



## The partner to optimize your wind turbine competitiveness

Power converters  
Electric generators  
Control solutions  
Services

***Ingeteam***



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optimize your wind turbine  
competitiveness**

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Energy

Industry

Marine

Traction

Basic Technologies

Services



A Corporation structured into 6 divisions, each specialising in a different sector, and all totally customer-oriented.

### International Presence



# Ingeteam

## Tailored electrical solutions



Ingeteam's core business is based on **power and control electronics, electric machines and application engineering**, directed at the rail, marine, industrial and energy sectors.

With a track record of more than 60 years' experience in the electrical sector and 15 years in the wind power sector, and with more than 3,000 professionals dedicated to engineering, project development and services, Ingeteam is strongly committed to innovation as a growth engine.

Within the Group, since 1990, **Ingeteam Energy S.A.** has been dedicated to supplying equipment for the Renewable Energies sector (wind, PV, thermosolar, hydraulic, biomass and biofuels).

Ingeteam designs, develops, manufactures, supplies and provides maintenance for a **complete range of electrical equipment for wind turbines**, offering a tailored solution, completely adapted to suit each and every customer's requirements.





# Commitment and experience with the customer



**16,500 MW**

of wind power, installed by  
Ingeteam across the world

## Why Ingeteam?

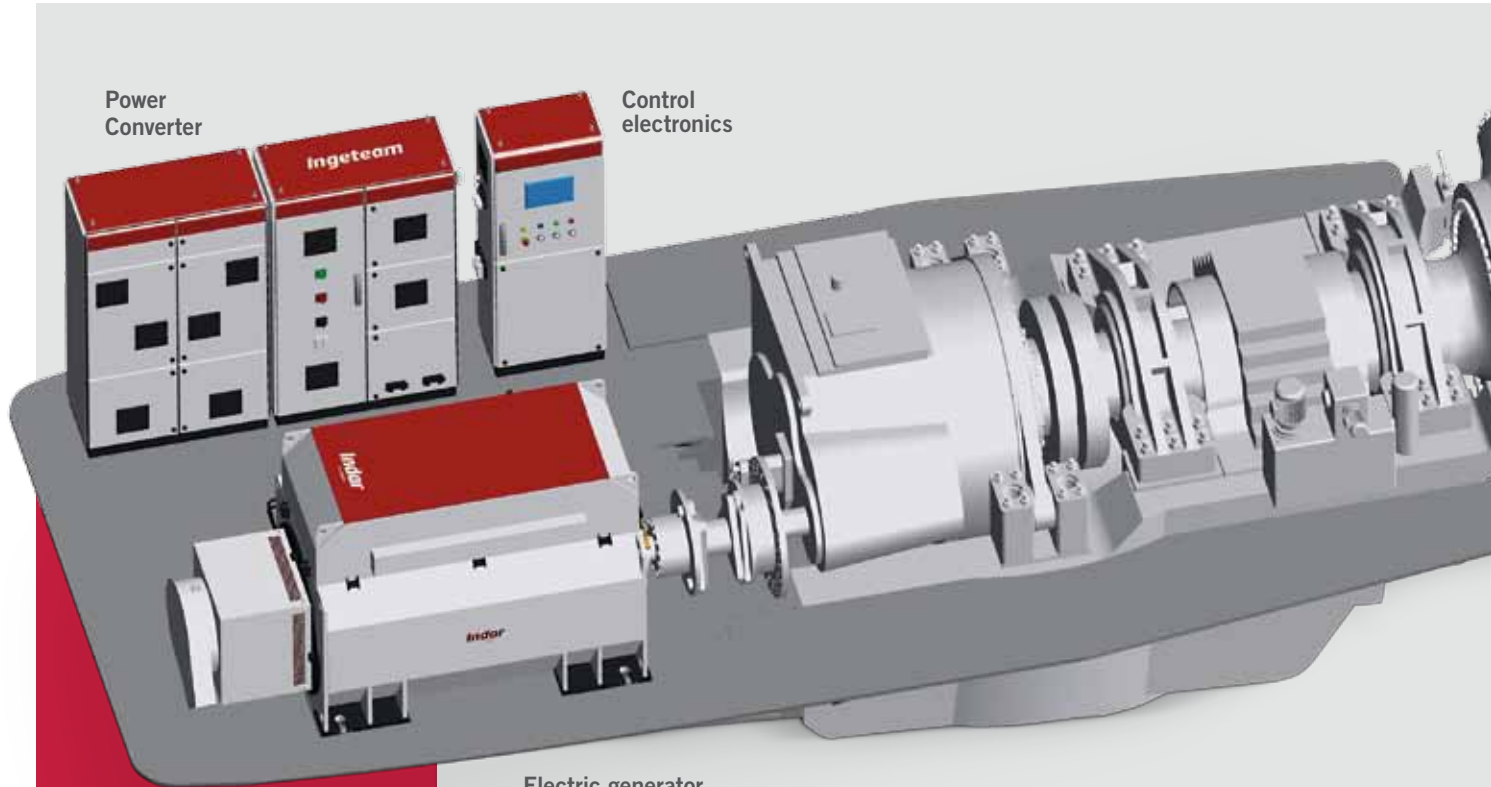
Ingeteam is an independent supplier of **power converters, electric generators, control electronics, pitch control systems, wind farm holistic management systems in addition to a comprehensive range of services.**

Thanks to this extensive offer and to the experience acquired over many years of operating in other sectors, since 1995 Ingeteam is the global market leader in the wind turbine electrical and electronic equipment sector.

Currently, more than 14,000 wind turbines are fitted with Ingeteam converters and generators, accounting for a power output capacity of more than **16,500 MW.**

Values which set us apart and which have allowed us to achieve our present position:

- **Customer orientation, service and adaptability:** Based on these core principles, Ingeteam products are tailored to suit the customer-established requirements.
- **Ongoing collaboration:** Ingeteam provides active support for each specific project, right from the initial new product development stage and throughout the entire product life cycle.
- **Commitment to innovation and to the development of in-house Technology:** in order to guarantee an in-depth knowledge of the systems and to orientate development towards the enhancement of customer applications.
- **Global presence:** With production facilities in the USA, China and Europe. Delivering support and services to customers anywhere in the world.



Power Converter

Control electronics

Electric generator

Ingeteam produces and markets all the electric and electronic equipment required for wind turbines, using state-of-the-art technologies.

Wind farm management



Services





# A comprehensive range of products and technologies...

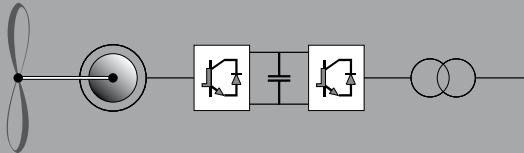


Electric pitch



## FC

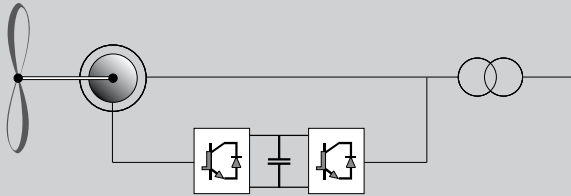
**Full-converter for wind turbines equipped with either a synchronous generator (PMG excitation) or a squirrel cage generator.**



A technology which is used by a number of wind turbine manufacturers due to its operating flexibility, energy management advantages and compliance with regulations. The generator is brush-less and offers the possibility of either eliminating or reducing the number of gearbox stages in the drive train.

## DFM

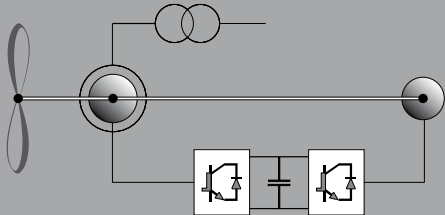
**Partial converter for wind turbines equipped with a doubly fed generator.**



A mature technology used by many of the main turbine manufacturers. Its key advantage is that the converter and associated parts are sized for 30% of the rated power, involving savings in costs and sizes.

## xDFM

**Partial converter for wind turbines equipped with a doubly fed generator and exciter.**



This new technology, featuring a power converter not connected to the grid and an additional electric generator acting as an exciter, has been named xDFM. It is an innovative, variable speed technology offering significant advantages over the DFM and Full Converter systems.

- High quality power
- Excellent performance during grid faults (LVRT)
- Dynamic electric braking capacity
- No power transformer required to power the converter.
- Back-up power from the exciter.

Ingeteam wind power products offer a wide range of possibilities and the provision of a holistic expert service allowing customers to select just the right equipment for each particular case.



## 1

### Power Converters

In 1995 **Ingeteam** developed its family of power converters for wind application, marketed under **Ingecon®Wind** brand.

These solutions are based on **IGBTs, IEGTs and IGCTs**, with PWM, latest generation DSP controllers and either air or water cooled.

Low or medium voltages.

## 2

### Electric Generators

Synchronous (PMG) or doubly fed asynchronous (DFM) or squirrel cage or the new xDFM technology.

Air or water cooled.

Low or medium voltages.

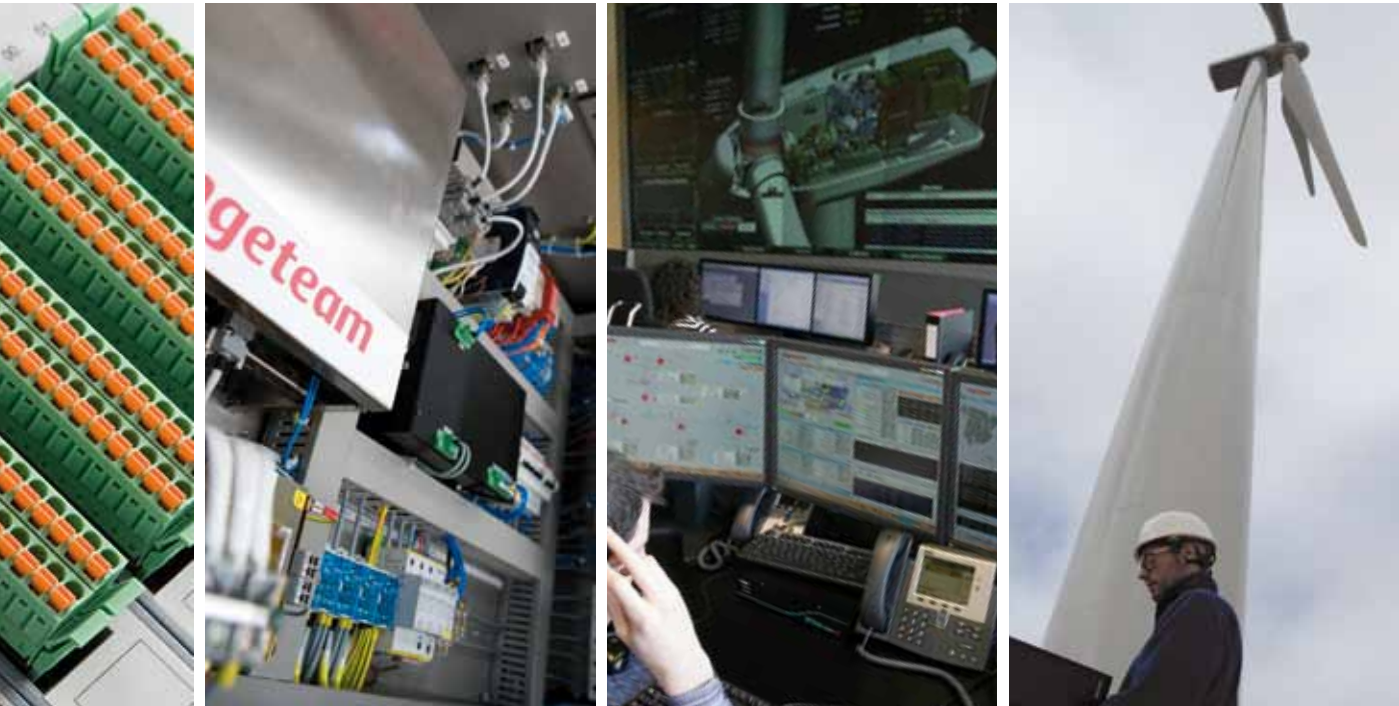
Direct drive, medium and high speed.

## 3

### Control Electronics

PLC systems offering advanced performance, with regard to input-output signals, processing capacity and communications, to meet the requirements of each and every wind turbine manufacturer.

...to provide a holistic service



4

**Electric Pitch Control System**

A system characterised by its high reliability and precision, full adaptation to customer requirements, advanced technology, compact design and easy maintenance.

5

**Wind Farm Management**

Complete integration of all the wind power plants in a single system, regardless of the wind turbine manufacturers' platform and its location.

6

**Services**

Ingeteam provides expert service throughout the entire product life cycle, adapted to suit the needs of each specific customer and supported by an extensive international network.



# Power Converters



## Ingecon<sup>®</sup>Wind

These PWM controlled converters are based on IGBT, IEGT and IGCT power semiconductors, having a very low inductance DC bus.

Equipped with latest generation DSP microprocessors, 32 bit parallel multiprocessing, the power converters include advanced Vector Control algorithms on the PWM, for either the rotor control (DFM or xDFM) or stator control (Full Converter) of the generator.

Each design meets the specific requirements of the wind turbine.

**Ingeteam has supplied more than 14,000 converters, equivalent to a total of 16,500 MW of accumulated power.**

The main features include:

- Rotor or stator vector control techniques.
- Total control, over both real and reactive power.
- Operating with generators of up to 4.16 kV and frequencies of 50 or 60 Hz.
- CE marking and compliance with the UL/CSA standards for the American market.
- Compliance with the power quality and EMC compatibility standards.
- Compliance with the most demanding grid connection standards.

## With Full Converter, DFM or xDFM technologies

### Features

- Air or water cooled.
- Generally, back to back converts (IGBTs) with PWM.
- Design range from 400 V to 690 V output voltage.
- Dual purpose design for 50/60 Hz.
- Total real and reactive power control.
- Excellent power quality: THD < 3%.
- CE certified and compliance with the UL/CSA standards for the American market.
- Filters included.
- Include generator and grid side disconnection switches.
- Onshore/Offshore applications.
- Extensive experience, in other applications and technologies.



## Low Voltage Power Converters



### And a choice of power ranges:

- **Full Converter:** from 800 kW to 6 MW,
- **DFM** systems from 660 kW to more than 6 MW.
- **xDFM** technologies: from 1.5 to 6 MW.
- And also **mid-size** wind turbines power from 70 kW to 300 kW.

## HV-IGBTs

### Features

- **Water cooled** (de-ionised water is not required except for press-pack devices).
- **HV-IGBT, IEGT or IGCT** converters with vector modulation (passive and 12-pulse rectifiers also available).
- Easy-to maintain, highly modular design.
- Designs for line voltages of **2.4, 3.3 and 4.16 kV**.
- Machine side frequency range **0-120 Hz**.
- **Total active and reactive power control**.
- Excellent power quality: **THDi < 5%** (depending on grid filter).
- Protection, sectioning and earthing switchgear included.
- Redundant and tailored **Offshore Applications**.
- Also extensive experience in industrial and marine applications.





## Medium Voltage Power Converters

### IEGTs



### IGCTs



#### Power ranges from:

- HV-IGBT: 2.5 MW to 12 MW.
- IEGT: 5 MW to 12 MW.
- IGCT: 5 MW to 12 MW.



# Electric Generators



As part of Ingeteam, **Indar Electric** is the company dedicated to the design and manufacture of electric generators, suiting the requirements of each and every customer. Indar has one of the best test benches in the world. This test bench allows Indar to fully test his designs for all kind of environmental conditions and to guarantee the best quality on his products.

Indar has a dedicated, high-tech, high capacity wind turbine electric generator production line, in addition to an efficient after-sales service. The mechanical and electrical software employed for the generator design is based on in-house technology, whilst advanced simulation tools, such as finite element mechanical calculations and magnetic flow measurements, are also used.

Our wind generators have been designed to operate in a range which covers the entire market energy requirements. Indar supplies asynchronous and synchronous generators with output powers ranging from 100 kW to 12 MW and voltages from 690 V to 12 kV.

The materials, insulation and impregnation systems used in the generator manufacturing process are of the highest quality, to ensure compliance with international standards and in extremely reliable, low-maintenance, high-performance machines.

The more than 15,000 wind generators supplied to date is a clear indication of the trust that customers have placed in Ingeteam.

## Features

- Generators of power levels from 100 kW up to 12 MW.
- Asynchronous doubly fed or synchronous with permanent magnets and technology xDFM.
- Direct Drive, medium or high speed.
- Air or water cooled.
- For all machines up to insulation H.
- Voltage from 690 V up to 12 kV for DFM Technology.
- Voltages from 690 V to 4.16 kV for PMG Technology.
- Frequency: 50 Hz and 60 Hz.
- Onshore & Offshore applications.
- Various fabrication structures and forms.
- Noise level adjusted to client needs.
- Compliance with international standards: IEC, UL, CSA, USTC, etc.

## Wind applications

### Doubly Fed, xDFM & Squirrel cage (Asynchronous)



### Customized design solutions for different environment applications:

- Cold Temperatures: -30°C, 50°C
- High Corrosion Resistant: C3H, C4H, C5MH
- Desert Conditions: Sandstorm
- Frequency: 60 HZ

# Electric Generators

Wind applications

## Permanent Magnet Generators (PMG) (Synchronous)



### Power ranges:

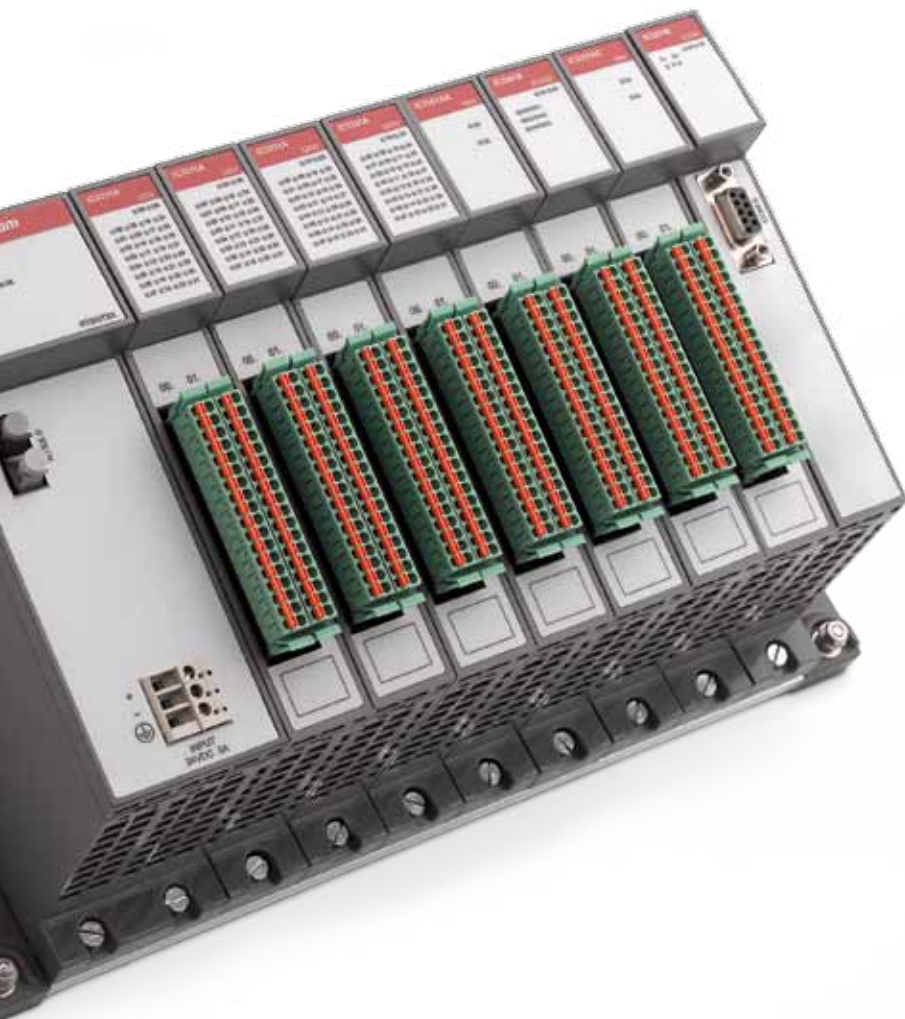
- from 800 kW to 6 MW (direct drive or medium or high speed) with **LV- PMG (<1 kV)**.
- from 800 kW to 12 MW (direct drive or medium or high speed) with **MV-PMG (<15 kV)**.
- **Permanent magnets:** from 100 kW to 12 MW (direct drive or medium or high speed).
- **DFM systems:** from 660 kW to more than 6 MW.
- **xDFM technology:** from 1.5 to 6 MW.
- Mid-size wind turbines from 70 kW to 300 kW with **PMG technology**.

## Features

- Tailored control solutions.
- **Power and flexibility** to adapt to current and future market requirements.
- **Versatile, thanks to its** extensive range of CPUs: a single system for both simple and complex applications with cycle times of less than 1ms.
- Modules specifically designed for wind turbine control.
- Wide range of **connectivity** interfaces: Profibus, CANopen, EtherCAT, Web Services, Modbus/TCP, OPC, FTP, USB, amongst others.
- Integration with **MATLAB/SIMULINK**: reduced design and validation times for advanced control algorithms.
- Possibility of integrating **C language** functions and libraries.
- Advanced functionalities in order to incorporate added value into the system: **Web applications** and applications in **.NET**.
- Hot swap and **redundant topology** options.
- Powerful and **user-friendly** development environment, based on the IEC 61131-3 standard and with an extensive range of function libraries.
- Easy to use and maintain: powerful diagnostic tools.



# Control Electronics



## Ingesys<sup>®</sup>IC3

The **Ingesys<sup>®</sup>IC3 family of PLCs** features cutting edge technology in a compact, robust system that is particularly suitable for such demanding applications as wind turbine control.

The customised control solutions based on this family of PLCs make Ingeteam the ideal partner for the provision of a holistic solution.



## Features

- AC or DC Motor
- Batteries or Ultracapacitors.
- High reliability.
- Customized design.
- Compact and robust system.
- Vibration resistant.
- Long lifetime.
- Easy maintenance.
- Fast dynamic response.
- High positioning precision.
- Controlled shutdowns for **LVRT and emergencies**.
- Regenerative braking.
- Auto diagnostics.
- Local or remote operation.
- **Monitoring/supervision** tools.
- Automatic adaptation to the operating frequency (**50/60 Hz**).
- Wide range of communication protocols.





# Electric Pitch



A system characterised by its **high reliability and precision, full adaptability** to customer requirements, **advanced technology, compact design** and **ease of maintenance**.

The electric Pitch Control System regulates the wind turbine blade pitch angle with total control and precision, to maximize the wind energy harnessed.

With **safety as a key factor**, Ingeteam Pitch Control System has been designed to operate at high wind speeds and at turbulent sites.

Ingeteam Pitch Control System is designed to enable the wind turbine to operate in compliance with the grid connection regulations during voltage drops and to perform **controlled shutdowns** in emergency situations.

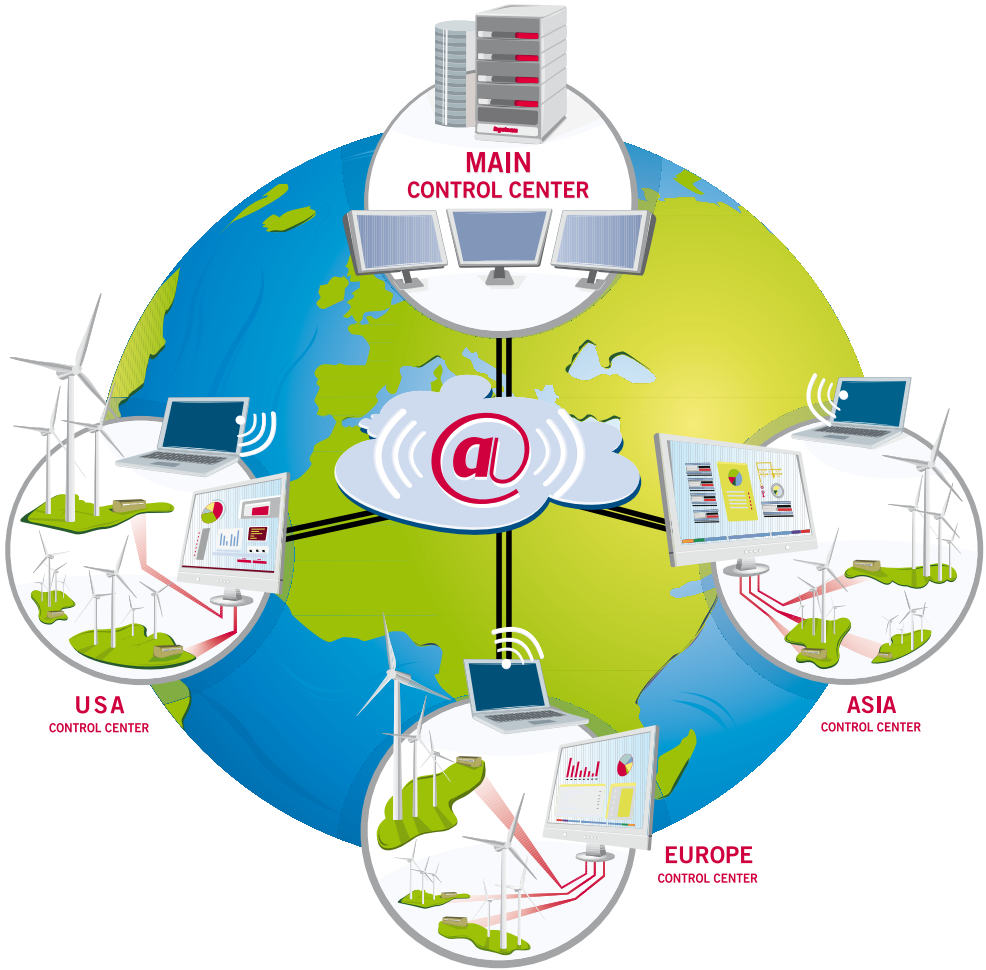
It is also possible to monitor the voltage, current and temperature of each one of the batteries or super capacitors used in the power storage system. This ensures that the status of each battery or super capacitor is known at all times, thereby always **guaranteeing correct system operation**.

## Features

- **Complete integration** into a single system.
- **Open system**.
- **Scalable** and flexible, thanks to its **client/server** architecture.
- Advanced tools for **Operating, Optimization and Analysis**.
- Generation of advanced **KPIs**, online and historical data.
- Integration with **maintenance and ERP** systems (SAP, Maximo).
- Dispatch Centres and **power or voltage control**.
- Wind and production **forecasts**.
- **High availability** configurations: redundancy and **100% data integrity**.
- Total connectivity even with **low bandwidth** communications.
- Secure **Web** operation.
- **Experience**: more than **15 years** supplying solutions and support to the principal markets (**USA, China, Spain, France, Korea, Mexico, Australia...**).
- More than **6,000 MW** distributed in more than **250** wind farms.



# Integrated Wind Farm Management



## Ingesys®Wind IT

### Optimum wind farm operation and integration

The Ingesys®Wind IT solution makes it possible to integrate into a single system all the operating, analysis and management requirements of all the developer's wind farm portfolio, regardless of global location or technology.

This scalable, robust, modular standards-based architecture makes it possible to adapt the system to ongoing customer requirements, thereby guaranteeing the investment made.



### Commissioning

- Quality audits on the WTG subsystem installation and integration.
- Pre-commissioning tasks.
- Commissioning tasks.

### Warranties

- Control of assets and asset warranty periods.
- Field service for equipment under warranty, with guaranteed intervention time.
- Control of asset upgrading, modifications and / or changes.
- Warranty extension.

### Preventive and Corrective Maintenance

- A number of component field preventive maintenance options.
- Component repair with guaranteed response times.
- Modification and installation of new components in machines in operation.

### Retrofits

- Retrofit design.
- Retrofit execution.

### Logistics / Spares

- Minimum stock maintenance.
- Stock design based on critical components.
- Field installation of spares with guaranteed response times.



# Services



Ingeteam's commitment to customers does not end with product delivery. Collaboration and service are provided throughout the whole product lifetime. In this way, maximum performance is achieved by facilitating **commissioning**, performing **integrated maintenance** and supporting the wind farm management and **operation**.

Ingeteam offers global technical services, with bases in Europe, Asia and North America, working alongside customers to support their global expansion.





***Ingeteam***

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