GUAL INDUSTRIE

STATOEOLIEN

GSE

TECHNICAL PRESENTATION

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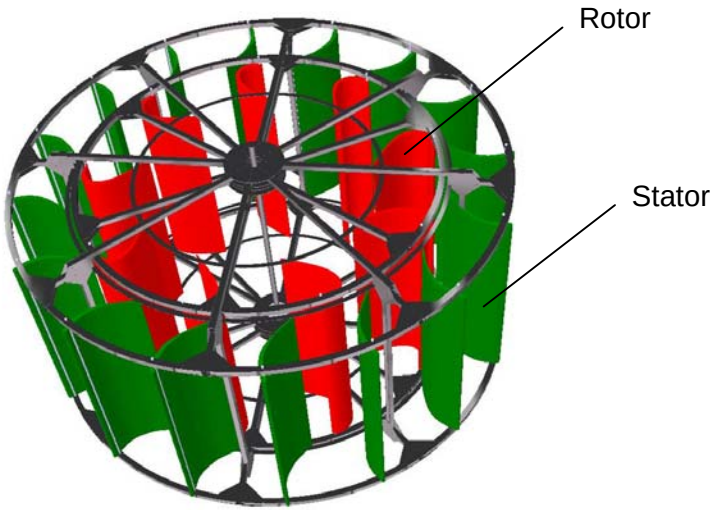
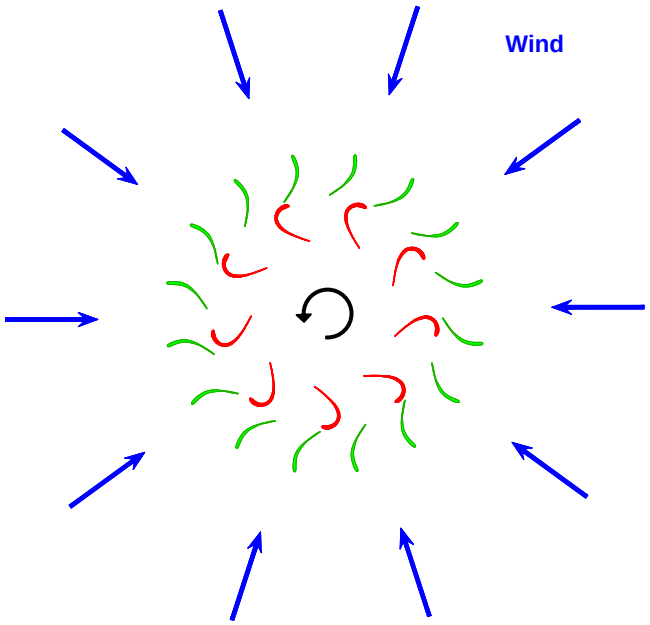
Introduction

The STATOEOLIEN is a Vertical Axis Wind Turbine (VAWT), composed of a fixed stator and a moving rotor, intended to be installed in urban environment. It makes it possible to provide renewable energy in the heart of cities, by being perfectly integrated, aesthetically and technically, in the built structures. It is adapted to highly turbulent urban winds and to modern architectural constraints.



I/ Aerodynamic Characteristics

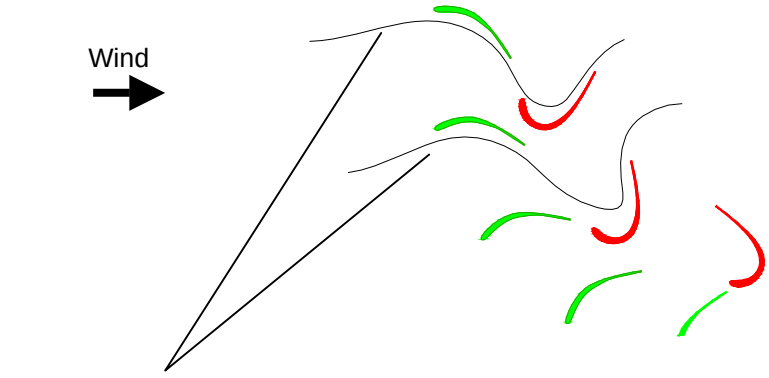


The axisymmetry of the STATOEOLIEN enables it to be totally independent from the wind direction changes. Indeed, the fixed wings of the stator and the moving blades of the rotor are distributed in a symmetrical way around the vertical shaft of the machine, thus supporting no privileged operating direction. The result is an optimal working whatever the wind direction, which is particularly useful with urban winds, that are characterized by frequent direction changes.

Principle of the stator:

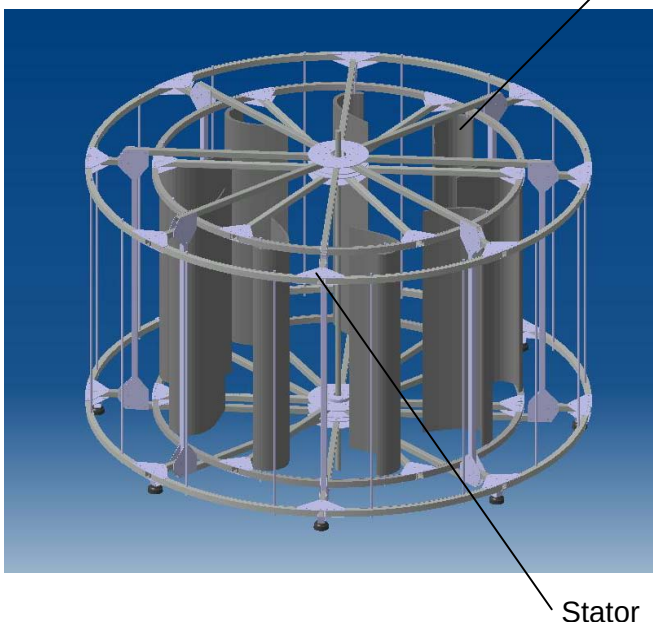
Using a stator offers three main advantages :

1/ The stator allows the flow to be optimally canalized tangentially to the rotor blades, in order to generate maximum power.

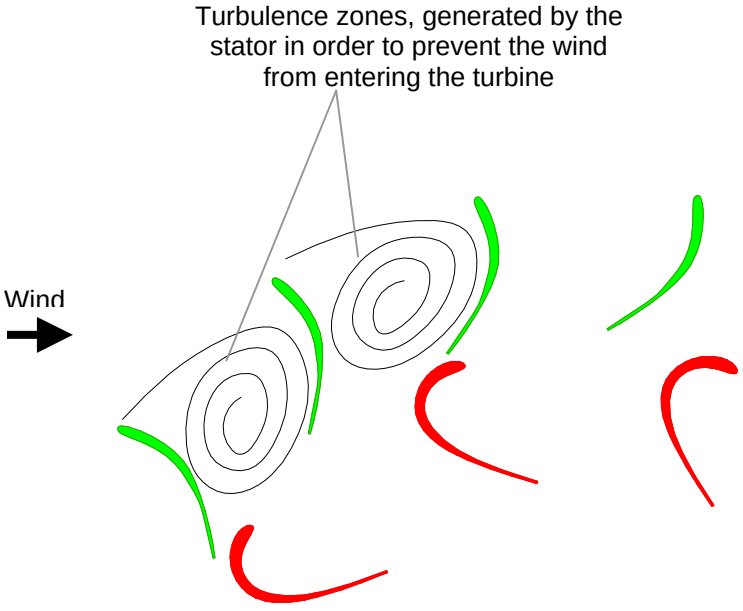


Deviation of the flow to the windward rotor blades

2/ The stator offers the possibility to integrate into the turbine a rigid tubular structure, that allows the STATOEOLIEN to resist violent winds. This structure surrounds the rotor and maintains it strongly, thus absorbing mechanical strains and aerodynamic vibrations (swirls on rotor blades, periodic variation of the torque applied to the shaft,...).

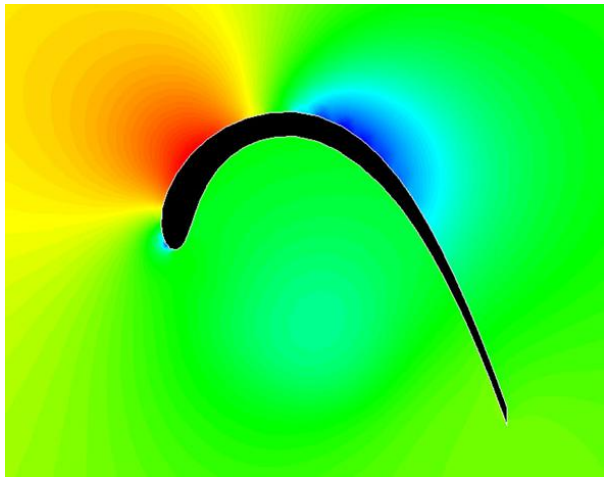


3/ When the rotor blades expose their leeward side to the wind, they generate a torque that will oppose the normal working rotation. This results in power loss. Therefore the stator has been designed to generate in this "brake" zone turbulences that will prevent wind from entering the machine and pushing the blades in the wrong direction, thus reducing this braking effect.

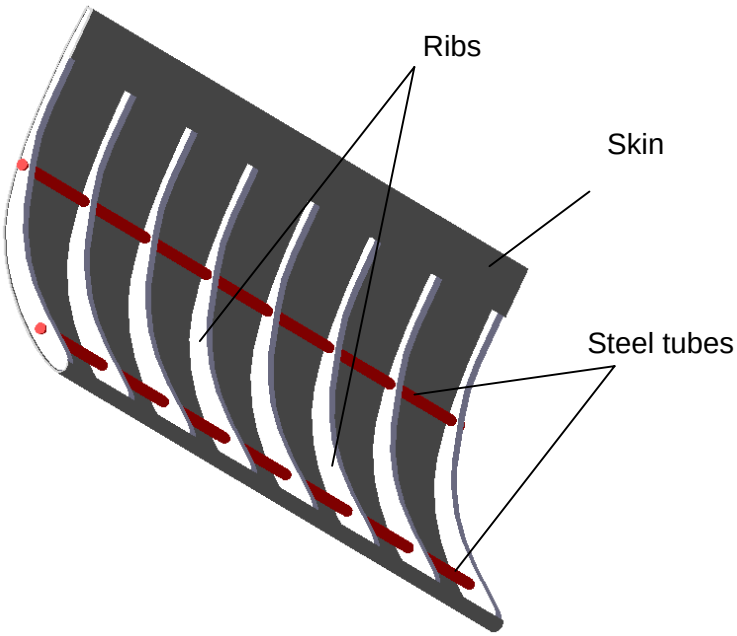


Rotor Blades and Stator Wings

The rotor blades have been designed to generate maximum power, whatever their position in relation to the wind direction. Their shape proceeds from the results of complex aerodynamic studies (CFD simulations). They are built on the same principle as modern aircrafts wings (technique known as "Skin + Ribs"). This process allows the rotor blades and the stator wings to be not only rigid but also very light.



CFD Simulation of a rotor blade



Making of a stator wing

The anchoring system of the rotor blades and stator wings makes the assembling and the disassembling particularly easy. Thus, the installation and maintenance of blades and wings become very simple (checking, cleaning, and changing).

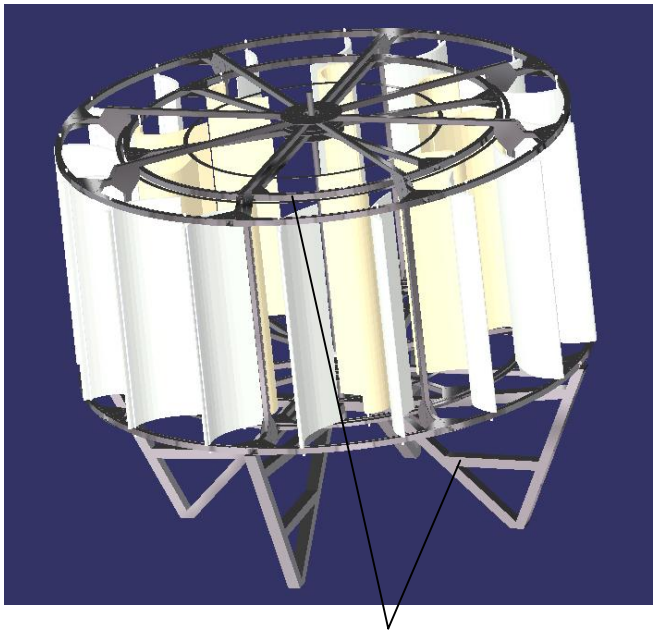
Summary of Aerodynamic Advantages

Insensitivity to the direction of the wind
Insensitivity to the speed of the wind

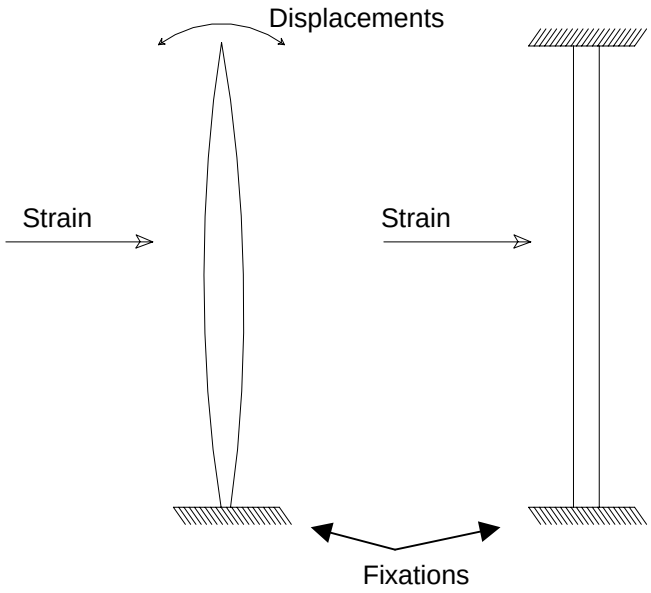
II/ Mechanical Characteristics

Rigidity of the stator structure

The tubular structure of the STATOEOLIEN allows it to resist 220 km/h winds, while remaining compact and aesthetic (Wire stays or external anchoring systems are not required to reinforce the structure). Besides, stator wings and rotor blades are helded by their two ends, which eliminates mechanical stability problems due to cantilever assembly. Indeed, the fastening of an aerodynamic profile (such as an aircraft wing or horizontal axis wind turbine blades) results in mechanical instability which causes vibrations and strain of the materials. Moreover, the STATOEOLIEN does not require the use of a pylon when it is set up on a building : it can be installed directly on the structure of the roof. Yet a pylon may become necessary when there is no building to receive the machine (installation in isolated environment, water pumping...).



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



Comparison between a cantilever structure (left hand) and a structure fixed at both ends (right hand). The first one is mechanically unstable (vibrations, high stress constraints applied to fixations). On the other hand, the second one transmits the efforts and vibrations to both fixations, leading to maximum stability.

Rotor Lightness

The whole rotor is made in aluminium, in order to reduce weight, and thus enabling it to adapt instantaneously its rotation speed according to the wind speed.

Easy Integration

The compact cylindrical shape of the STATOEOLIEN allows it to be adapted to all architectural patterns. It can be perfectly integrated to horizontal or sloping roofs.

Examples of STATOEOLIEN integration

Working in torque and not in speed rotation

The STATOEOLIEN working is linked to the torque and not to the rotation speed, leading to a reduced linear speed of rotor blade tips. While Horizontal Axis Wind Turbine (HAWT) blade tips can easily reech 400 km/h, the STATOEOLIEN's blade speed does not exceed 85 km/h, which reduces dramatically the centrifugal forces on the blades. In addition, low speed rotation offers an improved safety level (reduced emergency stop delay).

Vibrations absorption

The whole tubular structure of the STATOEOLIEN has been studied to generate only few vibrations due to resonance phenomenon. In parallel, the STATOEOLIEN is equipped with elastomer suspensions, intended to filter the vibrations that could be transmitted to the building (absorption of the resonance frequencies of the metallic structure of the turbine). The result is a very low noise level in working (even silent working).

Safety and reduced maintenance

As the STATOEOLIEN is intended to work in urban environments, it has to be perfectly safe. Therefore it is equipped with many safety devices : a rotation speed limitation device for winds higher than 150 km/h, a built-in electromechanic disc brake (integrated to the generator), which stops the turbine in case of failure, or abnormal vibrations. It is useful to remind that the stator itself constitutes a safety device by limiting access to the moving rotor, to people as well as to external items. The anchoring points (4 in whole) are built with anti-pull-up system, which eliminates roll of the machine when the winds are very strong.

No chemical sensitivity

The stator is made of painted steel, and the rotor in aluminium, which eliminates any risk of corrosion or degradation of the mechanical properties of the components of the turbine, occuring with UV, wind, sand, heat, or salty atmosphere. The result is an improved reliability and a reduction of maintenance operations number. Concerning the electrotechnical chain, it is designed according to the IP 54 standard, that prevents it from water projections and dust.

In addition, the STATOEOLIEN has been designed to reduce maintenance operations. For example, bearings (auto-aligned bearing on top of the turbine and conic bearing at the base of the shaft) are life guaranteed, and their verification is simplified by an extractible bearing box, which is entirely detachable. The gear box must be drained every 4 years, and completely changed every 10 year. The electrical chain (generator, power electronics) has to be controlled every year, as the whole turbine. Those maintenance operations are facilitated by the location of the machine : on a roof and not at the top of a pylon, thus improving safety.

Summary of mechanical advantages

Easy integration
High reliability
Low noise level
High safety
Reduced maintenance

III/ Electrical Characteristics

The mechanical energy generated by the STATOEOLIEN can be :

- converted in continuous current, and charge batteries,
- or converted in alternative current and supply the installation site with electricity,
- or converted in alternative current which can be reinjected on the grid,
- or directly used to pump water,
- or directly used by mechanical devices.

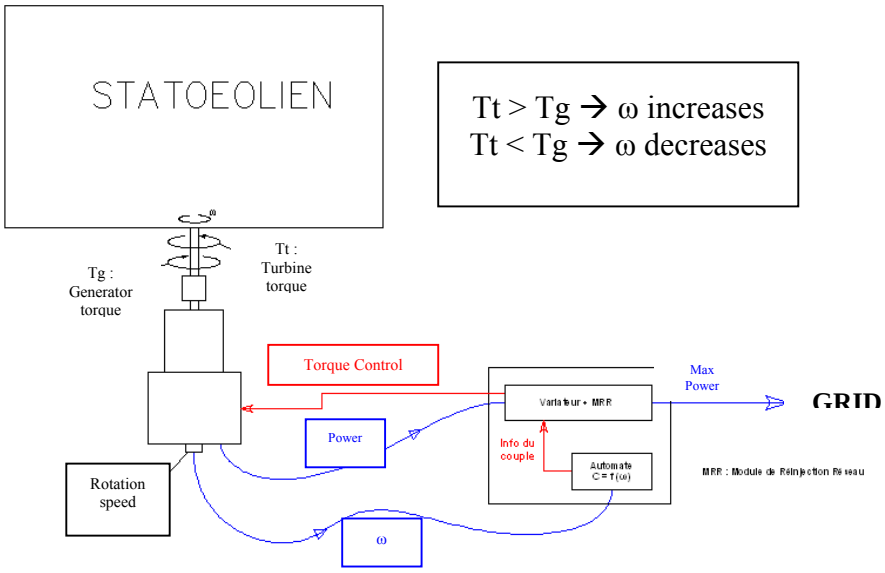
The electromechanical chain (gear box and generator) is integrated in the STATOEOLIEN's structure. It is surrounded by a phonic isolation casing, in order to eliminate every noise.

The electrotechnical chain of the STATOEOLIEN is composed of :

- a gear box
- a generator (synchronous or asynchronous, according to the turbine model)
- a frequency servo-variator, featuring an automaton and a continuous bus,
- a grid reinjection module,
- grid filters.

The principle of power regulation of the STATOEOLIEN is based on a "Direct Torque Control" command. It is electronically operated in the variator-integrated automaton.

This regulation system allows the STATOEOLIEN to work at maximum power, whatever the wind speed, and without anemometer requirement.



IV/ Range and Technical Information

Range :

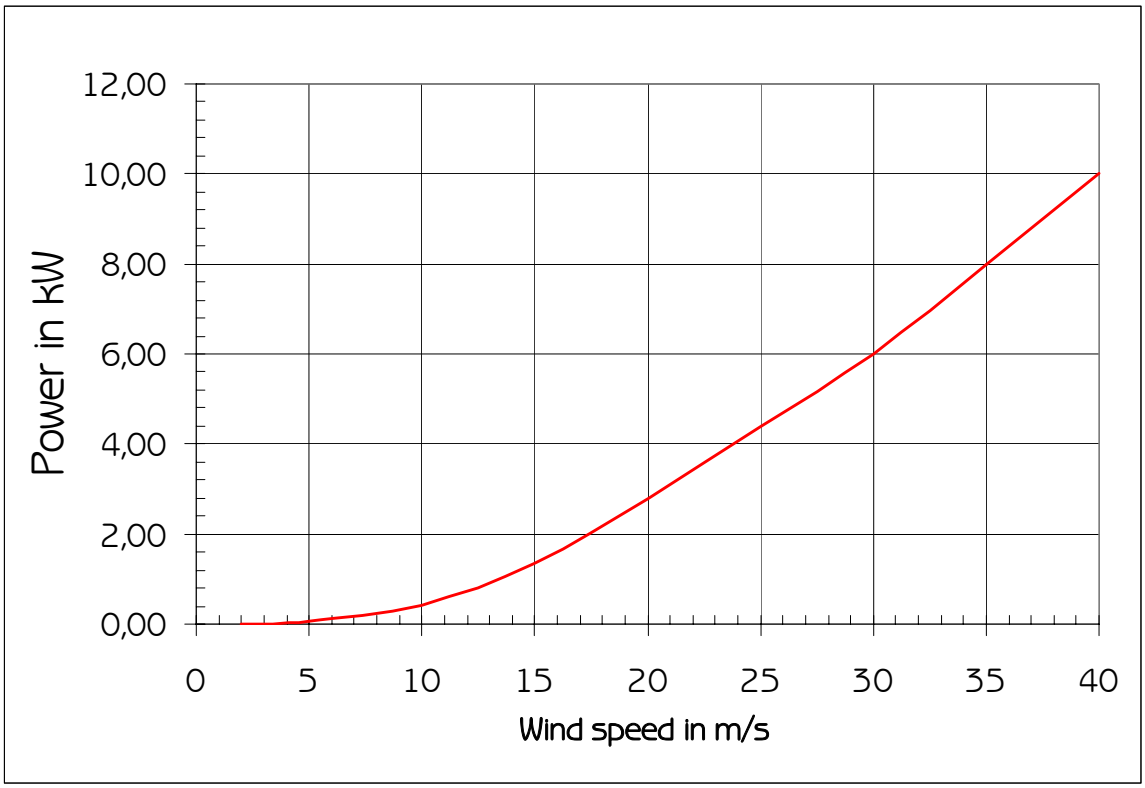
GUAL Industrie proposes two models : the GSE 4 and the GSE 8, whose technical data are listed below.

STATOEOLIEN GSE 4

Technical Datas :

Diameter / Height :	4m / 1,5 m
Starting wind speed :	2 m/s (7 km/h)
Operating maximum wind speed :	60 m/s (216 km/h)
Power at 15 m/s (54 km/h) :	1,3 kW
Power at 25 m/s (90 km/h) :	4,4 kW
Power at 40 m/s (140 km/h) :	10 kW
Rotation speed :	0 -120 rpm
Generator :	Synchronous Permanent Magnets
Power regulation :	Direct Torque Control
Weight :	800 kg
Maintenance :	Annual control
Warranty :	3 years

Power Curve



STATOEOLIEN GSE 8

Technical Datas :

Diameter / Height :	8 m / 3 m
Starting wind speed :	2 m/s (7,2 km/h)
Operating maximum wind speed :	60 m/s (216 km/h)
Power at 15 m/s (54 km/h) :	6 kW
Power at 25 m/s (90 km/h) :	19.3 kW
Power at 40 m/s (140 km/h) :	36 kW
Rotation speed :	0 - 60 rpm
Generator :	Asynchronous
Power regulation :	Direct Torque Control
Weight :	2 500 kg
Maintenance :	Annual control
Warranty :	3 years

Power Curve