A large white wind turbine is shown from a low-angle perspective, looking up at the tower and the blades against a clear blue sky.

# Wind Energy

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Sweep  
the future



**The wind energy sector has become the most mature of all renewable energy sectors, especially the part of the industry dedicated to offshore wind.**

Becoming one of the pillars of the global energy transition, the need to work with safe and efficient means in the installation, maintenance and repair of wind turbines and related infrastructure will become necessary.

# 1

## WIND ENERGY: DEFINITION

**The air has mass and, when in motion, causes kinetic energy by the effect of air currents that can be transformed into electricity.**

This kinetic energy is harnessed by means of wind turbines, whose blades, attached to the rotor, are pushed by the aerodynamic effect, turning the rotor of the generator which, through the power train, produces electrical energy.

Subsequently, what wind farms do is evacuate the electricity produced from their processing center by means of a power line to a distribution substation, which is supplied with the energy produced, which it provides to the end user.

**It is therefore a clean and inexhaustible energy source, which reduces greenhouse gas emissions and preserves the environment.**

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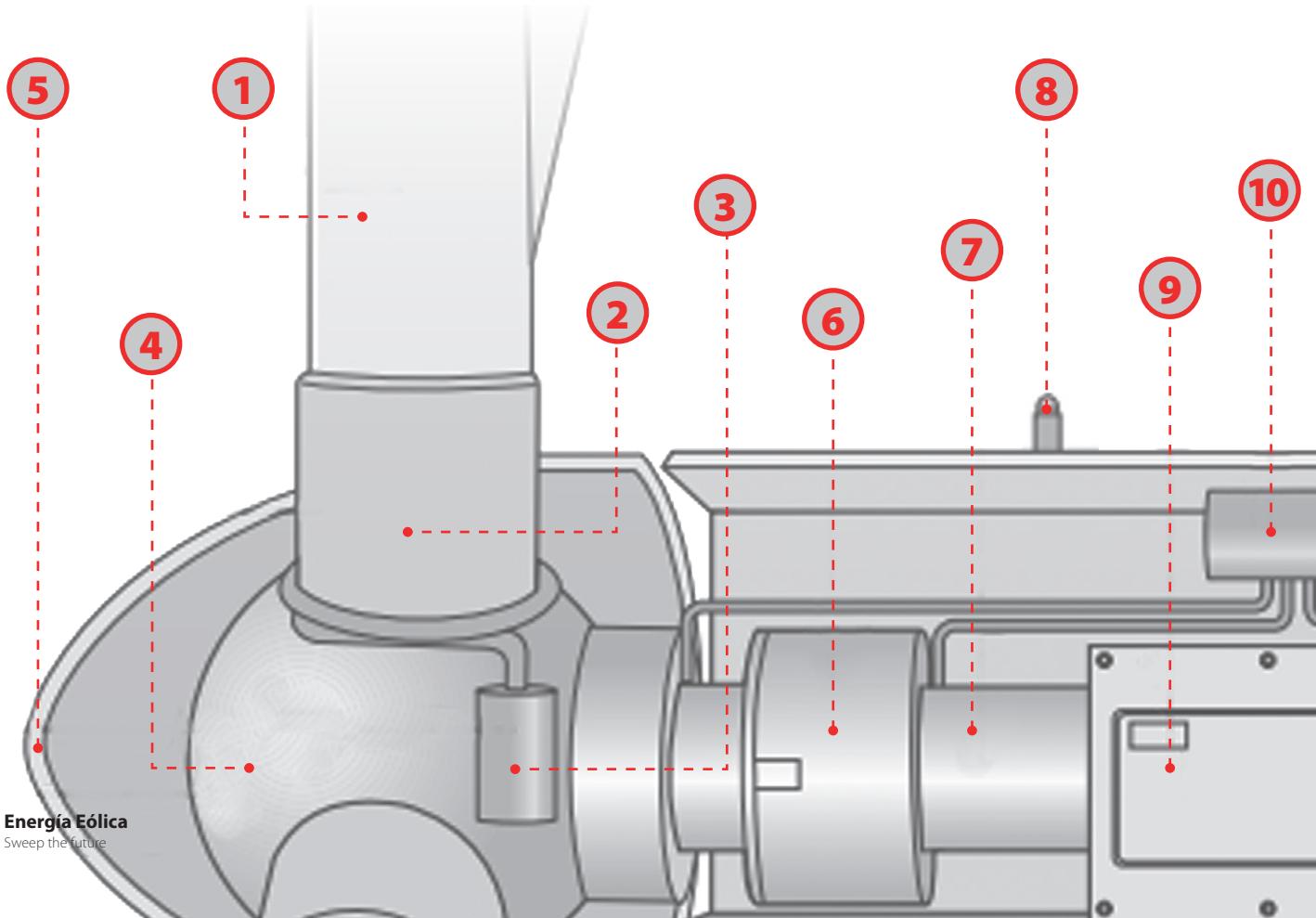
**The wind energy,  
is a clean and  
inexhaustible  
energy source, which  
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gas emissions  
and preserves the  
environment**

# 2

## WIND TURBINE PHYSIOGNOMY

As we see in the image above, the wind turbine consists of several parts:

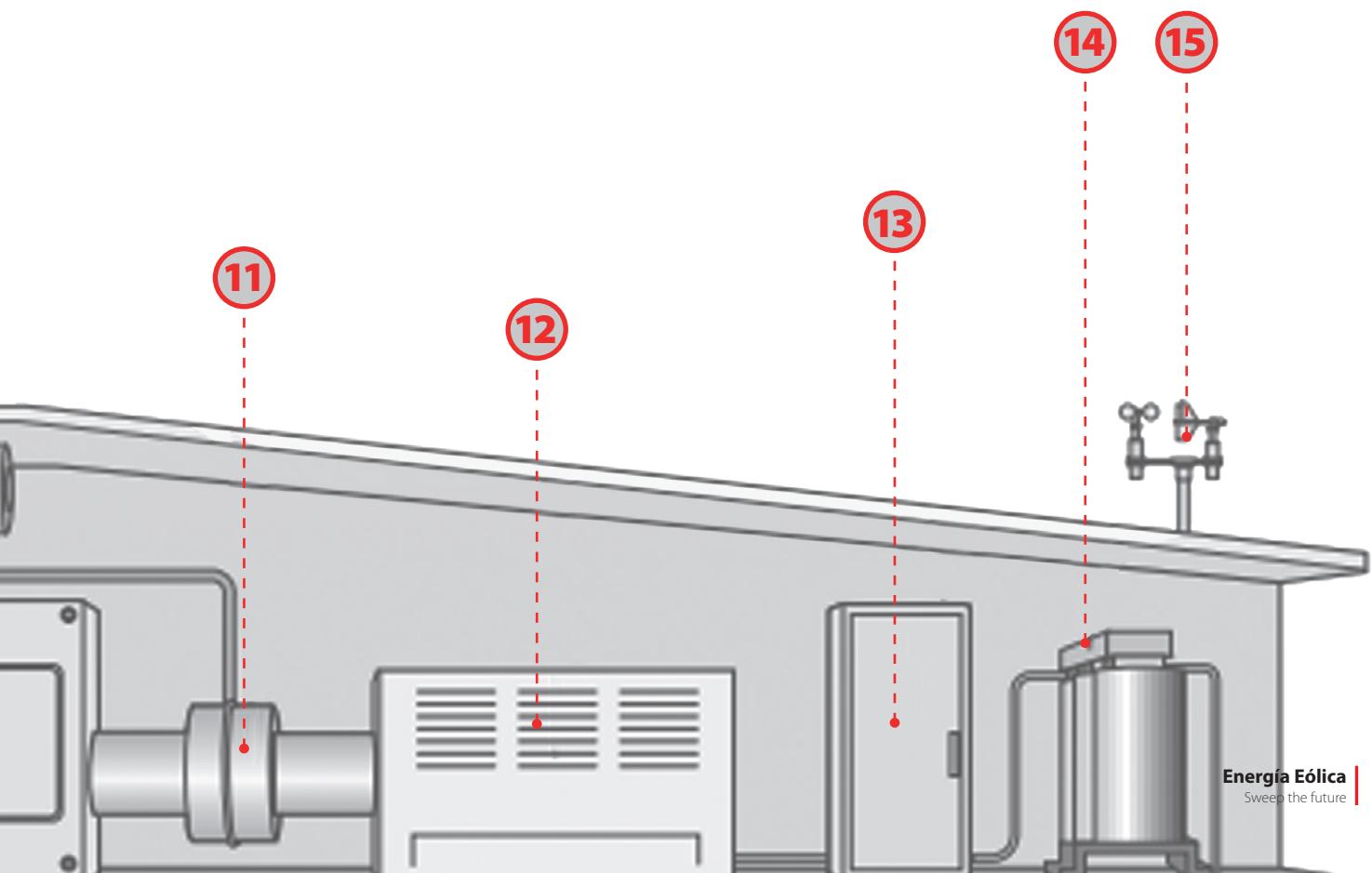
- 1. Blades:** These are aerodynamic profiles like NACA profiles, which capture the wind and transmit its power to where the hub is located.
- 2. Shovel holder:** Support where the blades are attached so that they fit perfectly.
- 3. Pitch Actuator:** A system that orients the blades to get the highest possible wind.
- 4. Hub:** It is a cylindrical component on which the low-speed shaft of wind turbines rests and rotates.
- 5. Hub Cover:** Covers the wind turbine's nose to prevent damage to the inside.

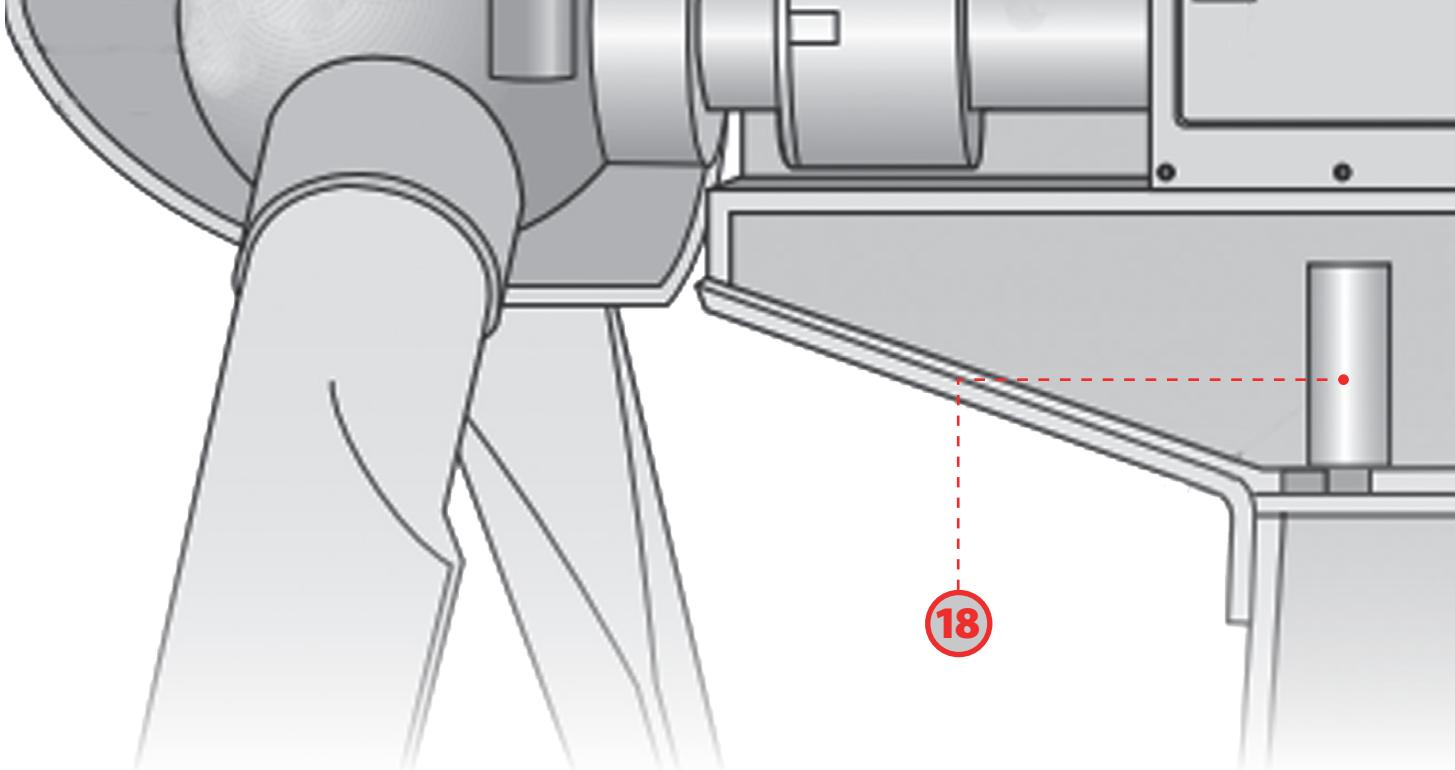


6. **Main bracket:** Acts as a support between the rotor and the main shaft (slow shaft).
7. **Low-Speed/Main Shaft:** The one that joins the hub with the multiplier. It allows the kinetic energy to be passed in the multiplier.
8. **Signaling light:** Light to signal the wind turbine and prevent air accidents.
9. **Multiplier:** It is a box that works by modifying the speed received from the hub. You can rotate the axis fast between 50 and 75 times faster than the slow one.
10. **Hydraulic element cooler:** The entire mechanism that works in a wind turbine generates heat, which is why it takes a cooling unit, an electric fan, to keep the generator

**Pitch actuator is the system that orients the blades to get the highest possible wind**

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and other elements cool. It also contains a coolant fluid that refreshes the oil used by the multiplier.

**11. High-speed shaft and mechanical brakes:** Located at the outlet of the multiplier, it allows to operate the generator or alternator. It can rotate to 1500 rpm. Accompanied by mechanical brakes to prevent accidents and to be able to stop the machine.

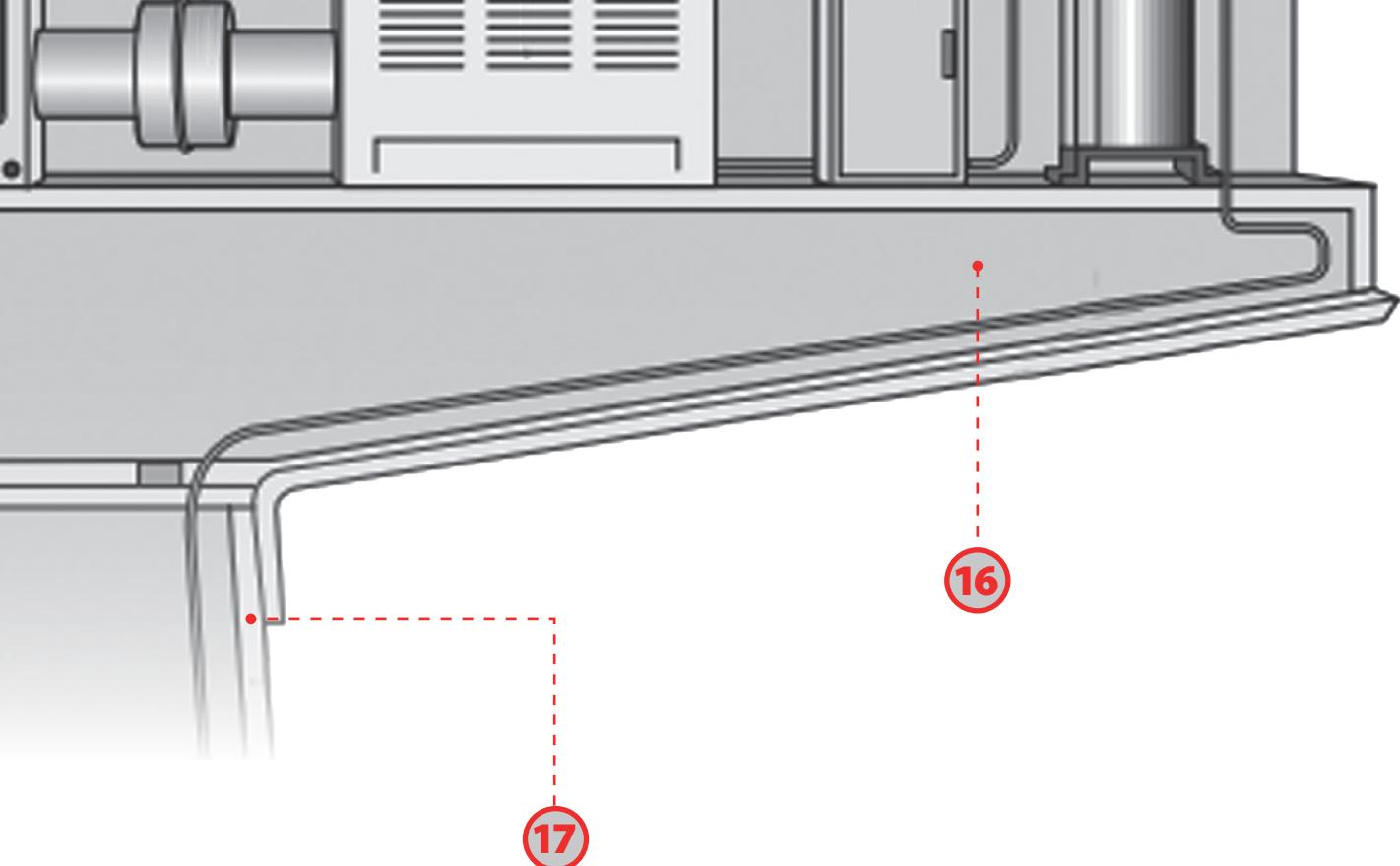
**12. Electric Generator:** Acts as an alternator modulating the energy that enters the multiplier transforming it into electrical energy. It is commonly an induction generator, whose power can range from 500 kW to 1500 kW.

**13. Electronic controller:** It is a computerized device that continuously monitors the status of the wind turbine.

**14. Transformer:** It is responsible for transforming the low voltage that comes out of the generator and increases it to medium voltage. It can be in the nacelle or in the tower. Offshore they are usually located in the gondola.

**All these parts  
are protected  
by a metallic  
structure called  
Nacelle**

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**15. Anemometer:** Essential to measure wind speed and obtain data for the proper operation of the wind turbine.

**16. Nacelle structure:** May have different shapes depending on the manufacturer. It serves to cover all the elements inside.

**17. Tower:** Vertical structure that supports the nacelle.

**18. Orientation mechanism:** It is a kind of sensor that is activated through an electronic controller and captures the direction that the wind carries by means of a vane and consequently orients the wind turbine in the direction of higher wind speed.

# 3

## OFFSHORE WIND STRUCTURES

Offshore wind industry has greater growth potential, as wind resources are 30 – 50 percent higher at sea than on land.

**The infrastructure required for the installation of a offshore wind farm is more complex than on land.**

You must take into account aspects such as:

- Anchoring systems
- Underwater wiring
- Substation structures
- Electrical systems

Among the types of anchorage systems there are two: fixed and floating.

### 3.1 FIXED

#### 3.1.1 Monopile

They are used in offshore wind farms with a maximum depth of 15 meters offshore. It is a cylindrical steel structure that is buried up to 30 meters, on sandy or clay soils, in order to hold the tower. An important advantage of this type of foundation is that it does not need the seabed to be conditioned. On the other hand, it requires heavy piloting equipment, and this type of foundation is not advised in locations with many blocks of ore on the seabed. Monopile foundations can be found in 81% of the offshore wind farms built today.

#### 3.1.2 Gravity-Based Foundation (GBS)

It is constituted by a large foundation of about 15 meters in diameter, which rests on the seabed, and can be built in areas at most 30 meters deep. Since you have to create a cement base (or steel as the case may be) it is necessary to pre-condition the land where it will be installed. This process allows gravity anchors to be placed on any type of seabed. They still account for 5% of offshore wind farms.

**These structures are installed at depths of up to approximately 30 meters.**

**The infrastructure required for the installation of a offshore wind farm is more complex than on land**

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## **Space frame: For depths of 25 – 60 meters**

### **3.1.3 Tripod**

The tripod foundation is inspired by the lightweight three-legged steel platforms for marine oil fields in the oil industry. From the steel pile under the turbine tower a steel structure departs that transfers the efforts of the tower to three steel piles. The three piles are nailed from 10 to 20 meters on the seabed, depending on soil conditions and ice loads.

### **3.1.4 Jacket**

It is a structure of 3 or 4 anchor points, being able to reach 60 meters in length. They can be installed on all types of beds, except if they are rocky. These supports are fixed to the ground by stilts.

### **3.1.5 Tri-pile**

It is a type of support structure like the tripod structure. The piles of this type of structure are of greater dimensions, so they give great stability to the whole. The function of this triangular base is to distribute vertical forces and support greater bending resistance.

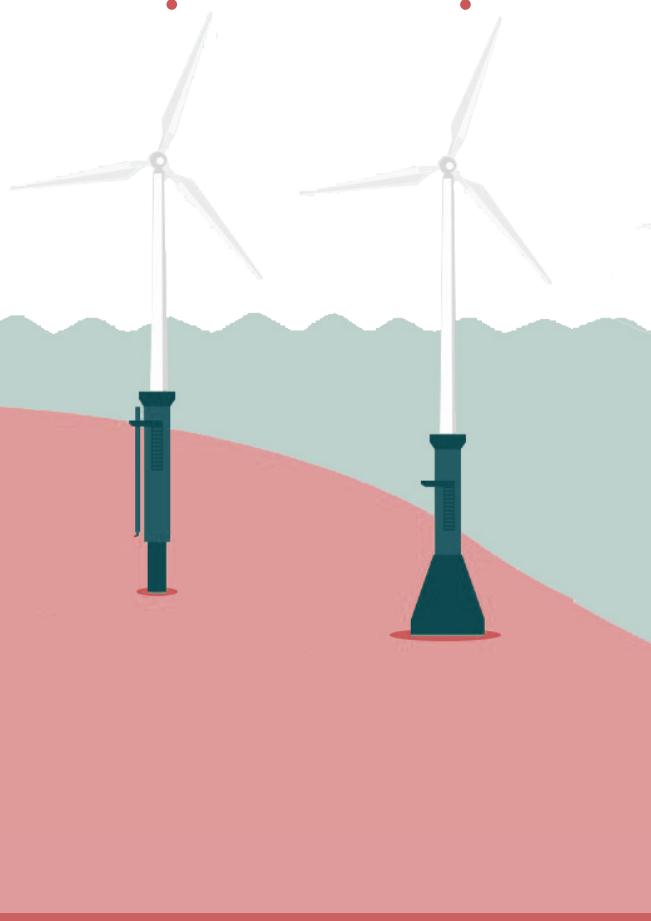
The transition piece is responsible for joining the three piles. In addition, in the center, a connection system is placed to link the wind turbine tower with the support structure, this makes the joint much easier.

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**Among the types of anchorage systems there are two: fixed and floating**

This type of foundation does not need the seabed to be conditioned, which is an important advantage

### MONOPILE

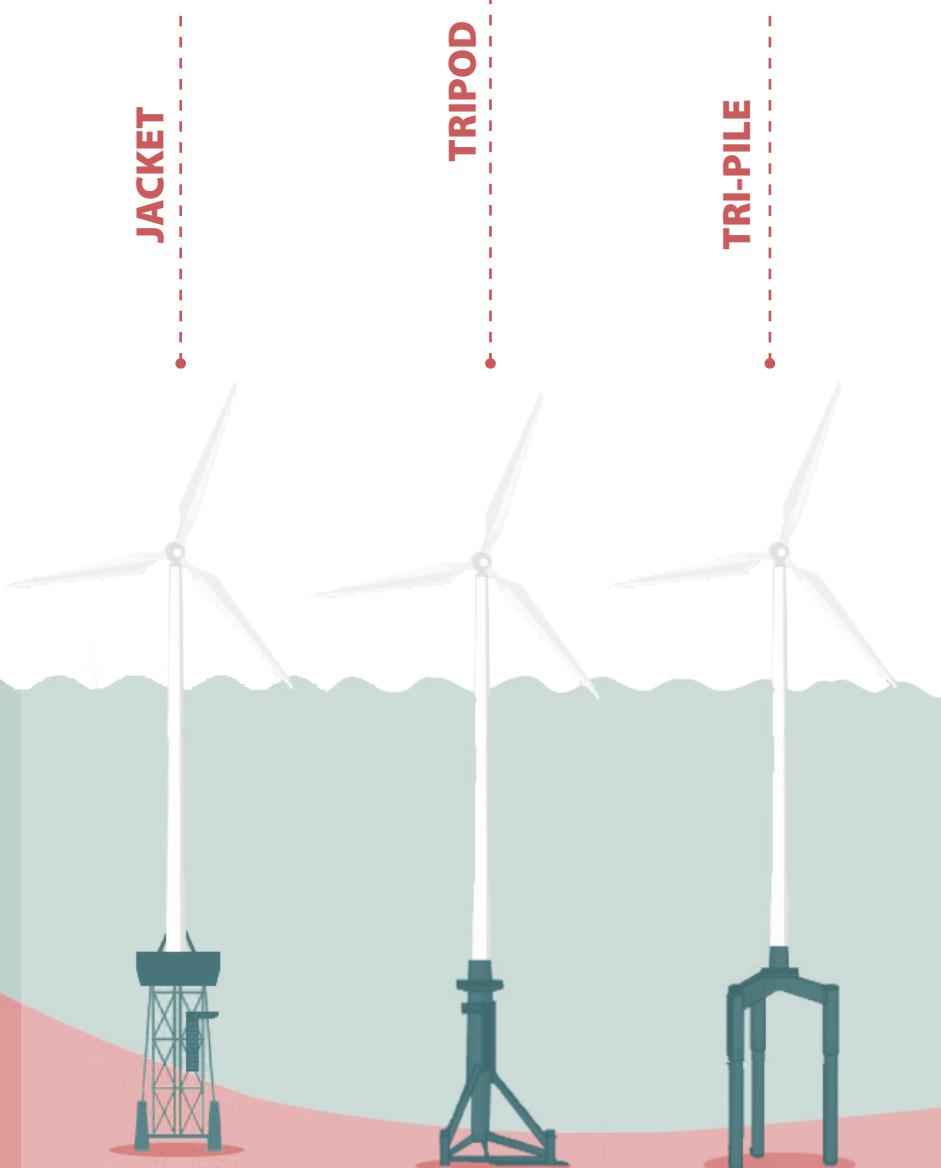


**FIXED** For depths  
**up to 30 meters**

It is necessary to pre-condition the land where it will be installed. This process allows gravity anchors to be placed on any type of seabed

Structure that has been worked on and greatly improved over time, thanks to the experience gained in the offshore O&G sector

### JACKET



**FIXED** For depths  
**from 25 to 60 meters**

This type of structures are able to reach 60 meters in length. They can be installed on all types of beds, except if they are rocky

### TRIPOD

The piles of this type of structure are of greater dimensions, so they give great stability to the whole

### TRI-PILE

## **3.2 FLOATING**

Currently they are in the testing phase, they are not yet ready to be marketed.

These include:

### **3.2.1 Spar**

It is a cylindrical steel or concrete structure. Within it are located watertight structures. The ones at the bottom are filled with sand or water ballast, while the top is filled with air, so that these structures stay afloat and upright. In turn its foundation is maintained through anchor tensioners. These structures are mostly from 100 meters deep.

### **3.2.2 TLP (Tension Leg Platform)**

These structures are used from 50 meters deep. They consist of a platform designed from a large central column and arms connected to tensioners that ensure the stability of the structure. These tensioners are solid and high strength, usually made of steel. They are usually placed between 2 or 3 wires on each leg of the base. Since these cables are always in tension, their stability and buoyancy are ensured, however, they are complex anchorage systems that cannot be installed on any bottom.

### **3.2.3 Semi-sub**

This type of structure consists of 3 columns joined together by arms, these columns provide the hydrostatic stability necessary to keep the structure stable in the water. The foundations are kept in balance by tensioners. They are systems that are not suitable for areas of strong swell and extreme conditions, as it would generate a constant movement of the assembly and a malfunction of the wind turbine.

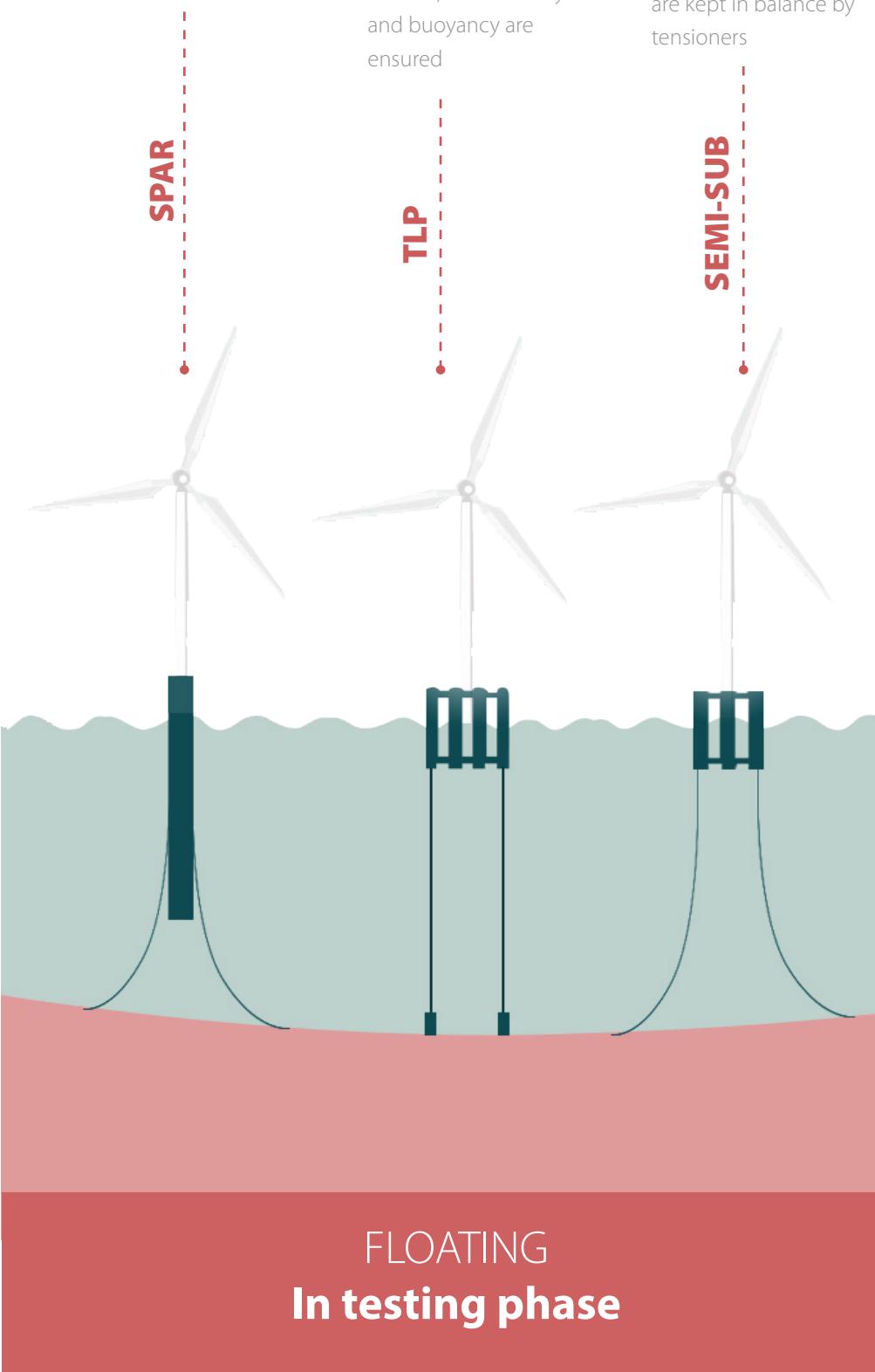
**Floating structures  
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Watertight structures, the ones at the bottom are filled with sand or water ballast, while the top is filled with air, so that these structures stay afloat and upright

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This structure consists of 3 columns joined together by arms, these columns provide the hydrostatic stability necessary to keep the structure stable in the water. The foundations are kept in balance by tensioners



# 4

## MAINTENANCE AND REPAIR OF WIND TURBINES

### 4.1 TURBINES

Turbine maintenance processes are important to ensure their long-term productivity. The activity is divided into preventive maintenance (scheduled) and corrective (unscheduled) work. Most preventive work will typically be carried out during periods of low wind speed to minimize the impact on production. However, in practice this is not always possible.

Corrective service is performed in response to unscheduled outages and is often considered more critical due to the accumulation of downtime until the failure is resolved.

Typical maintenance includes inspection, bolted joint verification, and replacement of worn parts (with a shorter service life than project life).

Unscheduled interventions are in response to events or failures. These can be proactive, before the failure occurs, for example, by responding to condition monitoring inspections or reagents (after a failure has occurred that affects generation).

### 4.2 BLADES

**Inspection and repair of shovels consists of inspecting the condition of the blades and replacing or repairing them in a timely and cost-effective manner.** Issues such as leak edge erosion have been the source of availability problems in the industry and proactive blade inspection and its preventive repair is now widely pursued in response.

### 4.3 FOUNDATIONS AND ANCHORS

**Foundation inspection and repair identifies and addresses corrosion and structural problems above and below the waterline.** Maintenance consists of visual inspections, non-destructive testing (NDT) and seabed inspection work, and repair service work is completed when needed. Inspections focus on structural integrity, lifting, safety equipment, corrosion protection, and protection against undermining.

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**The typical maintenance of the turbines includes inspection, bolted joint verification, and replacement of worn parts**

Regular inspections are required on secondary steel structures such as stairs, gates, and platforms. In some places, it is necessary to clean to remove guano from seabirds, which can be a serious danger to health and safety.

Inspections and surface studies include internal monopile inspections of cement or bolted connections and splash zone inspections. Activities requiring underwater operations may include infrequent structural cathodic protection inspections and weld inspections.

Diving is necessary only in exceptional circumstances and efforts are being made to maximize the use of safer remote techniques.

#### **4.4 OFFSHORE SUBSTATION**

**Maintenance and service of the offshore substation consists primarily of non-intrusive inspections** of upstream switchgear and transformers, transformer oil sampling, inspection of foundations and upstream structures and the resulting infrequent service interventions.

**The maintenance and service of the offshore substation consists primarily of non-intrusive inspections**

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# 5

## EGA GROUP SOLUTIONS

### 5.1 CONTROLLED TIGHTENING

**In both the installation process and the maintenance and repair of the turbines, tightening, inspection and replacement of bolted joints must be carried out.** This requires the correct torque to be properly adjusted for such joints, avoiding endangering wind structures, and the safety of other operators.

In the EGA group we have developed extensive experience in the field of controlled tightening, which has allowed us to develop a wide range of torque wrenches and screwdrivers, calibrators, and adapters.

Among the type of controlled tightening tools we manufacture are:

- Torque wrenches
  - Analogic reversible
  - Digital checking QC
  - With Wireless data communication
  - With angle and torque measurement
  - Interchangeable heads
  - Battery-on
  - Hydraulic
- Angle adapters and meters
- Torque multipliers
- Dynamometric screwdrivers and nutrunners

#### 5.1.2 EGATORK control system

The weather conditions of offshore wind farms tend to be adverse because they are areas with heavy winds that can severely affect wind turbine structures, so it must be very precise in the tightening torque applied to existing bolted joints.

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**In both the installation process and the maintenance and repair of the turbines, tightening, inspection and replacement of bolted joints must be carried out**

Therefore, from the EGA group we have developed the **EGATORK CONTROL SYSTEM**, a remote tightening torque management system, based on software and wireless automated tools, with the aim of:

- Ensuring the quality of the assemblies
- Get absolute traceability and subsequent certification
- Optimizing production and improving safety

## **EGATORK Control System is a remote tightening torque management system, based on software and wireless automated tools**

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## 5.2 ANTI-DROP® TOOLS

When installing a wind turbine, as well as performing maintenance and repair operations on them, it is inevitable to carry out these works at height. This is a need and obligation to ensure the tools to be used in order to prevent their fall.

The consequences of a tool's fall can be very severe, as gravity increases the strike force with which it can hit the wrench on a structure or person.

**At EGA Master we are aware of this, a whole range of ANTIDROP® products and solutions that have been designed to control and prevent object dropping when working at height.**

These products have been designed to allow a comfortable, productive, and efficient use of tools while assuring workers' and equipment safety against object dropping.

On the one hand, we offer belts and retractable lanyard with carabiner.

### 5.2.1 Belts and wrist bands

They are designed to fit the worker's body, to enable user freedom and provide maximum tool fixing points, and to make internal hooks safely to retain tools while the operator is climbing or moving location.

### 5.2.2 Lanyards

They are designed for maximum safety and to give an optimum working freedom. The many systems provide all the necessary solutions for a safe and comfortable use at heights, and at the same time, they ensure a better shock absorption.

### 5.2.3 Premium tools for industrial use

On the other hand, we offer different ranges of ANTIDROP® premium tools for industrial use: non-sparking, insulated 1000V, ESD, non-magnetic. These have attached a thermo-



shrink system and retention ring, following DROPS recommendations. Such system is much effective and safe, and also it avoids damages on the properties of the tool.

It is true that most of the tools can be turned in ANTIDROP®, we discourage to put sleeves oneself. It is not economic nor safe, since one must put it registering temperature, time, diameter of sleeve and length of sleeve. And then, TEST it.

If the tests succeed, then for that particular code the design parameters are settled, and the rest of ANTIDROP® tool units of that code are manufactured according to these parameters.

Without having made TESTS to the design parameters, they can never assure that the outcome will perform properly in the first fall. They can't assure safety; if they make the tests, it will cost them much more than buying complete ANTIDROP® tools.



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**ANTIDROP® products  
and solutions have  
been designed to  
control and prevent  
object dropping  
when working at  
height**

### **5.3 TOOL CONTROL SYSTEM**

While ANTIDROP® tools are ideal for the wind turbines maintenance and repair operations, we also see an efficient and safe management of tools inventory.

**Therefore, we have also developed different tool control systems, essential in many applications, especially in cases where “lost” or forgotten tools increase risks and decrease security.**

Therefore, we offer as a solution an exclusive and personalized tool control system avoiding the loss or loss of these.

**The EGWARE software allows to control which tool is taken from or returned to the stock**

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#### **5.3.1 Software EGWARE**

**EGA Master offers a unique stock control system, that will control which tool is taken from or returned to the stock.**

- A. The user logs in with its username and password.
- B. The worker picks up the tool that he will work with.
- C. The worker scans the barcode.
- D. The software detects that the tool has been taken.
- E. The worker returns the tool and scans the code again.
- F. The software detects that the tool has been returned.

#### **5.3.2 Smart opening system for drawers**

Avoid mistakes in the tool selection, increasing efficiency and therefore, productivity.

**Each door is assigned a radio frequency card that is passed through the RFID reader of each roller cabinet allowing the opening and locking of the drawers.**

Laser technology that detects errors such as a drawer that has

not been completely closed.

LEDs in the drawers facilitate the visual recognition of the status of each drawer (open / locked).



**The smart  
opening system  
for drawers  
avoids mistakes  
in the tool  
selection**

## 5.4 1000V ISOLATED TOOLS

These are used for work in voltage or close to active parts that are, whose rated voltage reaches 1000V in alternating current and 1,500V in direct current.

There are two ways to generate the 1000V isolated layer:

- **By immersion:** Insulated tools manufactured by immersion process have two layers of insulation in contrasting colors (red and yellow, or orange and yellow). In addition, the inner layer also acts as a safety indicator. When this layer becomes visible through the outer layer, the tool is no longer safe to use and must be replaced.
- **By injection:** What is done is inject molded handles with insulating material.

While design may be more of a personal preference, it is necessary that they comply with IEC60900

### 5.4.1 IEC 60900

While they are said to be 1000V isolated, the regulations require that they be tested at a voltage 10 times higher, and that they satisfactorily meet 4 additional tests:

- **Adherence test:** Tests the adherence of the insulating material to the metal elements of the tool.
- **Impact test:** Tests the resilience of the insulating part to external impacts and falls.
- **Heat Resistance propagation test:** Tests whether the insulating material does not propagate flames.
- **Dielectric Penetration Tests:** Measures and leakages through the insulated material



**Our insulated tools follow the verification process indicated above, and therefore meet the requirements indicated by the international standard IEC 60900.**  
These offers:

1. The double insulation of hard-soft PVC provides maximum adherence and safety in case of possible unforeseen events.
2. Anti-shock guards and ends.
3. Un-erasable laser marking.

Therefore, they are safe for use with or near objects under voltage (up to 1000V A.C. or 1500V C.C). **However, it is important to remember the following points:**

1. Never use tools under voltage if they present pores, fissures, encrusted elements or if the yellow insulation layer is visible.
2. Insulating floors and safety shoes are recommended to work under voltage.

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**EGA Master  
1000V insulated  
tools meet the  
requirements  
indicated by the  
international  
standard IEC 60900**

3. Avoid contact with water while working under voltage.

4. Do not ever directly touch any item that may

Finally, since most tools can be designed to have some isolated part (commonly the handle) to be used with or near objects under electrical voltage, we can develop custom insulated tools, and also offers the largest range of 1000V in the world.

#### 5.4.2 The world's widest range

**We have the widest range in the world in premium industrial tools, isolated 1000V.**

- All kinds of tools for working with cables
- Pipe cutters and pipe tools
- Open and ring wrenches in millimeters and inches
- Long and short socket wrenches, 6 edges, 12 edges, in mm and inches
- Torque wrenches
- 1000V insulated non-sparking tools

#### 5.4.3 Tailor-made development and manufacturing

**Thanks to our long experience and knowledge in the most demanding industries, we develop and manufacture 1000V custom insulated tools that fit the specific needs of each customer.**

In addition, once manufactured they are subjected to the 5 tests set by IEC 60900, thus ensuring that the quality of our 1000V insulated tools are suitable for working near, or in environments where there is voltage up to 1000V AC and 1500V DC.



#### **5.4.4 Other safety elements for work under high-voltage**

- Insulating blankets
- Insulating carpets
- Insulating gloves and testers

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**EGA Master can develop tailor-made insulated tools, and also offers the world's widest range of 1000V insulated industrial Premium tools**

## 5.5 TITANIUM TOOLS

In the case of using synchronous motors, the magnetism of permanent magnets may require the use of a magnetic tool. In EGA Master have developed a range of tools of Titanium 6Al-4V. Such alloy is the best currently available for critical and special applications that require great mechanical capacity, combined with characteristics that another alloy cannot achieve, such as that of being non-magnetic, etc.

Among the tools that make up our wide range of Titanium amagnetic tools are:

- Adjustable, fixed, hexagonal and double offset ring wrenches
- Torque wrenches
- Pliers and pincers
- Socket wrenches
- Screwdrivers
- Socket bits
- Cutting tools and hammers



# 6

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By EGA Master