data inspection and processing in order to analyze the wind behaviour.

It compiles all kind of atmospheric variables gathered during a measurement campaign, both through meteorological towers or remote measurement devices (SODAR or LIDAR), as well as data from other models.

It carries out vertical extrapolations and statistic analysis in order to determine the atmospheric behaviour in a measurable point that can be selected among other options, allowing to get estimations of the atmospheric variables.

It gets synthetic variables through mathematical operations obtained from the measured variables. As a result, it is possible to obtain the maximum knowledge as possible of the location from the measured meteorological data.

It is a self-developed wind energy resource calculation engine, composed by two different models: a lineal model, and a fluid dynamic model, for locations that show a complex orography and/or a high roughness.

Versatility: it offers wind resource studies and evaluation of orography of any level of complexity.

Sensibility studies for each meteorological variable in any map coordinate.

The software's output provides with the necessary knowledge for the wind farm design and its adaptation to the location characteristics, through the determination of the wind conditions in all its parts, the restrictions of that environment and the necessary class of the devices.

Optimization module. It allows to introduce restrictions within the location studies (such as buildings, roads, HV lines). This module makes it possible to optimize the plant performance in order to maximize its production, considering the trails effects

Energy module. It calculates the production of each machine and plant, as well as it provides a compiling report including all the orographic, meteorological and yield results It includes 7 different wake models.

Class and subclass study module. It evaluates the parameters that determine the class and subclass of each wind turbine, as well as it includes the Wind Sector Management strategies design. This analysis is carried out in comparison to different editions of the IEC, including edition 4.

Environmental impact modules. Noise and shadow flicker impact are analyzed to be contrasted with the national, regional or local regulations of the location.

Financial module. It allows the introduction of the estimated economic and financial inputs for the promotion and subsequent construction of the plan, as well as hypothesis about its functioning: estimation of the wind farm lifetime, energy rates, etc. It solves the economic and financial flows and return financial parameters such as the Net Present Value or the Internal Rate of Return (LCOE).

Meteorological Forecast

SOLUTE's forecast services applied to the energy industry are a result of an investment in internal R&D, that has made it possible to obtain highly reliable results that are essential for the planification and decision-making process of our clients. Within this forecast system, extreme events detection (such as wind gust, thunderstorms, ice event, etc.) carries out a major role.

Wind potential study

Detailed modeling of the location, based on orography, roughness and obstacles data.

Wind energy potential preliminary study, including mesoscale data, re-analysis and land stations.

Creation of a **wind energy mapping** of the location using the lineal flow model FUROW, through the extrapolation of frequencies distribution data that results as most representative in the long-term for the hub height. The atmospheric stability effects would be included in case that different levels of temperature information was available.

Wind turbine's layout optimization, taking into account the losses caused by trails as well as other restrictions.

Determination of the **plant annual energy**.

Meteorological campaigns design

Detailed modeling of the location, based on orography, roughness and obstacles data.

Selection of the location in which the wind behaviour is representative of the whole area

Location filtering according to its viability because of external factor: accessibility, access typology, etc.

Possibility of carrying out an **additional remote measurement campaign** through SoDAR or LiDAR in order to complete the information that is available in the location selection process.

Energy and meteorological forecast

Energy and meteorological forecast services adapted to the wind farm production and operation needs. Estimation of the operation conditions with two weeks in advance for the operation strategies design and the energy sale.

Energy forecast: Hybrid Model

Forecast model developed in SOLUTE that joins two types of methodologies: **statistic models**, through the usage of Deep Learning techniques, and high-resolution **physical models** that carries out a regionalization or downscaling of the meteorological conditions, in a way that it adapts to the climatological conditions of the studied location. This combination results in a unique system that places SOLUTE ahead of the industry.

Hybrid model products depending on its maximum forecast horizon:

- **Nowcasting (0-6 hours):** by means of the constant monitorization of SCADA data, SOLUTE artificial intelligence models provide an adapted forecast whose main application takes place in the intraday market.
- **Short-Range (0-24 hours) & Medium Range (24-96 hours):** the hybrid model combines the regionalization of meteorological conditions through the use of high-resolution models with statistics and machine learning.
- **Large Range (96-336 hours):** probabilistic forecast to estimate production scenarios in periods from 1 to 2 weeks. It includes production percentiles for the estimation of uncertainty.

In order to set energy forecast services in motion, the following data is necessary:

- **Geographic location of the wind energy plant**
- **Layout** (which is important for the Nowcasting model)
- **Wind and/or power data series measured in the wind farm**. With these internal forecast services, it is also possible to not have these temporal series, since in that case the casuistic would be solved through the use of a microscale model

Meteorological forecast: LAM Model (3 & 1 km)

LAM (Limit Area Model) **meteorological model** with a resolution of 3 km that covers the Iberian Peninsula. The analysis of the calculated meteorological variables makes it possible to design action windows within the renewable plants' environment.

Development of high-resolution atmospheric models (up to 1 km) on demand for any part of the world.

High-range configuration model that takes into account both the location climatology and complex topography.

High added value forecast with enough resolution capacity for the management of events that would impede the carrying out of O&M activities in the plant: strong gusts of wind, storms and thunderstorms, fog, etc.

Model validation and update reports

SOLUTE carries out a constant monitorization of the described models ability, reliability, accuracy and uncertainty.

By means of the study of key statistics, both related to continuous variables and categorical variables, reports about the models' status are elaborated including graphs such as Taylor's Diagram, which contribute to a better understanding of the service quality by the client.

Constant improvement of predictive algorithms and periodic update of operative

Long term temporal series reconstruction by means of mesoscale models and/or artificial intelligence.

Development of AI self-developed methodology in order to reconstruct wind speed and direction from 1980 to the present, allowing to obtain a higher representativeness of the wind turbine that can be used in long-term specific studies.

Development of self-developed mesoscale models based on LAM models, which make it possible to reconstruct temporal series by means of dynamic regionalization, that can also be refined through AI procedures.

Aeroelastic load calculation

New products development

Aeroelastic models

Aeroelastic models generation through the compilation of the machine definition parameters (tower, foundations, nacelle, rotor and blades): geometric dimensions of each tower section and its mass distribution, characteristic modules of the used materials. Hub and nacelle geometric dimensions, mass distribution and stiffness, inertia, aerodynamic coefficient, geometric and structural definition of the blade and polars (thrust, drag and lift according to the angles of attack) that are determined by the aerodynamic profiles geometry.

Usage of several codes, both commercial (such as Bladed, Flex5 Hawc2) and free (FAST), or even the manufacturer's in-house developed models.

Models translation to different codes. Validation based on the effective correlation of the obtained results.

Offshore

Complete analysis of loads for fix or floating substructures, including additional hydrodynamic loads originated by waves, currents and tides.

Meta oceanic data processing in order to define load cases (dispersion model, extreme values, etc.)

Complete analysis of floating turbines loads, considering the dynamic and Strip Theory relevant loads effects, as well as the dynamic analysis of anchoring lines.

Control adjustment

Checking of the operation modes, nominal and extreme values of certain parameters under which the wind turbine must be operating. Through the application of specific global statistical analysis, as well as specific time series detailed analysis, it can be verified if the control and wind turbine operation are appropriate or if some adjustments must be performed.

Frequencies analysis, Campbell diagrams.

Verification of existent margins between natural and excitation frequencies and evaluation of the results on the control adjustment according to the analyzed modes,

Study of new components designs

Analysis of the wind turbine loads when some of the components are redesigned. Not only the redesigned component but also all the rest are again analyzed from a loads perspective to validate if the wind turbine is still suitable.

Sensitivity studies regarding to some of the win¬¬¬d turbine specific parameters in relation to the strategy definition and decision-making process.

Power curves calculation

Generation and analysis through the work with a large number of simulations that try to cover all the possible scenarios over which the wind turbine could be operating. In that sense, a wide range of wind conditions (density, shear and turbulence intensity) is considered.

Wind farm evaluation

Calculation of site-specific loads. Analysis of the site-specific conditions (wind definition, layout) and creation of wind farm files and load cases under IEC standard. Generation of time series and calculation of extreme and fatigue loads through the use of several post-processing, methods and components analysis tools.

Lifetime extension studies. Analysis of the implementation of strategies that, on one hand, do not negatively affect production and, on the other hand, allow to extend the wind turbine lifetime. Analysis of the impact of these strategies on the loads that imply changes in the control strategies, in order to make appropriate decisions.

Databases generation

Preprocessing and post-processing tools for the data specific management, the automation of processes and the achievement of productivity and traceability improvements. Effective management of a large volume of load cases and a wide range of conditions.

Documentation. Generation of all the technical documentation that is necessary to present to the previously accorded certification entity.

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1 Production

2 Fault occurrence during production

3 Start up

4 Normal stop (shutdown)

5 Emergency shutdown

6 Idling

7 Fault occurrence while parked

8 Transport, assembly, maintenance and repair

Towers and foundations design

Studies that encompass the whole process from the predesign in the first stages of the project, to the detailed calculation and the constructive and certification documentation production.

Towers

Conventional steel towers

Precast hybrid concrete towers

- Concrete parts joined in situ and post tensioned together.
- Precast rings, sewed through vertical joints in situ and post tensioned through tendons
- Keystones without vertical and horizontal joining reinforcement in joints, with rings post tensioned through tendons.
- Joints only created by means of exterior tendons

On site precast concrete towers

Hybrid concrete towers built in situ and post tensioned by external tendons

Standard application: IEC61400-6, DNVGL-ST-0126 and Model Code 2010

Usage of FEM tools on specific singularities for optimizing design parameters

Foundations

Circular and octagonal plant foundations: in case of steel towers, it is a solid conventional type, that uses a soaked steel ferrule or a bolts cage in the connection.

Partial shallow foundation, which is the common solution for hybrid towers where trench allows the access to the prestressing anchors for its installation and maintenance.

Ribs foundation of in situ construction

Precast foundations

Pile foundations

Structural and mechanical engineering

Structural and mechanical engineering advanced analysis through numerical simulation

Finite elements (FEM) advanced models construction, calculation and postprocessing, using several commercial codes (ANSYS, NASTRAN, ABAQUS, PAMCRASH, BETACAE suite and ALTAIR suite).

Diverse problem typology: implicit and explicit models, non-linearities, dynamics and fatigue, screwed joints, depending on the problem's nature in each case.

Modeling and analysis criteria according to rigorous procedures established by the guidelines of different certification entities, such as DNVGL.

The main applications in relation to this field are:

- Mechanical components design, calculation and certification
- Stress, fatigue, and damage tolerance analysis
- Welded and screwed joints analysis
- Thermal and aerodynamic analysis (CFD)
- Mechanical components lifetime extension
- Redesign solutions design, calculation and implementation
- Inverse engineering

Wind turbine development

Turbine design, calculation and certification, in a process that encompasses from the predesign stage to certification.

This process is related to the wind turbine **structural components** that require a mechanical evaluation of their structural resistance to extreme and fatigue:

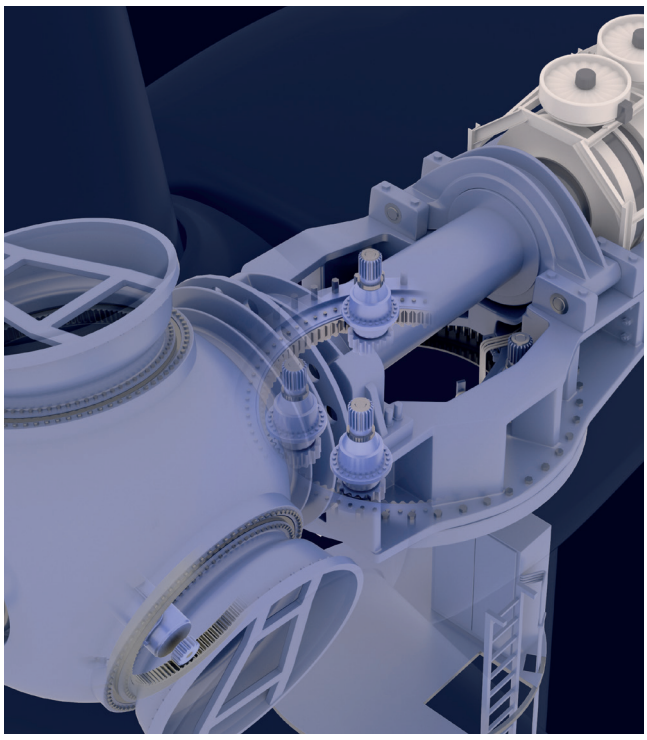
- Rotor blades
- Rotor hub
- Rotor axe
- Main bearing housing
- Multiplier
- Torque arms
- Main nacelle cover
- Main and secondary frames
- Yaw system components
- Pitch system components
- Screwed connections
- Welded connections

The **resistance analysis** includes:

- Structure and outline conditions modeling
- Primary loads and load cases determination and modeling
- Analysis execution
- Model verification
- Results evaluation and valuation
- Documentation of the process for a consequent certification (if necessary)

Study of the energy transmission system dynamics ("drive train") by means of a multibody modeling process through a software tool that represents the system dynamics, thus allowing to carry out the resonances evaluation and the structural integrity verification.

Wind turbine certification. Calculation process that is focused on the machine and its components certification, in front of certifier entities (such as DNV-GL, Fraunhofer Institute for Wind Energy Systems, UL Group, Technischer Überwachungsverein). Specifications tracking: EC61400, DNV-GL guidelines, VDI2230, Eurocode and IIW among the most usual codes, besides clients self-developed codes.



Scanning, virtualization and BIM

SOLUTE offers advanced virtualization services through the utilization of forefront techniques in order to capture reality for digital 3D representation, providing the clients with an added value in the form of cost savings, effective management and training in a safe environment.

Digitalization

Space and components digitalization through 3D scanning

Facilities interior and exterior spatial representation

Representation of each component fabrication defects and deviations

Generation of interactive virtual tours with geotagged information and media

Three types of virtualization solutions:

- BIM methodology
- Geometrical replication for detail studies or calculation
- High-quality rendering through the use of cinematographic quality graphic motors

BIM

Generation of 3D models from plans or scanning processes

Application to civil, real-estate and heritage projects

Project planning and operation problems control

Budget estimations associated to the model information and its automatic updating according to modifications in the 3D model

Energy efficiency studies

Virtual Reality

3D model creation based on scanning models that are supplemented with blueprints and detail photography

Application of the VR immersive experience to wind turbine management activities: emergency evacuation, inspections, maintenance tasks, component assembly, etc. with high-resolution renderings, advanced pro-graming, graphic and sound effects.

Generation of complete simulation platforms, includ-ing a large quantity of processes and also adapting the geometries and tools to different scenarios.

Simulators that include the implementation of remote activities in order to recreate scenarios for guided or collaborative training.

Evaluation scenarios in which it is possible to collect diverse KPIs that test the technician capacities facing a real situation.

Operation & Maintenance Engineering (O&M)

Definition of the operation and maintenance task strategies, that are not only oriented to support the production conditions, but also focused on the service and lifetime extension besides the 20 years covered by the initial design certification.

Failure analysis

Audit services in order to **determine the root cause analysis (RCA),** both for structural elements (blades, hubs, frames, towers, etc.) and rotor and drive-train elements (blades bearing, main axis bearing, multiplier, yaw system, pitch system, etc.).

Determination and study of the **failure mechanisms**, as well as the **proposal of redesigns** or interventions in order to avoid or reduce similar errors in the future or even to mitigate assembly and/or design deficiencies.

Collection and study of the available information for the analysis:

- Inspection reports
- Historical repairing reports
- SCADA data and warnings
- Field actuations and access to the turbine
- Extraction of samples in order to carry out both destructive and non-destructive tests in accredited laboratories, with the purpose of defining the mechanical properties and thermal treatments

Installation of sensors (strain gauges, temperature, accelerometers, tachometers, etc.)

Historical data study and analysis: anomalies detection, recreation of the functioning conditions during failure.

Big data processing and analysis for its structuring, filtering, and establishment of correct functioning patterns.

Leadership, team and interventions management

Design of **integral plans** for solutions and preventable actions

Programming of **components inspection tasks**, coordinating workers into multidisciplinary teams

Evaluation of procedures, definition of new tasks and methodologies for its application

Definition of campaigns and development of destructive and non-destructive tests programs in coordination with specialized laboratories for **material characterization**

Coordination and management of **maintenance activities**

Equipment installation and data tracking

Meteorological data measurement, collection and transferring through the installation of different specific hardware devices.

Installation of strain gauges and data management

Monitoring strategies definition in order to evaluate the components' detected defects and its time progression during production.

Design of data collecting plans and massive transfer of all kinds of data

Development of a **self-designed SCADA system** for old wind energy devices with insufficient data

IOT system development

Processing and real time graphic representation of the collected data.

Generation of wind farm **control panels** that allow remote control of several mechanic components.

Design and repair proposals

Application of the transverse knowledge over the components mechanical-structural behavior in order to observe and analyze their service lifetime through the collected data interpretation and analysis. This knowledge has been acquired throughout our experience in the development and certification field.

Determination of the root cause of structural failures by means of finite elements models (FEM), that have been supplied with the collected data, as well as other analytics.

FEM modelling of the repair for the detail analysis of its behavior.

Procedures' evaluation

Evaluation and review of the assets' inspection and maintenance procedures.

Proposals for the execution time optimization and the data-taking quality improvement, including the integration of new measurement digital technologies.

High Voltage electrical support

- Design and maintenance review of substations and wiring.
- RCA breakage in transformers, converters, connectors, among others.
- Electrical protections and safety analysis.

Wind Farm Electrical support

- Audit costs and components unavailability.
- RCA of electrical components.
- Proposals to improve logistics and procedures.
- Tests and components coordination and evaluation.

Mechanical-structural support:

- RCA of components (blade, hub and spinner, racks, nacelles, tower, and joints).
- Tests coordination and evaluation.
- Design analysis and corrective modifications proposals.
- Evaluation and development of procedures for repairs and maintenances.
- Data processing inspections.
- Detailed structural-mechanical studies (FEM). Loads for redesign studies.

Rotating equipment mechanical support:

- RCA of components (gearbox, main bearing, pitch and yaw system, lubricants).
- Statistical failure analysis.
- Tests coordination and evaluation.
- Vibration analysis.
- Design modifications proposal and repair and maintenance procedures

Monitoring systems:

- Full asset sensorization
- Sensor data evaluation and damage diagnosing
- Machine Learning for predictive maintenance
- Alarm analysis and implementation

Operative reliability support

- Development and optimization of DDBB for operational data
- Business intelligence
- Software development for monitoring of assets and farm control

Civil Works support

- Tower and foundation design review
- RCA: pathologies in foundations and geotechnics
- Peer review and repairing solutions design
- Life extension analysis

Technical Due Diligence for farms in operation

Asset inspection:

- Detailed inspection of turbine components under non-destructive techniques
- SCADA and alarm historical data review
- Damage and risk evaluation

Systems and protocols evaluation:

- Control system
- Electric System
- Safety protocols review under required legislations
- Equipment: maintenance and safety

Real performance evaluation:

- Historical power production vs expected production
- Performance of each turbine vs design performance
- Asset availability (maintenance, emergency shut downs, unexpected damages,...)

O&M Plan review:

- Historical data evaluation from inspections, maintenance and repairing tasks.
- Analysis of fidelity in the follow-up of protocols
- Logistics plan review and replacement components availability

Solar energy and hybrid plants

Solar Energy

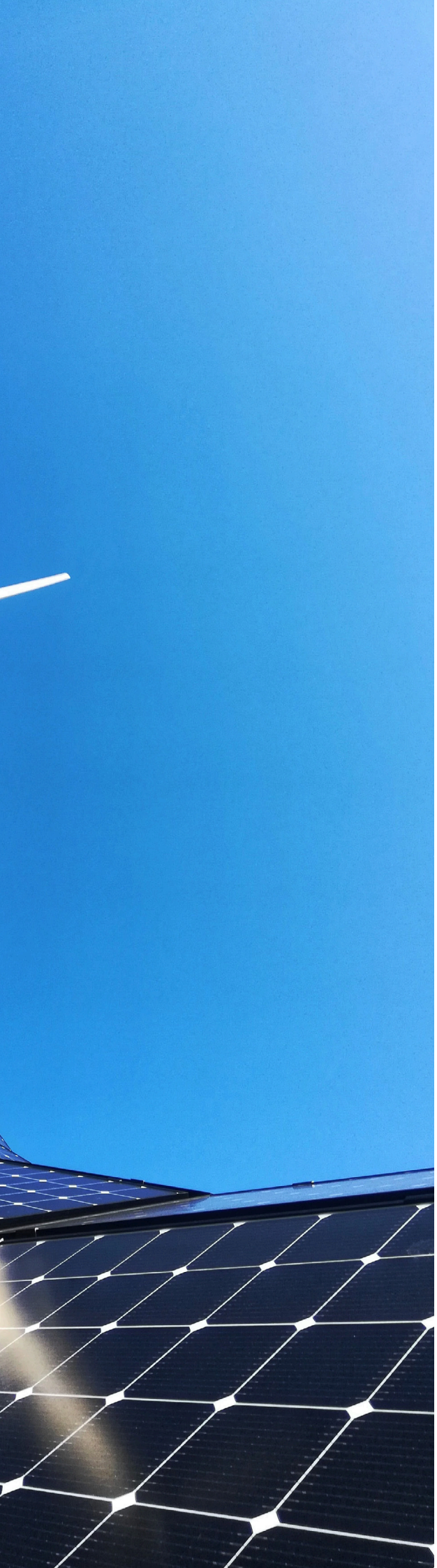
Building upon SOLUTE's extensive experience in wind energy and considering the current trend towards the hybridization of renewable plants, our expertise in photovoltaic energy has been significantly strengthened in recent years. We have successfully completed international projects totaling over 3 GW calculated since 2020, collaborating with developers and operators of solar plants.

The services offered by SOLUTE related to the assessment of photovoltaic plants encompass site assessment and selection, resource and meteorological studies, plant design, and production estimates with uncertainties.

The methodology begins with an initial study and analysis of solar resource and meteorological variables using data obtained from databases and site measurements to evaluate the existing potential at the location. These values are then transposed into the calculation plan in subsequent phases.

Subsequently, the most suitable equipment is selected, and the optimal plant design is developed based on the available space. Finally, energy calculation is carried out using specialized software such as PVsyst, considering potential losses of the installation and providing the main sources of uncertainty affecting the project.

The entire calculation procedure and results can be utilized in photovoltaic pre-feasibility studies in the early stages of development, project development, or as a technical document to support the financing process and subsequent economic and LCOE evaluation studies.



Hybrid studies

The development of renewable hybrid plants is a technical capability that SOLUTE has been working on for several years. This is due to global efforts to decarbonize and the growth of renewable energy development on a global scale. Solar and wind energy projects constitute the core of SOLUTE's foundations.

Following this line, as the demand for hybrid plant development increases among companies, the SOLUTE team has also developed services combining experience in wind and photovoltaic projects. This allows for joint energy production studies, synergies, and overproduction between technologies, combined technical, electrical, and civil designs, and economic project evaluations.

These analyses, both technical and economic, are carried out based on the combination of energy productions from each of the technologies. This allows for the optimization of both the size and design of the plants, through comprehensive analysis that determines the power to be installed for wind, photovoltaic, and storage technologies, taking into account existing costs and energy market prices.

The final result encompasses the different variables and scenarios studied, emphasizing the optimal solution reached. The study of the hybrid plant can be useful for conducting pre-feasibility studies, project processing, supporting financing processes, and subsequent economic studies.

Solar and hybrid projects

Preliminary design of hybrid plant (DDT)

- Design review (distribution, geotechnics, assets)
- Preliminary analysis of wind and solar resources
- Review of preliminary production calculation

(Hybrid) Wind farm study

- Meterological variables study
- Terrain assessment
- Preliminary layout and electrical optimal design
- Losses and production estimation

PV solar plant study

- Site study
- Meteorological study
- Plant design
- Equipment analysis and proposal
- Losses and production estimation

Hybrid plant production

- Joint production study
- Joint performance
- Final electrical and civil design and grid connection
- Joint profitability and economic model

PV self-consumption projects

- Meteorological study
- Solar resource assessment
- Production estimation
- Layout optimization
- Equipment study or proposal
- Economic model

Detailed studies of PV assets

- Mechanical-structural analysis
- Panel aerodynamic analysis
- Estimated lifespan according to meteorological study
- Aerodynamic-structural hybrid model
- Redesign proposal, modifications, or repairs

Electrical and Control Engineering

SOLUTE has a comprehensive electrical, electronic, and control engineering team, which includes electrical engineers, control instrumentation engineers, and software engineers, all with vast experience in various areas within these fields. This enables us to provide a complete package to address all project requirements, from study and design to implementation phases.

Smart Technologies and Monitoring Systems

Cloud-Based SCADA systems for industrial machines, factories, commercial buildings, and for larger scale, such as wind farms and PV plants:

- PLC and RTU programming (IEC 61131-3)
- Industrial communication protocols (MODBUS, CANBUS, EtherCAT, Profinet)
- Industrial Internet-of-Things (IIoT)
- HMI interfaces

Condition Monitoring Systems (CMS) for wind turbines in both structural elements (blades, hubs, nacelle, towers, etc.) and drive-train elements (main axis bearing, gearbox, generator, etc.):

- Installation of cloud-based controller and related sensors (Vibration, accelerometer, strain gauges, etc.)
- Real-Time monitoring and data collection
- Big data processing and artificial intelligence to predict or detect failures
- Periodically technical report

Electrical Diagrams and LV/MV/HV Networks

Design of electrical networks for onshore wind farms and PV plants, both underground and overhead:

- Study and design of evacuation lines
- Study of environmental constraints along the power line
- Specifications of towers for overhead lines and trench configuration for underground networks

Design and calculation of collective and individual substations, transformation centers, sectioning centers, protection centers, control and measurement centers (including all civil works: trenches, control center buildings, access roads, among others)

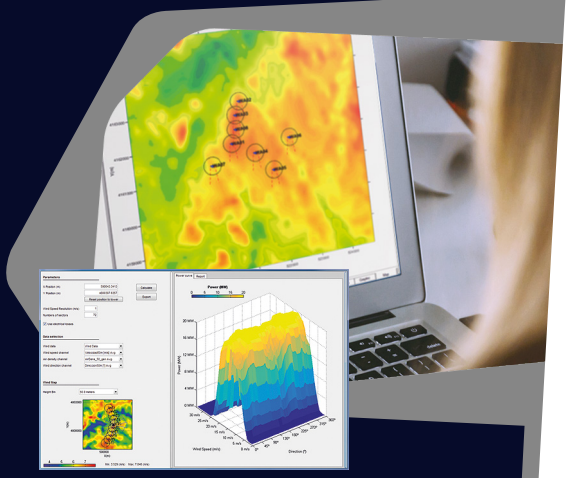
Electrical calculations for all types of networks (Power losses in the cables, voltage drops, conductor reactance, etc)

Our products

solute

Our mission is delivering solutions on a global, multidisciplinary level through our technical rigor and our engineers´ knowledge, with R&D as our backbone.

The result of more than 15 years listening to different stakeholders´ problems is the development of products for the renewable energy industry, in the shape of software, hardware and services.



furow

WRA and Wind farm design software

Furow is a complete and exhaustive wind energy software, which possesses features directly with wind resource assessment calculations, wind farm modelling and project development at any given stage. Furthermore, its compatibility is flexible while working with other software, therefore, allowing users easy access to share and compare information

- Data analysis
- Wind resource assessment calculation (lineal model &CFD)
- Micrositing

aphelion

Multi-function weather and energy forecast software

Our meteorologists, data scientists, and software engineers are specialized in tools optimization in order to obtain the most accurate forecast for a wide variety of projects and clients.

From a high-resolution forecast, Aphelion offers meteorological and energy forecast as well as climate consultancy within a two-weeks' time horizon. Moreover, these capacities can be useful for both companydriven and particular-driven services.

Hybrid forecast model + Machine Learning

- Up to four multi-view maps with different models and variables
- Extensive range weather forecast (up to 16 days)
- Short-term weather forecast (0-72 hours)
- Four daily forecast updates and detailed meteograms

Aphelion Wind

- Automatic software with +5 machine learning architectures and ad-hoc features
- Wind farm and wind turbine forecast
- Customizable forecast ranges, updates, granularity, and time resolution
- ML models can calculate uncertainty estimations for production assessment scenarios (p90, p10, among others)

EVE

Enhanced Virtual Environments

Virtualization and digitalization services for industrial sectors

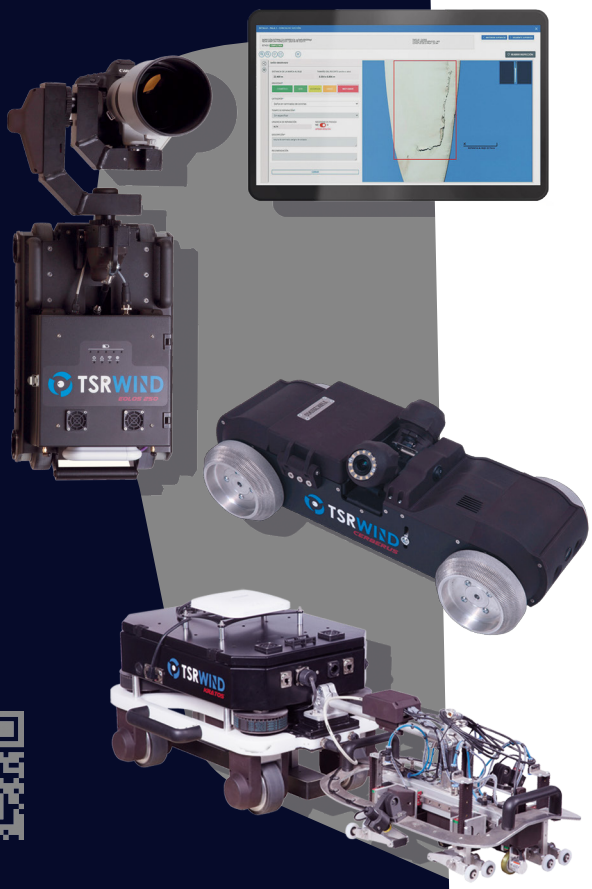
- High detail 3D laser scanning
- Virtual tours with embedded technical information
- Maintenance tasks digitalized in tablet device for field guidance
- VR platform for operation and emergency instruction
- Multi device and multiplayer options

EOLIAN

Predictive maintenance plaftorm for renewable farms

Deep Learning on the Edge and IA algorithms combined for an optimization of the maintenance interventions in renewable energy farms

- Asset sensorization and monitoring
- Remote cloud monitoring
- Predictive maintenance IA algorithms
- Big data techniques for traceability, accessibility and analysis
- Real-time processed on edge data uploaded to servers (IoT+edge computing)



TSRWIND

Comprehensive wind turbine inspection

TSR Inspector

TSR Wind customers' cloud software platform for inspection data processing and management.

EOLOS

External blade inspection robot with high resolution photo camera, capable of climbing any metal surface by permanent magnets

CERBERUS

Remote inspection of blade interiors by small mobile robot with 3 high resolution video cameras to access impossible places for technicians.

KRATOS

Bidirectional magnetic coupling robot designed to climb any metal surface and follow the welding cords using an NDT ultrasound equipment

solute

www.solute.es

aphelion

www.aphelion.com.es

furow

www.furow.es

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