A LITTLE BIT OF HISTORY (I)

The first wind turbine was created in 1887 by Charles F. Brush.

The wind turbine had a power of 12 kW, 17 m of rotor and 144 blades. It worked for 20 years.

Article in the Scientific American magazine about Brush's wind turbine.
20th December, 1890
http://guidedtour.windpower.org/res/sciam.jpg
2. A LITTLE BIT OF HISTORY (II)

Catalonia was pioneer in the development of wind energy in Spain. On 10th February 1984, the first wind turbine was inaugurated in Vilopriu, Baix Empordà.

The wind turbine that started this project is located in Figuerola del Camp, in the region of Alt Camp, and is one of the oldest wind turbines in Catalonia (year 1988).

It has three blades, 12 m of rotor diameter and it has a nominal power of 25 KW.

This wind turbine doesn’t have the cilindric structure that most wind turbines have. It has three cylindrical supports connected by transverse bars. It preserves the three blades and it has a windmill in each side to go according to the wind direction. It has two anemometers at 7m, and another one at 14 m, to measure the wind speed.

Its conservation state is excellent and we think that it should be considered a valuable machine in the Catalan industrial heritage.
ECOTECNIA MODEL 12/30

Ecotecnia was the first Spanish wind turbine company that was created in Catalonia.

- Brake disc
- Coupling shock absorber
- Gearbox
- Generator 1
- Generator 2
- Lateral orientation helix
- HUB
- Coupling blade
- Bedplate
- Orientation gears

Left: measuring the bedplate; Right: measuring the spoiler (emergency break) mobile part of the blade.
In our region, we can see the way time goes by for Ecotecnia technology: in Figuerola, the first technologies of 25 kW, and in Serra de la Voltorera, 16MW, using 10 wind turbines of 1,6 MW.

12/30 Ecotecnia wind turbine, property of Josep Canela, its located in Figuerola del Camp, in the region of Alt Camp, at the UTM position: N 41° 22.236’ E 001° 16.294’

ECO-74 Ecotecnia wind turbine at Serra de la Voltorera’s wind park (Cabra del Camp).

The future seems to be related with offshore wind turbines, in front of Tarragona’s coasts...
5 PARTS OF A WIND TURBINE

- Blades
- High-speed shaft
- Generator
- Hub
- Gearbox
- Low-speed shaft
- Tower

6 HOW A BLADE WORKS

The displacement of the blade is produced in part by the Bernoulli effect: at the top there is less pressure and more on the bottom, causing an upward force.

Air passing through the top of the blade has to cover more distance, speed in this area increases and pressure decreases.

The air passing through the blade at the bottom has to travel less distance, speed in this area is lower and pressure is higher.
7 SHAPE OF THE BLADE. AERODYNAMICS.

Note the shape of the blade and the attack angle into the air. The more a point of the blade gets away from the center of rotation, the speed is higher.
In the future, the blades will be built with carbon fiber.

The turbine blades are made of fiberglass and epoxy resin.

We can see that the lightning conductor is something important because electricity tends to go towards the tips.
9 TURN OF THE NACELLE

In a wind turbine as the ECO-100, of 3MW power, the nacelle can turn a maximum of 3 laps in one direction. If it gave more laps, power lines running down the tower would have problems of torque. The rotation system used is an electric motor.
Knowing the wind speed is very important.

Before installing a park you must know perfectly which are the conditions of wind turbine to see how you can install.

With wind over the 100 km/h it must to stop the wind turbine for avoid damage.

Source: TV3 time on the web
WIND DIRECTION

A weather fan is needed to know the direction the wind blows from and to register the data.

Gray code to register the data and convert them in a binary system of 4 digits.

The name of the winds and its directions are:

- **Tramuntana** (N)
- **Gregal** (NE)
- **Llevant** (E)
- **Xaloc** (SE)
- **Migjorn** (S)
- **Garbí o Llebeig** (SO)
- **Ponent** (O)
- **Mestral o Cerç** (NO)

http://ca.wikipedia.org/wiki/Rosa_dels_vents

![Gray code diagram]

![Image of wind farm]
PROJECT ZEPHIR: THROUGH THE RESEARCH OF OFFSHORE WIND POWER IN DEEP WATER.
COR DE MARIA SCHOOL (VALLS)

12ND MEASUREMENTS ON THE COAST OF TARRAGONA

Source: http://es.windfinder.com/windstats/windstatistic_boja_de_tarragona.htm

Source: http://www.renewablesmadeinspain.com/noticia/pagid/200/titulo/Catalonia%20plans%20to%20build%20an%20offshore%20wind%20%22test%20station%22/

Source: http://es.windfinder.com/windstats/windstatistic_boja_de_tarragona.htm
WIND MEASUREMENTS BY SATELLITE

QuikSCAT satellite
It measures the wind speed from 3-20 m/s

Density of power in oceans. Winter (top graphic), summer (bottom graphic).

http://winds.jpl.nasa.gov/missions/quikscat/seawinds_img.cfm

HIDRAULIC BLADE CONTROL

At low speed wind we will place the blades with low angles, for maximum uptake. When the wind reaches about 13 m/s wind turbine produces maximum power, and must be controlled not to increase the speed above 19 rpm (case of ECO-74). If it exceeds 25 m/s wind turbine must be stopped.

The blades can rotate from 2 degrees (maximum uptake of wind) to 86 degrees (no wind capture, aerodynamic brake). The angle of each blade is independent.

Source: brochure Alstom ecotècnia ECO-74
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DISTRIBUTION OF WIND TURBINES

In order to locate the turbines, we have to consider that distance between turbines has to be two and three times the rotor diameter to avoid problems between them.

Using larger turbines involves having less machines maintenance and obtain higher powers.
PROJECT ZEPHIR

The “Catalonia Institute for Energy Research” (IREC) will conduct a pilot test plant, where offshore wind energy companies involved in the project, will install their turbines.

The Project has two phases: in a first phase four wind turbines will be installed fixed to the seabed for about 3.5 km from coast. In a second phase, up to eight floating wind turbines will be installed, for about 30 km from the coast.


<table>
<thead>
<tr>
<th></th>
<th>PHASE 1</th>
<th>PHASE 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of sea</td>
<td>40-45 m</td>
<td>&gt; 100 m</td>
</tr>
<tr>
<td>Distance from the coast</td>
<td>3 km</td>
<td>30 km</td>
</tr>
<tr>
<td>Number of wind turbines</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Installed power</td>
<td>20 MW</td>
<td>50 MW</td>
</tr>
<tr>
<td>Type</td>
<td>Monopile fundation</td>
<td>Floating structure</td>
</tr>
</tbody>
</table>

The type of technology used in marine wind farms is due to the depth of the seabed and the cost of different technologies.
Zephyr Project Phase I. Four turbines are located and fixed to the seabed at a distance of 3.5 km from coast and at a depth of 35 m. with a power installed of 10 to 20 MW.
PROJECT ZEPHIR PHASE II
DEEP WATER

Zephyr Project Phase II. Eight floating structure wind turbines will be located at a distance from coast of 30 km at a depth of 100 meters.

Project HYWIND. Worldwide the only floating marine wind turbine that is today in deep water is located in the North Sea to Norway. It is in the experimental stage with a power of 2.3 MW (March 2011).

The center of the electrical connection is proposed to put in Vandellós because it is a strategic place of the electric grid.

The submarine electric cables which connect the wind turbines with the transformer station have to take care with the environmental impact of the posidonia.

In the green zones there are some posidonia.

Remains of posidonia in the beaches near Vandellós.

http://www.ree.es/transporte/mapa_red_transporte.asp

WIND TURBINES PROJECT ZEPHIR

WIND TURBINES WITHOUT GEARBOX? YES

WIND TURBINES WITH TECHNOLOGY OF PERMANENT MAGNETS OF 6 MW

http://www.aeeolica.es/userfiles/file/reoltec2010/3-2-Pep-Prats_ALSTOM-WIND.pdf

The energy of the wind is a resource a lot of abundant. To use it correctly we must use the climatic advantages of the countries to obtain renewable energies and can reduce the consumption of the fossil energies.

For reaching the obstacle present on the shores of our country, where the marine is very narrow and waters are deep a few miles from the coast, it is necessary to advance research on offshore wind energy in deep waters.

The sea breeze has an air flow strong and constant.

Wind power can save over 2,000 liters of water per MWh of electricity produced.

To mitigate climate change, the energy sector should not only prevent the emission of polluting gases into the atmosphere, but also to drastically reduce water consumption. The wind energy is a sustainable solution that would get these two challenges.