ESTREYA is a state-of-the-art Vertical Axis Wind Turbine (VAWT) engineered and manufactured in Luxembourg by SWIRL SeCS. In July 2014, after over a year of intensive system engineering work, it became the first VAWT worldwide with an Engineering Design Certification according to IEC 61400-2 for Wind Class I for building integrated applications. Calculations for a first installation in Berdorf (L) were dimensioned for this purpose, even if Luxembourg is not even in Wind Class IV. This applied especially to civil and control system engineering and was decided in view of further installations in Wind Class I and II areas. The complete System Certification will involve a six month operation in Northern Germany under surveillance of DNV-GL , the certifying body.

WE ARE SMART WIND INTEGRATED RENEWABLES LËTZËBUERG, S-W-I-R-L. WE PRODUCE "ESTREYA"_

Myriam Muller

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In the Antique, the ancient Persians already used vertical axis wind turbines to mold grains. So what makes ESTREYA so special?

It all starts with the physics of wind energy, the kinetic energy of air in motion. The available wind energy flowing towards an object is: ½ air density *swept surface* wind speed3

So, wind power is proportional to the third power of the wind speed: meaning the available energy increases eightfold when the wind speed doubles. As wind turbines for harvesting this available energy need to be particularly resistant and efficient at greater wind speeds, we decided to certify ESTREYA for Wind Class I, the toughest one of all.

Speaking about efficiency, one must consider the physical limits to wind energy extraction, the so called Betz law which gives the theoretical maximum power that can be extracted from the wind energy, independently from the design, by any wind turbine in open flow. According to Betz, no wind turbine can capture more than 59% of the kinetic energy of the wind.
Further, business considerations also need to be taken into account. A wind turbine is an investment good, supposed to bring a return over time high enough to justify its financing. Consequently, it needs to be:

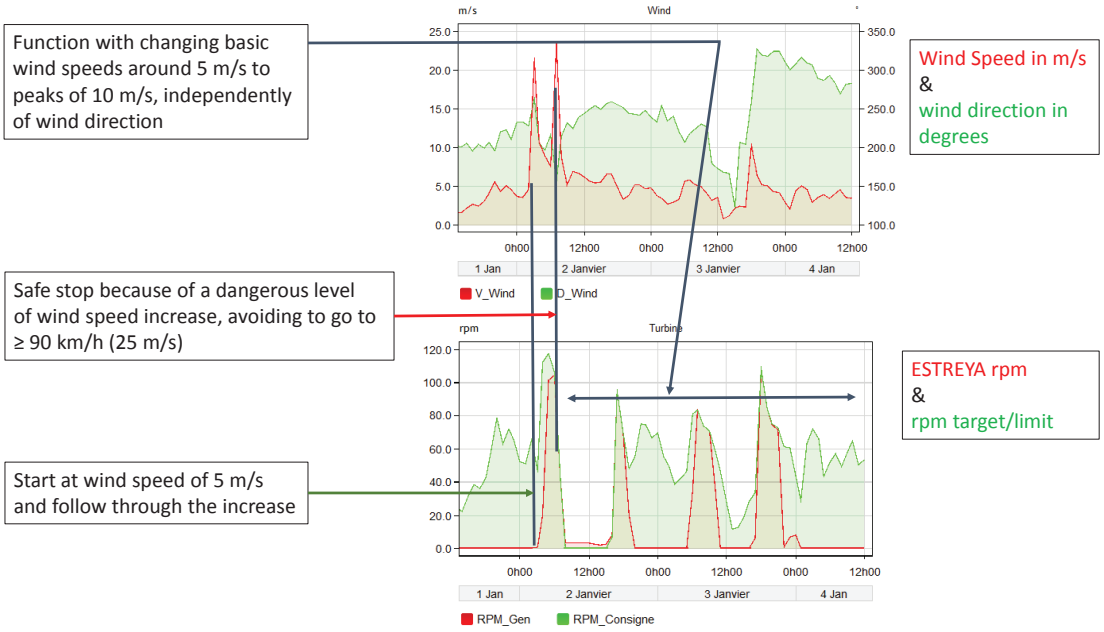
_Placed where the winds are strong enough to be harvested successfully,
_Engineered and manufactured in top quality to stand those winds,
_Installed by qualified and skilled professionals,
_Monitored and maintained during its whole life time to fulfil this duty.

As one cannot separate ESTREYA from its business concept, our initial concern was the development and manufacturing of a mechatronic device responding to the following challenges:

_a state-of-the-art machine designed and engineered to stand heavy winds, knowing that next to the physical limits to performance, economic considerations in manufacturing also influence the value chain,
_setting up the necessary know-how about wind site qualification, installation, remote monitoring and maintenance, as well as the inter-connection with other renewable energy systems, battery charging systems and the smart grid,
_establishing the right structure to fulfil this assignment:
_engineering, manufacturing and subcontracting teams,
_mechanical and electronics labs, tools, test sites, IPR,
_benchmarking the existing wind market (who, what, where, why),
_understanding the applications of our technology on the different potential markets,
_measure and anticipate the effects of these markets to our activity
_do business development out of Luxembourg
_be ready to consider and organize necessary technology transfers to such markets,

And
_find the right industrial partner(s) to help with this complex development.

As one of the renewable energy converting segments, the market for small wind turbines (machines up to 200m2 of swept surface) is closely linked to the trend of decentralized energy production and the rise of the smart grid. This market evolves differently depending on the geographical location and the reliability of local grid infrastructure. Where a reliable grid exists, reasoning is only based on the prices for grid electricity. Elsewhere, prices for any available energy source are bench mark. Here, reliable VAWT have strong advantages when they work together as a cluster or with other renewables and diverse storage facilities. Availability of sufficient wind power will of course shorten the return on investment period.



The existing ESTREYA L3 version, has a swept surface of 7m2. It has been designed and engineered by SWIRL SeCS in Dommeldange (L) and enters now the final phase of the IEC61400-2 certification which will confirm its ability to fulfill all safety and performance criteria to access world markets. In Luxembourg, a first ESTREYA unit performs nicely on top of the water tower in Berdorf (L) since June 2014, others will follow. Its performance curves under local conditions (wind speeds from 4 to 12m/s) have been confirmed by an independent wind turbine expert. Additionally, Berdorf, not even being a Wind Class IV site, created the surprise by offering on January 2nd 2015, for a short time, a wind behavior close to the one normally experienced in Northern Germany. Data were recorded by the ESTREYA L3 Remote Condition Monitoring System, operational since September 2014 and the result of a few man/years' work by SWIRL and its suppliers in 2013-2014. Similar experiences will allow us to verify, perfect and tune the correct functioning of the ESTREYA Control and Safety System in preparation of the forthcoming System Certification on the site of DVN-GL in Northern Germany.

"As shown here, also in Berdorf extremely short and violent gusts up to 70 or 90 km/h can occur. Estreya reacted by first following up during a violent up, down and up again wind gust and then stopped safely when the predictive control system indicated 90 km/h (25m/s) wind speed potential. The rest of the time corresponded to smaller movements remaining in the "Berdorf" category of 5 to 12 m/s."

The question why a VAWT, when most competitors do horizontal axis, is not trivial. A VAWT is more complex in some aspects than a horizontal axis wind turbine (HAWT), but once these challenges have been mastered, it has strong advantages that could potentially lead to a complete re-definition of the world wind turbine market. Few examples:

_VAWTs turn slower than HAWTs and therefore are nearly silent and less dangerous for birds, so they could also be placed close to urban environments,
_As VAWTs can be designed and manufactured to be in complete balance, their foundations are subject to less stress over time than those of HAWTs. This makes a huge difference in the life cycle and maintenance costs of the machines, especially for large and off-shore installations,
_VAWTs function well and under certain conditions even enhance the total production when set up closely together in a cluster formation where HAWTs need large space between 2 machines. SWIRL recently filed a related European Patent Application.

Such features can translate into concrete and valuable benefits when it comes to giving back the power of their own energy supply into the hands of human communities.
In fact what the ancient Persians had intuited was quite complex, challenging and nearly impossible to design, manufacture and operate reliably without modern tools (CFD, finite element methods, FEM). Since the patents from Mr. Savonius and Mr. Darrieux beginning of 20th century, few fundamental innovations had been introduced and applied in the domain of VAWTs. We now start to understand the full scope of possibilities given to VAWTs and how their potentials could be translated into assets. We are SWIRL, Smart Wind Integrated Renewables Lëtzebuerg. We build ESTREYA, just the first of a new generation and an innovation in the state of the art of wind energy conversion.
I gratefully acknowledge the SWIRL SeCS team members, partners and subcontractors and the Commune of Berdorf (L), who contributed to the development of ESTREYA and to this article.

www.s-w-i-r-l.com

http://en.wikipedia.org/wiki/Wind_power

http://www.wind-power-program.com/betz.htm

http://en.wikipedia.org/wiki/Betz's_law

„„… wenn wir diesen Planeten als Lebensraum für 10 Milliarden Menschen vorbereiten wollen. Wenn die die Bewohnbarkeit des Planeten nicht durch Übernutzung und Klimawandel ruinieren sollen, brauchen wir Wohlstand und Energie für alle. Dazu müssen ca. 40 Jahre lang jeden Tag etwa 3 Gigawatt Solar- und Windenergie weltweit ans Netz gehen – jetzt sind es etwa 0,1 Gigawatt." Dabei ist für Knies Desertec eine Hoffnung und wohl auch eine letzte Chance für die Menschheit, den Klimawandel noch in den Griff zu kriegen." In „Die Desertec Industrie-Initiative (Dii) legt Zwischenbilanz vor Nach fünf Jahren erfolgreicher Arbeit: Phase 2" Press Release, 28. Dezember 2014

http://en.wikipedia.org/wiki/Savonius_wind_turbine

http://en.wikipedia.org/wiki/Darrieus_wind_turbine

http://en.wikipedia.org/wiki/NACA_airfoil