The new generation windmill

GUAL StatoEolien

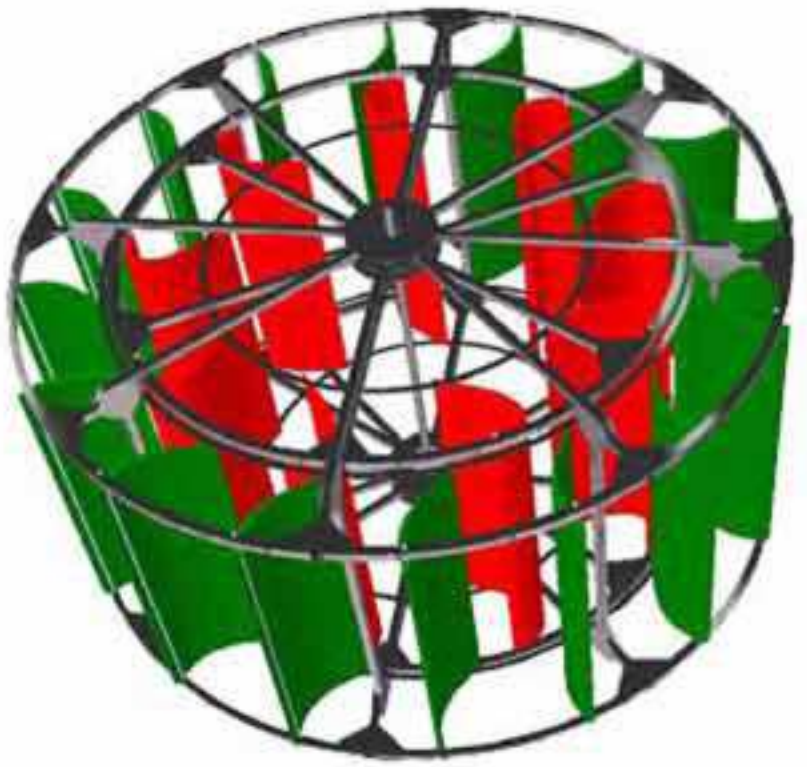
GSE4/1.5 - GSE8/3

Technical documentation

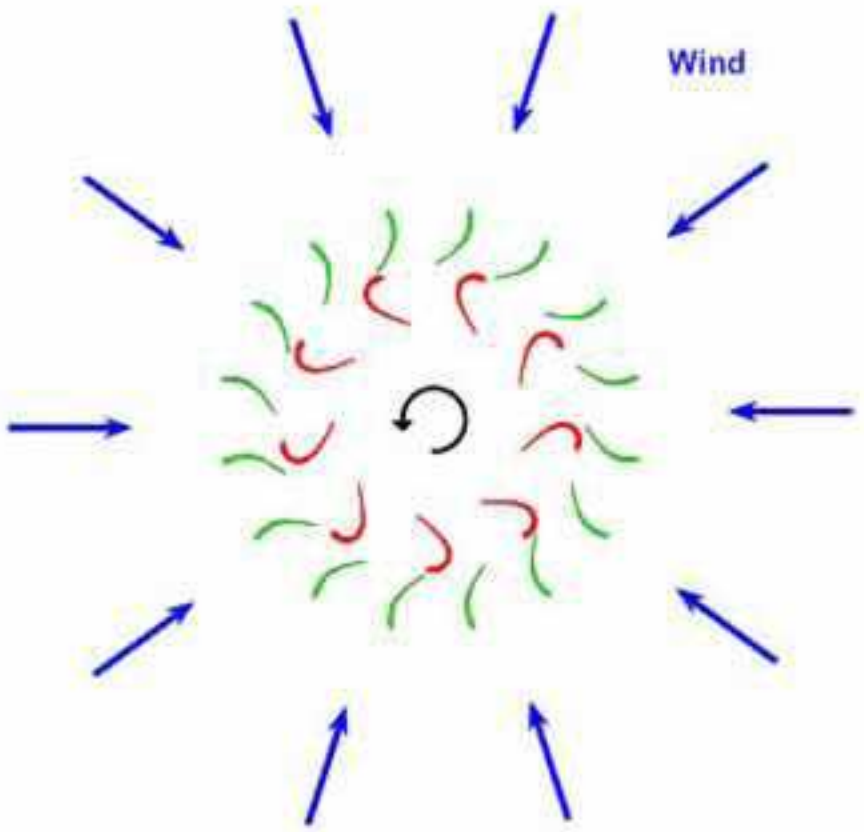
Summary:

Introduction

The " STATOEOLIEN " is a vertical axis windmill consisting of a stator (the concentrator) and a rotor (generator) fit to urban areas implantation. It offers the possibility to produce renewable energy within cities while allowing noiseless, aesthetic integration in the architecture of the buildings. It is well adapted to the highly turbulent wind in urban areas as well as meeting the constraints of modern architectural demands.



I/ Aerodynamic Characteristics

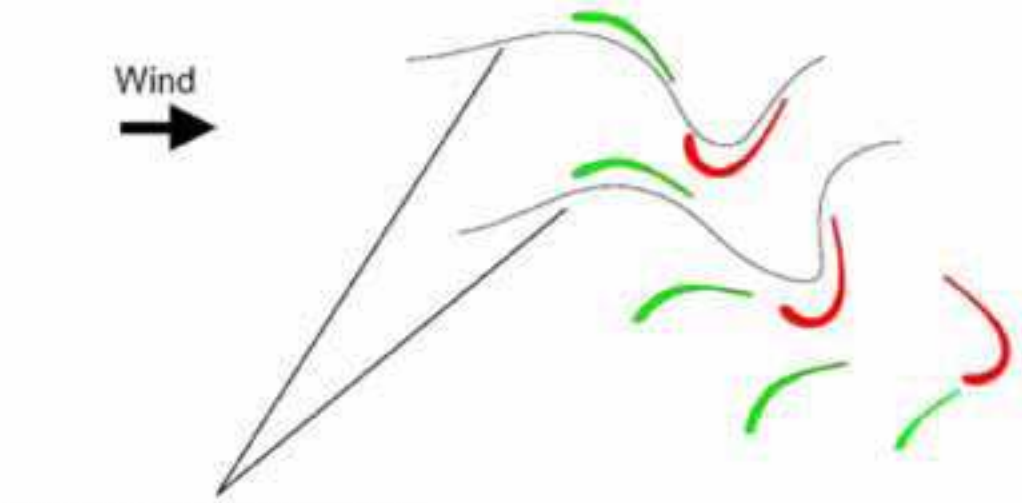


The axial symmetry of the " STATOEOLIEN " make it fully independent from wind direction. Indeed, the fixed blades of the stator and the mobile blades of the rotor are symmetrically set around the vertical axis of the windmill, favouring no particular direction. This result in an optimal and predictable behaviour whatever the wind direction is. This is of particular interest in cities where the air flow is highly turbulent and winds exhibit frequent shifts in direction.

Principle of the stator:

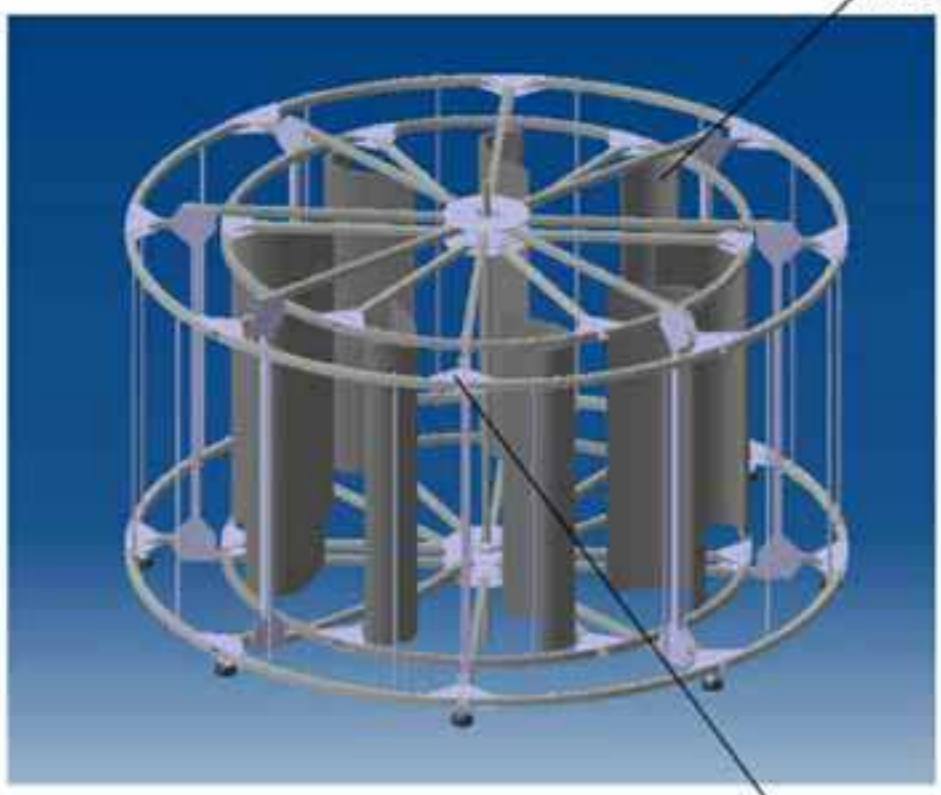
The use of a fixed stator brings three main advantages:

1/ Firstly, the stator allows to channel more effectively the air flow on the under-surface of the rotor blades to generate the highest power.



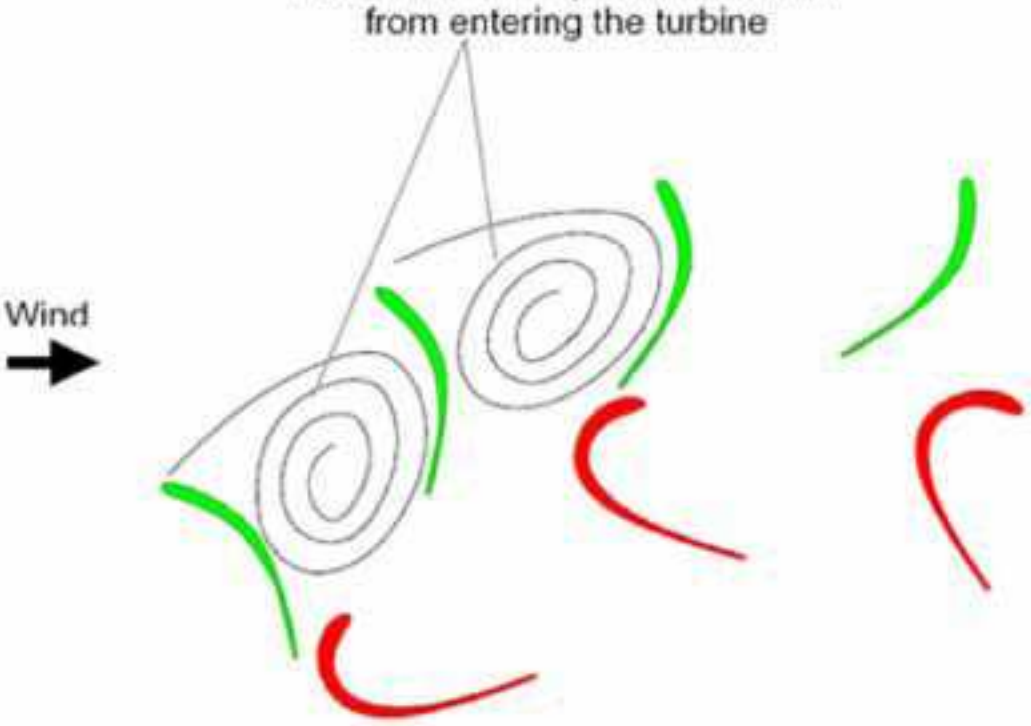
Deviation of the flow to the windward rotor blades

2/ The stator allows to integrate the engine within a tubular, rigid structure which permits the STATOEOLIEN to withstand very strong winds. This structure surrounds the rotor and holds it firmly, withstanding all the strains and generated vibrations (eddy on the blades, periodical variation of the torque applied to the shaft...).



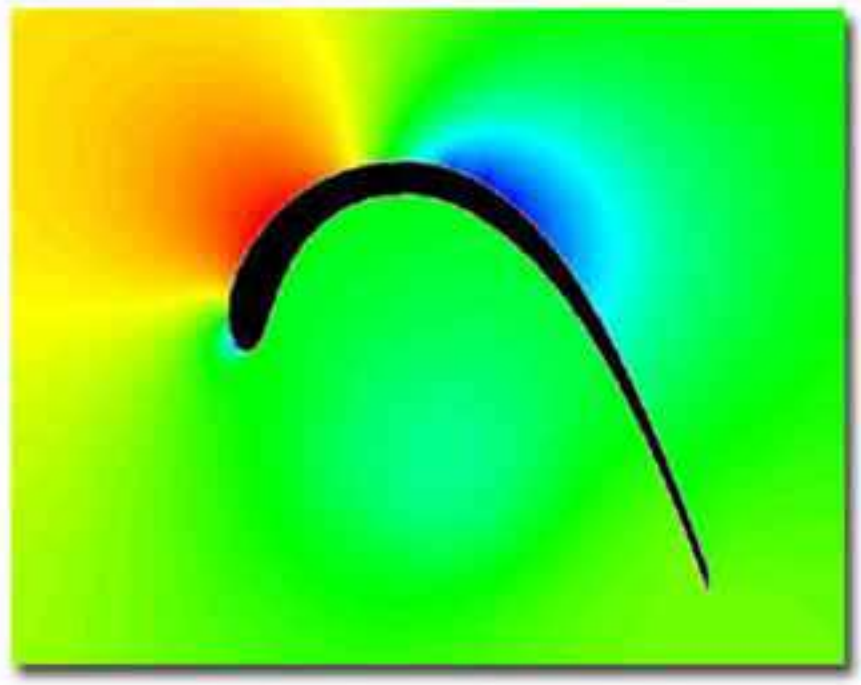
3/ When the rotor blades show their suction face to the wind, without proper care taken, they generate a resisting torque on the shaft. This result in a decrease of the actual power. The blade of the stator are built to create in this orientation a check zone where eddy will prevent the wind from entering the engine and slowing it down.

Turbulence zones, generated by the stator in order to prevent the wind from entering the turbine

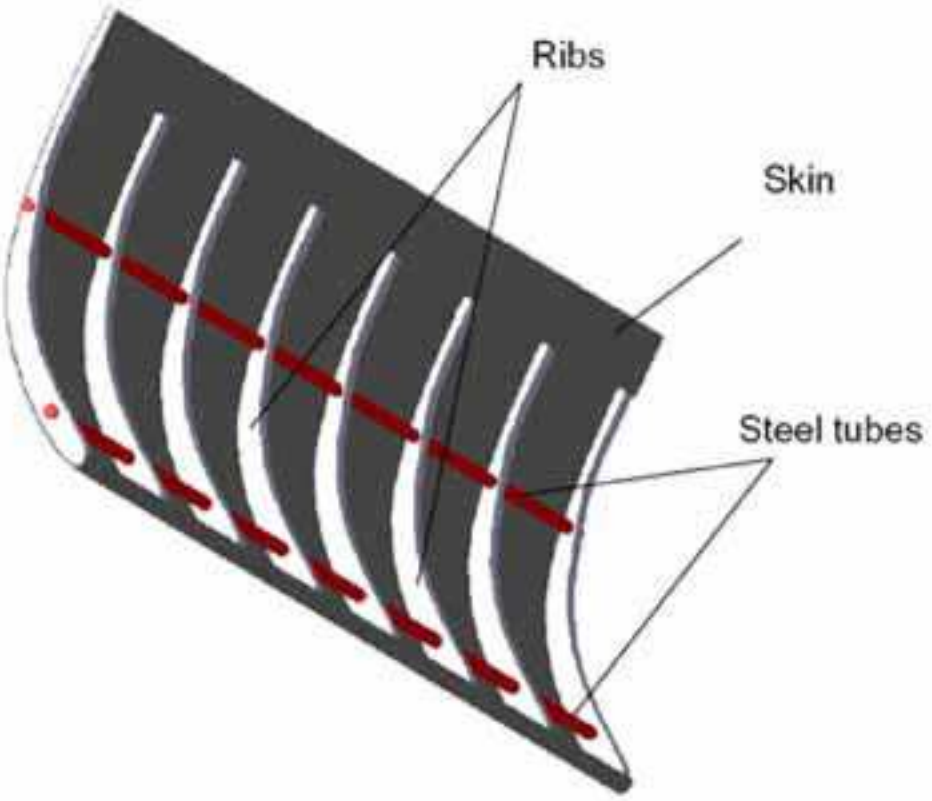


Rotor Blades and Stator Wings

The rotor blades have been conceived to generate the maximal power whatever the direction of the wind is. Their shape results from complex aerodynamic studies (numerical simulations). They are built the same way modern aeroplane wings are (rib + skin). which allow both low weight and high rigidity.



CFD Simulation of a rotor blade



Making of a stator wing

The fastening system of the blades, both rotor and stator, allow fast mounting and removal, making not only installation but maintenance easy (control, cleaning, exchange).

Summary of the aerodynamic advantages:

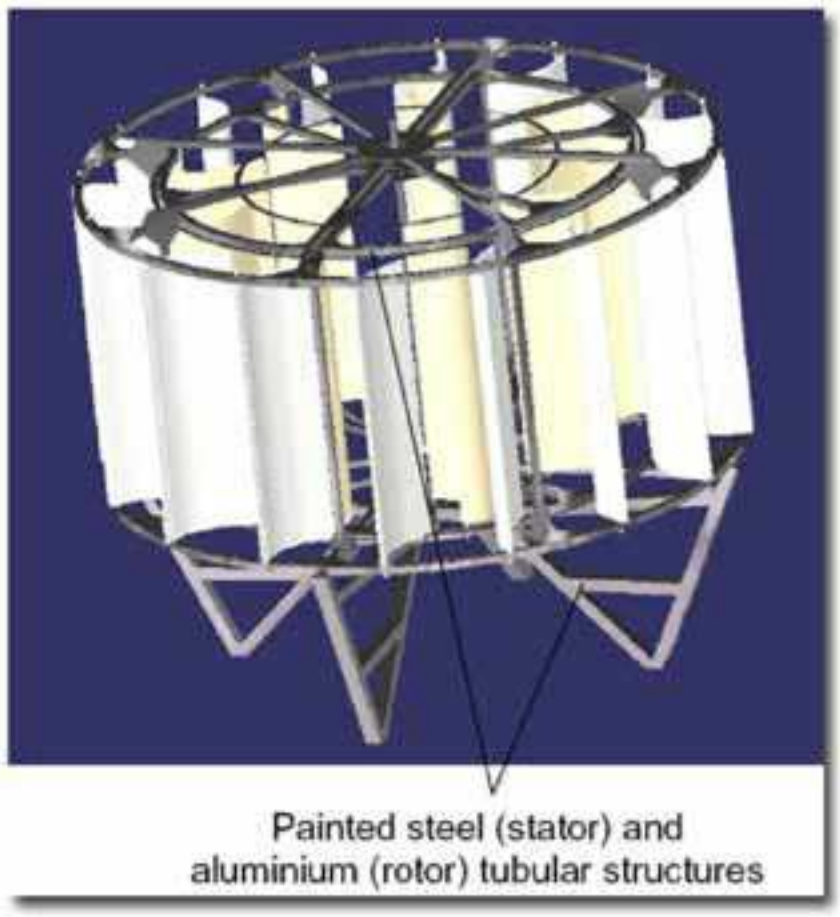
insensitivity to wind direction

insensitivity to wind strength

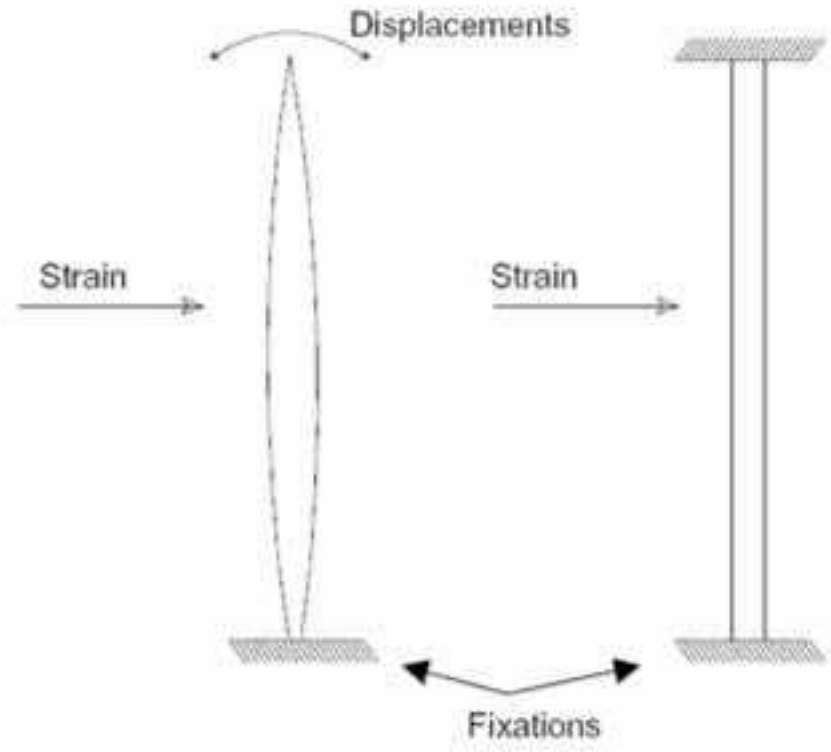
II/ Mechanical Characteristics

Rigidity of the stator structure

The tubular structure allows it to withstand winds in excess of 220 km/h while remaining compact and aesthetic (no need for cables or additional fastening systems). Furthermore, the blades, both rotor and stator, are embedded on both ends which eliminates the common problem of stability met with single-ended mounting. In fact, the mounting of an aerodynamic profile (aeroplane propeller or standard windmill blade, for example) single-ended creates a mechanical instability which in turn becomes a source of vibrations and stress on the material. Additionally, the STATOEOLIEN does not require the use of a pole when it is mounted on top of a building. However, it will be necessary when no building exist that can hold it (remote places, water pumping...)



Painted steel (stator) and aluminium (rotor) tubular structures



Comparison between single-ended (left) and double-ended (right) mounting. The one is mechanically unstable (vibrations, high stress at the embedding point). The second one, on the other hand, shares efforts and vibration evenly between the two embedding points. This leads to much higher stability.

Low weight of the rotor:

The rotor is made out of aluminium to reduce the weight and allow faster adjustment as a function of wind speed.

Ease of integration :

The compactness of the STATOEOLIEN and its cylindrical shape allows it to fit in many architectural configurations.. It can be integrated on slanted or flat roofs alike.

Examples of integration of the STATOEOLIEN.

Top: Actual test house in Caves, 66, FRANCE

Bottom: Example of integration on a building

Operation on torque instead of rotational speed :

The statoeolien operates at constant torque and not at constant speed. This leads to a decrease in the linear speed at the edge of the rotor blades. While the linear speed on a standard windmill can reach up to 400 km/h, the blade edge on the STATOEOLIEN never goes above 85 km/h thus eliminating vibrations and considerably decreasing the centrifugal strain. Besides, the low operating speed brings additional safety (emergency stop is faster) and makes it very silent.

Vibrations absorption

The entire tubular structure has been studied to generate little vibration resonance. Beyond that, the STATOEOLIEN is equipped with elastomer silent blocks in order to filter the vibrations that could be transmitted to the building (absorption of the resonant modes of the tubular structure). This results in an almost noiseless operation.

Security and low maintenance :

The STATOEOLIEN being geared toward urban areas implantation, it has to be perfectly secure. This is why it is fitted with various security equipment. On one hand it has a limitation of the operation beyond 150 km/h wind speed, on the other hand an electromechanical disk brake will stop the engine in case no current is delivered by generator or in case of abnormal vibrations (integrated detector). The stator itself improves security by limiting the access, by people or objects, to the moving parts of the rotor. Last of all, an anti-tilt security system (4 of them) equip each of the mounting legs of the engine. They eliminate the risk of toppling over during a

Insensitivity to external stress :

The stator is made out of painted steel, the rotor out of aluminium which eliminates the risk of premature corrosion or decrease in the mechanical properties of the components upon external stress like UV, wind, rain or heat, even salty atmosphere. This result in increased reliability and lower maintenance. The electromechanical parts are scaled according to the IP54 norm, against projections of water or dust.

In addition, the STATOEOLIEN has been designed to decrease the maintenance as much as possible. The bearings (auto aligning for the summit, conical for the base) are guaranteed for life and their control is made easy by a fully removable bearing casing. Maintenance of the multiplier only requires an oil change every 4 years, a complete replacement being necessary after 10 years only. The electromechanical parts must be verified once a year like the STATOEOLIEN itself. All these operations are easily done as the windmill is usually installed on a roof and on top of a pole. They can be conducted in the safest way.

summary of the mechanical advantages :

ease of integration

high reliability

low noise level

high security

low maintenance

III/ Electrical Characteristics :

The mechanical energy produced by the STATOEOLIEN can be:

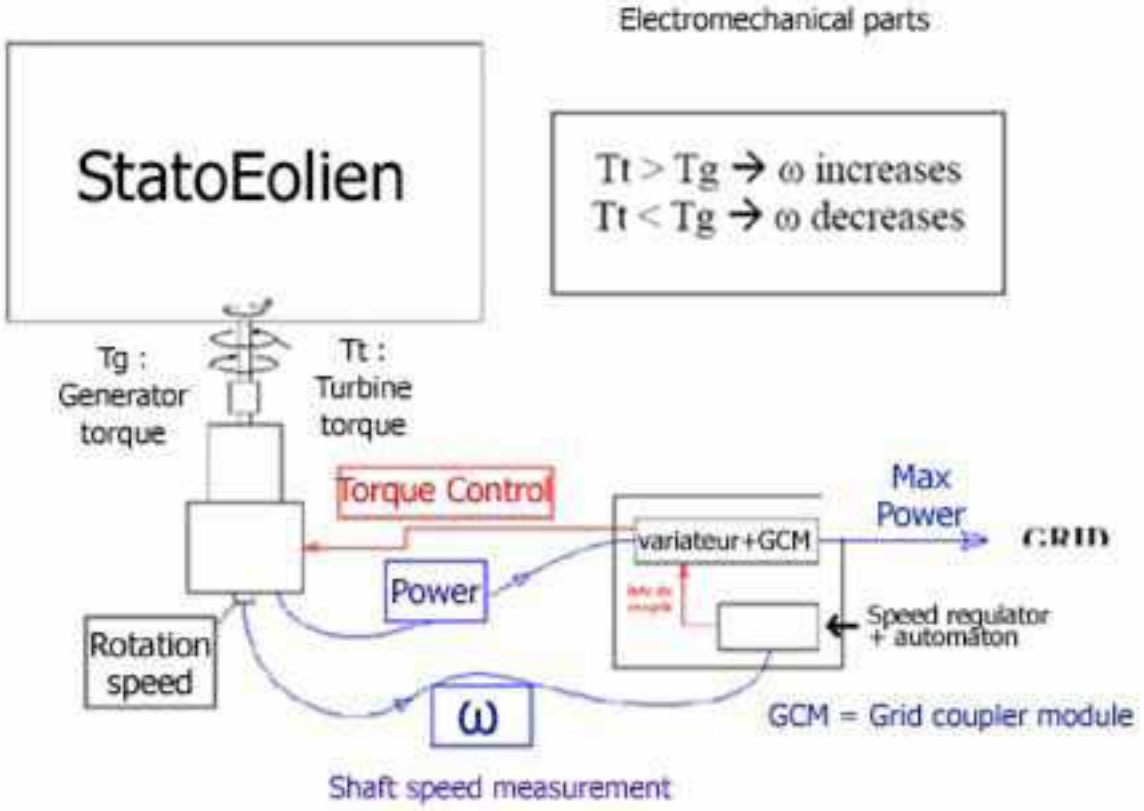
- converted into DC and stored in batteries
- converted into AC and used on site
- converted into AC and injected in the local power grid (EDF,...)
- used directly, water pumping for example.
- used directly to power any mechanical engine.

The electromechanical parts, the multiplier and generator are integrated in the structure of the STATOEOLIEN. It is completed by a noise reducing casing to eliminate any operational noise.

The electromechanical parts consist of:
- a multiplier
- a generator, synchronous or asynchronous depending on the model.
- a speed controller integrated with automaton and DC bus
- a mains network coupler.

Electromechanical parts

The principle of operation of the power regulation in the STATOEOLIEN is " torque driven " and is implemented electronically in the automaton integrated in the speed controller. This regulation system allows the STATOEOLIEN to always operate at maximum power output without requiring an anemometer.



IV/ Range and Technical Information

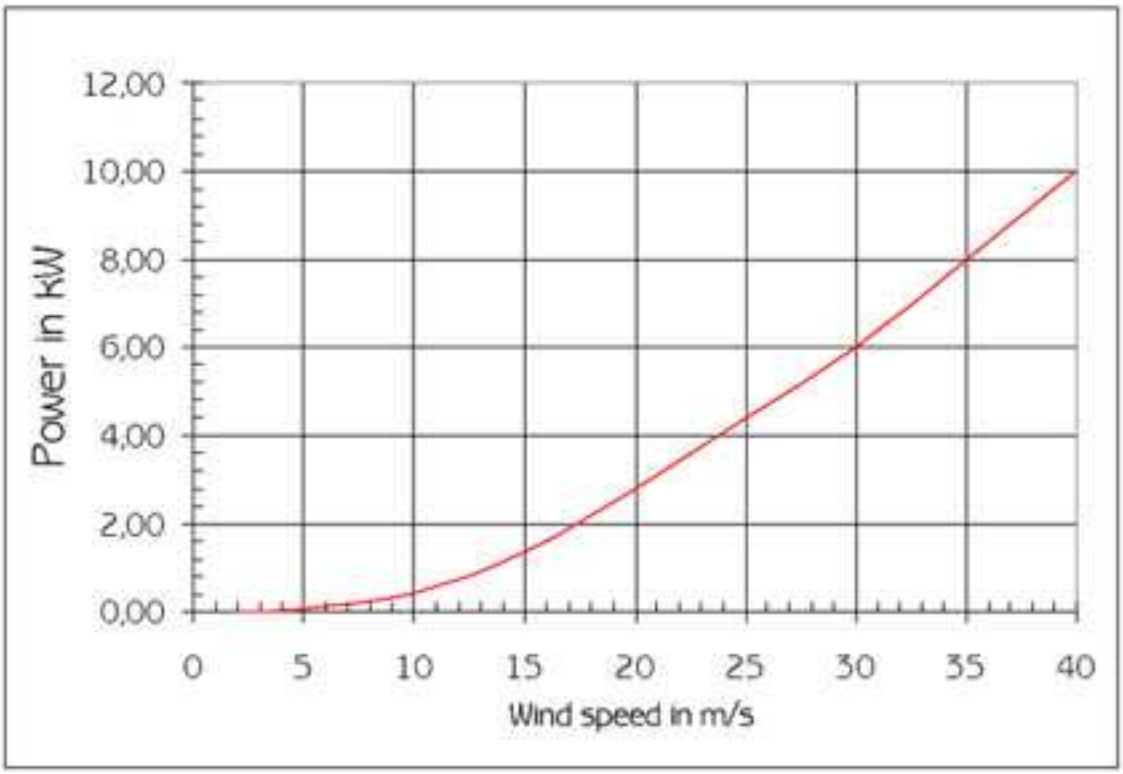
GUAL Industrie proposes two models : the GSE 4 and the GSE 8, whose technical data are listed below.

StatoEolien GSE 4

Technical data sheet
Product specification

Diameter/height	4m / 1.5m
Cut in wind speed	2 m/s (7 km/h)
Cut out wind speed	60 m/s (216 km/h)
Output power at 15 m/s (54 km/h)	1.3 kW
Output power at 25 m/s (90 km/h)	4.4 kW
Output power at 40 m/s (140 km/h)	10 kW
Rotational speed	0 to 120 rpm
Generator	permanent magnet synchronous
Power regulation	Electronic, torque driven
Weight	around 600 kg
Maintenance	annual
Warranty	10 years
Noise level in operation	less than 50 db (ambient noise)

Power Curve



StatoEolien GSE 8

Technical data sheet
Product specification

Diameter/height	8m / 3m
Cut in wind speed	2 m/s (7 km/h)
Cut out wind speed	60 m/s (216 km/h)
Output power at 15 m/s (54 km/h)	6 kW
Output power at 25 m/s (90 km/h)	19.3 kW
Output power at 40 m/s (140 km/h)	36 kW
Rotational speed	0 to 60 rpm
Generator	asynchronous
Power regulation	Electronic, torque driven
Weight	around 2500 kg
Maintenance	annual
Warranty	10 years
Noise level in operation	less than 40 db (ambient noise)

Power Curve