Sotavento Galicia presents an innovating management tool for wind farms

The experimental wind farm **Sotavento** offers its management system for wind farms to the sector, an innovating computer application developed together with **Engasoft**, to follow and control exploitation tasks in these generating farms.

Wind energy has been living over the last years a very fast increase, in which we observe that following and controlling the maintenance of wind farms (from the point of view of guarantees and economy) has become less important. Therefore we have crated a universal computer tool (which can be applied on every kind of wind technology) that makes it possible for the user to verify and quantify and apart from this, gives us information about scadas, the most significant parameters from the point of view of exploitation, such as accomplishment of power curves, availability, energy loss, profit cease due to maintenance work ,etc. All this with a very intuitive application, easy to use and complete. A tool which has been qualified by the sector as “spectacular” and “very complete”.

STATE OF ART IN WIND MANAGEMENT SYSTEMS

All over these years, in which wind energy has experimented a fast expansion in our country, applications for following and control of farms on the market, have been tied to the specific scadas of wind energy of each farm, suffering a great deal of limitations for the promoter when evaluating the performance of the installation:

- Programs for technicians and maintenance firms with restricted access and different privileges.
- Elaboration of a limited number of reports with no knowledge of the methodology by the promoter and without the possibility of validating facts.
- Non-universal applications only tied to each producer of wind generators.

THE EXPERIENCE OF SOTAVENTO

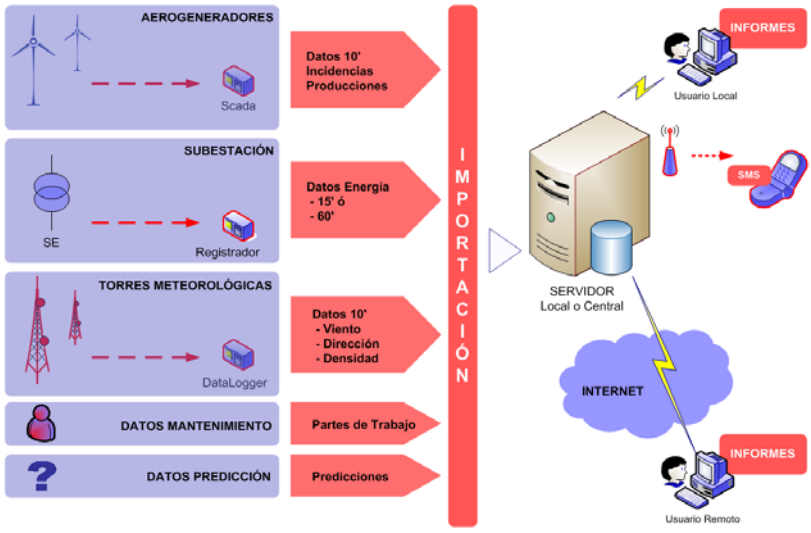
Sotavento Galicia S.A. has become an Experimental Wind Farm promoted by the Xunta de Galicia in order to create a new concept of wind farm, coordinating private and public initiative in a project where you could find wind technologies from everywhere in Galicia. **Sotavento Galicia S.A.** is held by three public entities which form 51% of its social capital: SODIGA GALICIA, S.C.R., IDEA (institute for energy diversification and saving), INEGA, S.A. (energetic institute of Galicia) and four private firms which represent the electrical sector of Galicia: ECYR S.A. (Endesa co-generating and renewable), Enel Union Fenosa Renewable S.A., Iberdrola Renewable Energy of Galicia S.A. and ENGASA (Energy of Galicia).

The aim of **Sotavento Galicia S.A.**, is apart from exploiting a wind farm commercially, to obtain four noticeable objectives:

- To be a “Show window” farm for different wind technologies that at present exist in Galicia.
- To be a frame for activities of I+D+I, with the possibility of offering the wind sector more valuable elements.
- A training and debating centre for renewable energy.
- A divulgation centre for renewable energy.

The Experimental Wind Farm Sotavento was inaugurated in June 2001 by His Royalty Prince of Asturias . It has an installed power of 17.56 MW, consists of 24 wind generators of 9 different models made by the 5 producers that are at present implanted in Galicia (Gamesa, Made, Ecotecnia, Neg Micon and Bonus . In this installation different projects and studies about the wind sector are being made, as for example the simulation of performance of machines when there is wind, studies of wave quality, wind prediction systems, etc.

By using the knowledge obtained about different scadas in these years(communication protocol, storage formate) and about maintenance philosophies of the actual producers on the farm, conscious of the need of interpreting and homogenizing all this information, **Sotavento Galicia** has developed and tried out, together with **Engasoft S.L.**, on its installations its own system of integral management of exploitation, which can be applied on every wind farm, without having to take into account its technologic features.



USED METHODOLOGY

These are the stages that have been made during the development of the application:

A) COMMUNICATION SYSTEMS

Network integration of the local operation posts that existed in the control room of the farm and that held the different scadas corresponding to the five technologists, meteorologic tower and substation.

B) HOMOGENOUS STORAGE IN DATA BASE

The dates from the different systems of the wind farm are imported from their scadas to the data file situated in the central server. The importation of these dates can be done manually (helped by an operator), automatically (in real time just in the moment when they are produced) or by programming (according to the plan set up by the operator).

The dates that have to be imported are:

- **Windgenerator dates**

Due to the use of different scadas, the formats or the stored files in the data bases of every technologist present different configurations, not adjusting to a determined standard. Therefore a routine programming treatment is done for every file for homogenisation and definite storage in data base (ten-minute-periods with of variable fields measured by date, hour, wind incidence, generated kw, that will be used to elaborate reports).

- **Windgenerator incidence.**
- **Ten-minute-dates from the anemometric towers.**
- **Dates from operations done in maintenance.**
- **Dates of electricity generation in substation.**
- **Hour dates from prediction systems.**

C) PROGRAM TO ELABORATE REPORTS

The management program is prepared for:

- Generation of multiple reports from the data base.
- Exportation of dates and results.
- Sending reports to addressee.

REPORTS OF THE SYSTEM

Here are the different information and reports you can get from the application:

Energy movement
The report reflects the flows of electric energy of the wind farm (generated energy, consumed energy in windgenerators and control building, reactive flows and electric loss in the farm) obtained from the counters of substation and windgenerators.

Wind in anemometric towers
Showing of the features of wind resource (wind, direction, density, pressure, temperature, etc) registered in the anemometric towers in a selected period of time.

Wind in windgenerators
The features of incident wind in the positions of the farm are reflected by taking into account average values of wind speed registered in ten-minute-periods in the gondola anemometer of every windgenerator.

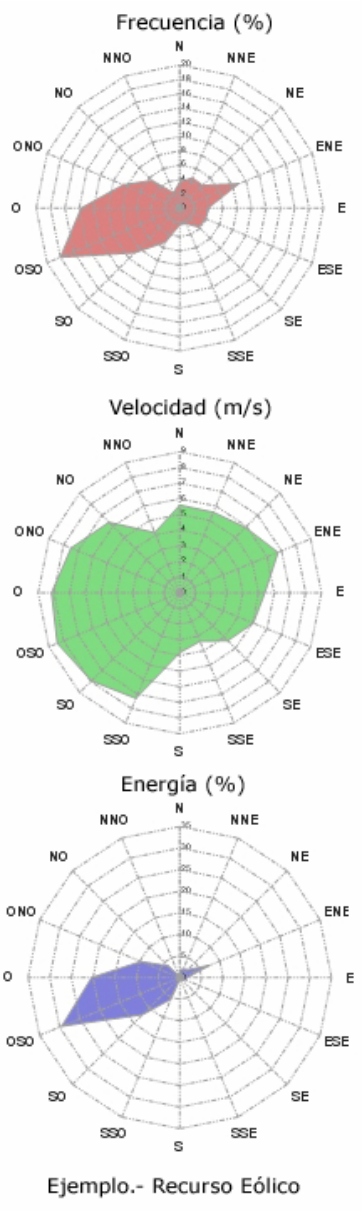
Summary of production and equivalent hours
The report reflects comparatively the energy produced by windgenerators of the farm in a previously selected period of time, as well as other related variables (availability, capacity factor, etc.).

Windgenerator power curve
It represents the grade of accomplishment of the power curve of windgenerators in selected periods.

We use the ten-minute dates of generated power and incident wind in windgenerators, which are normalized to wind density on sea level 1.225 KG/M3 (according to UNE 61.400-12). From the ten-minute values of wind density registered in the anemometric towers of the farm, we correct the generated power in the case of fixed-step-machines, or we correct the incident wind speed if the machines are variable-step.

The report incorporates data filters to calculate the power curve for perturbed and non perturbed sectors, for wind range, for density periods, etc.

Power curve of the farm
The report calculates the ten-minute and hour power curve of



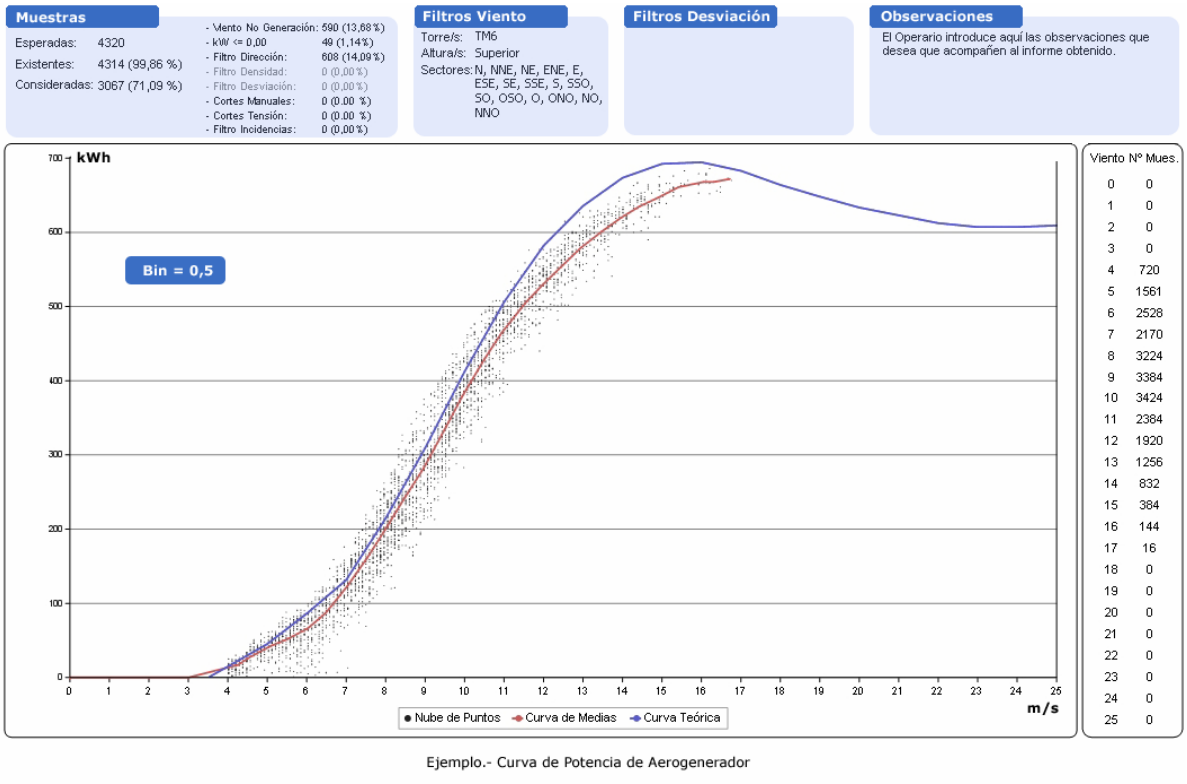
Ejemplo.- Recurso Eólico

the farm depending on the selected periods of the data base:

<u>Ten-minute farm curve</u>
We use the ten-minute wind dates from the anemometric towers of the farm and the ten-minute power dates from the sum of all windgenerators on the farm.

<u>Hour farm curve</u>
We use the hour wind dates from the anemometric towers of the farm and the hour power dates from the substation counter or from the sum of windgenerators on the farm obtained from the technologist's database.

We incorporate the following filters:
- wind density: allowing a farm curve for a range of wind density in the determined emplacement.
- incident wind direction in the anemometric towers: allowing a



Ejemplo.- Curva de Potencia de Aerogenerador

farm curve for the selected sectors.
- percentage of power availability of the farm: obtaining a farm curve when availability is higher than the selected percentage.
-selection of unavailable windgenerators: allowing a farm curve that counts these ones out, which is very useful for prediction and generation systems.

Data map

The report represents visually (in ten-minute-periods) for every windgenerator and month information about: the periods with absence of dates of generated active power, the periods with unavailability errors, the periods with absence of tension, the manual stops programmed by the exploitation, the periods with absence of generation but with enough wind and the periods with maintenance operations in the machine.

Availability

The report reflects on a bar graphic the percentages of availability and of lost energy due to unavailability for windgenerators and selected period.

By incorporating different filters of dates to calculate availability; applying different variables existent in the windgenerator's supplying contracts (total period, period with generation wind, period of maintenance and absence of tension, etc).

For every windgenerator we preconfigure an incidence-guide in which we select the errors that cause unavailability. In the same way, the program allows the calculation of lost energy in the periods of generation wind in which the windgenerator reflects no production and without the existence of error.

Energy deviation

The report reflects the lost energy by windgenerators in the periods with available machine due to an unaccomplishment of the curve.

We use ten-minute power dates and incident wind in windgenerators, referred to the ten-minute registered density in the emplacement of the anemometric towers of the farm.

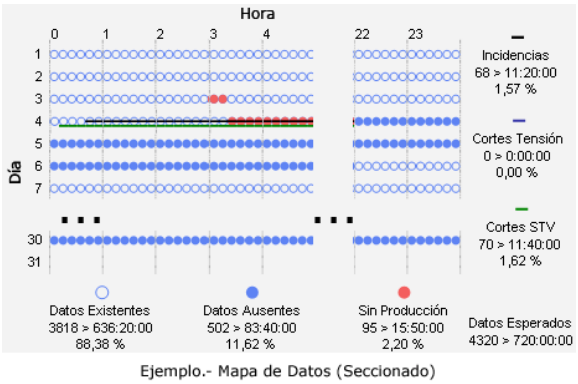
The calculation is done for every range of generation wind, allowing the possibility of filtering perturbed sectors.

Maintenance module

It is a specific module inside the management program that is going to allow on the one hand a following of maintenance labours done and on the other hand the elaboration of reports that allow us to extract conclusions about these labours, trying to minimize the periods of unavailability associated to maintenance.

By taking the work reports (designed by Sotavento) we introduce manually the operations that maintenance firms carry out on the farm. Once they are all introduced, the management system allows the showing of different reports both graphically and numerically:

- Comparatives of time spent on maintenance between windgenerators.
- Time spent on prediction, prevention and correction.
- Time spent on maintenance in the different systems of the windgenerator.
- Average wind in windgenerator



Ejemplo.- Mapa de Datos (Seccionado)

during the operating periods.

- Lost energy during maintenance labours.
- Operation list per windgenerator.

FUNDAMENTAL TOOL FOR THE MANAGEMENT OF A WIND FARM

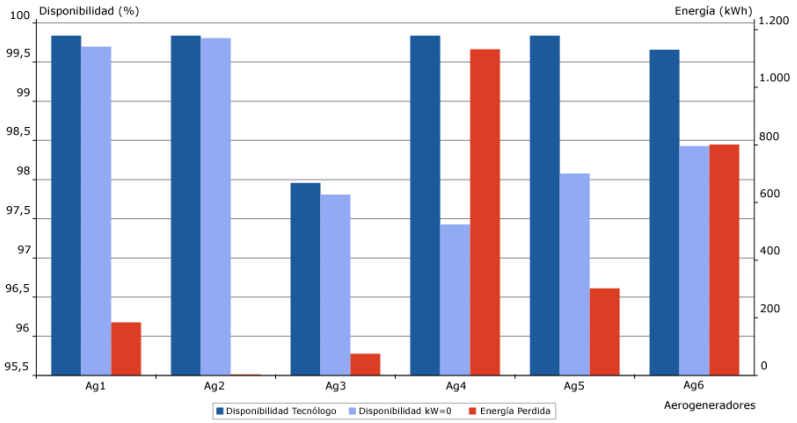
These reports, detailed and flexible, turn the application into a fundamental tool to follow and analyse the working parameters of the different components of the wind farm, allow taking decisions depending on results and all this with the aim of improving the performance of the installation to obtain a better efficiency of the exploitation.

The multiple reports of this system offer relevant information related to the exploitation, such as may be:

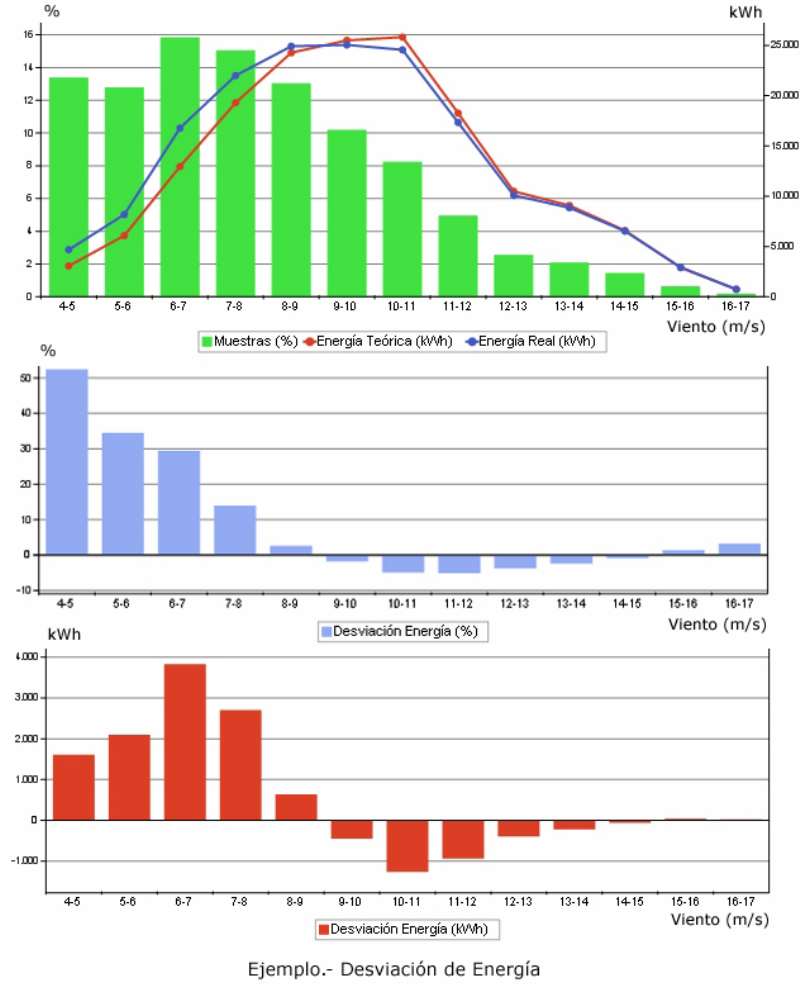
- Comparatives of behaviour between windgenerators in different wind ranges.
- Lost energy due to unavailability of windgenerators.
- Lost energy due to unaccomplishment of the curve.
- Maintenance control (time dedicated to prevention, prediction and correction, time of maintainer response, energy loss during maintenance operations, real cost associated to maintenance, substituted materials, error statistic in turbines, possibility of sending SMS messages in real time to maintainers, etc).
- Monthly billing, economic evaluation due to ceasing profit and comparatives of fares.
- Study of the behaviour of deviation of prediction systems.

As a **summary**, we will now name the technical features that were taken into account in the elaboration of the application, and that mean certain advantages for users:

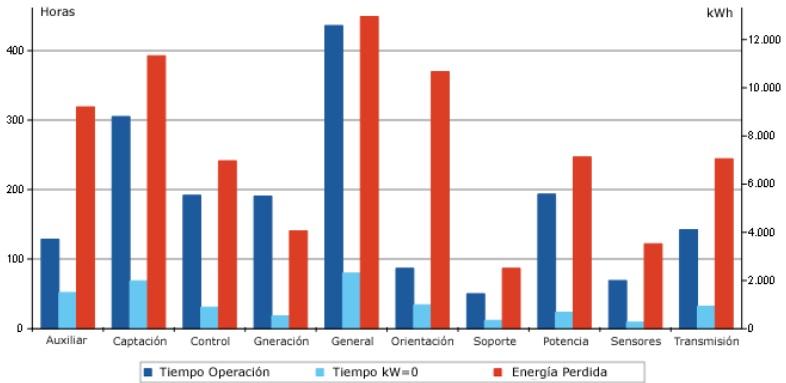
- Compatible with all wind technologies.
- Can be applied on all possible farm topologies (one only farm, several farms, a farm with different producers, multipromoter or different farms with several producers).
- User's possibility of using parameters for dates in order to validate the information to process



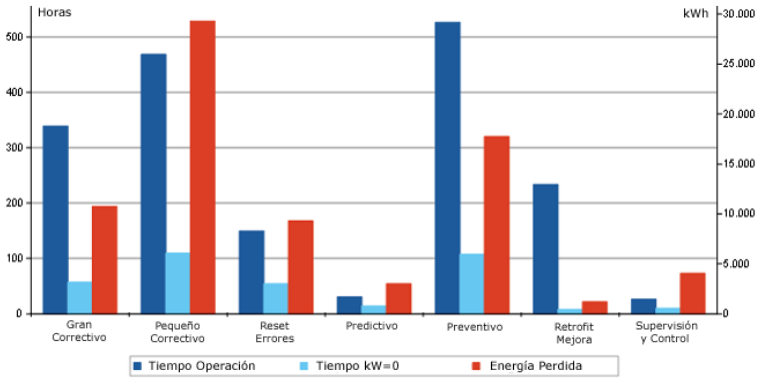
Ejemplo.- Disponibilidades para 6 Aerogeneradores (01/04/2005-30/04/2005)



Ejemplo.- Desviación de Energía



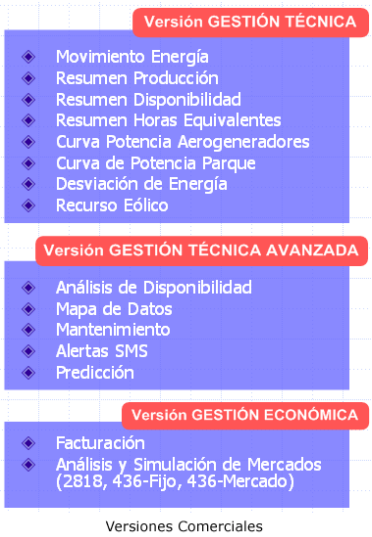
Ejemplo.- Informe Mantenimiento por Tipo de Sistema (Anual/Parque)



Ejemplo.- Informe Mantenimiento por Tipo de Trabajo Realizado (Anual/Parque)

and to be able to leave out abnormal values.

- Inclusion of possible filters in each report to delimitate the dates we want to evaluate.
- "top-down" reports for all periods of times.
- Possibility of other reports suggested by clients, as well as integration of dates in systems of alternative measuring that exist or are implanted on the exploitation.
- Standard and intuitive user interface.
- Planning emission and sending of periodic or real time reports to local or remote addressees.
- Possibility of contrasting the results by exporting the dates to other user programs.



Versiones Comerciales

All these possibilities turn the system into:

- An instrument of wind auditory for analyse and following of the accomplishment of contractual guarantees between technologists, maintenance enterprises and promoters.
- A tool that can be used to analyse, in determined periods, the behaviour of the installation (reception period, annual , 3-annual balance,...)

COMMERCIALIZATION

At present, Sotavento Galicia S.A. can offer this product commercially to the sector (promoters, technologists, engineers, maintainers, insurers, financial entities, etc).

For more information about it our contact address is:

Sotavento Galicia, S.A.

C/Hórreo, 94 Entresuelo
15702 - Santiago de Compostela
La Coruña)-(España)

Tel.: (+34) 981 563 777
Fax: (+34) 981 572 690
info@sotaventogalicia.com

www.sotaventogalicia.com