

Portugal Wind Energy Situation

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Abstract: In the last few years, the wind energy development in Portugal has increased enormously. Since 2000 there was an expansion from 76MW to the actual 1908MW, with an annual average increase of approximately 68% last year. To reach the 39% target set for the installed capacity from renewable sources until the year 2010, Portuguese plans, assumed by the governmental authorities and wind park investors, addresses until that year the installation of 3750 MW, multiplying the actual capacity, by approximately, two times.

Last year wind energy has represented 6% of the total energy produce in the country, and it is expected that in 2010 this value rise until 15%.

This work intends to describe the wind potential in Portugal in several aspects, meteorological, technological and economical.

Key-Words: Wind energy, Wind Potential.

1 Introduction

In recent years, the importance of renewable energy such as solar, wind, biomass, small hydro, etc., has been increasing because of the need to prevent global warming and to reduce harmful substances in environment.

Portugal is showing extreme difficulty in fulfilling the Kyoto Protocol, whose goal of 27% of increase of emissions, face the 1990, will enter in vigour already in 2008. To fight against this raise, the Portuguese Government has been making strong bets in renewable energies. To reach the 39% target set for Portugal in the European Union Directive 2001/77/EC, (recently reviewed by the Portuguese Government to 45%), the Government established an objective for the installed capacity from renewable sources by the year 2010, firstly through the "E4 Programme" and, on the 28th of April 2003 through the Resolution of Council of Ministers n° 63/2003. From nearly 7200 MW total capacity installed in June 2007, the current target is to reach a global 9680 MW by 2010 (based on gross national electricity consumption of 56,1 TWh).

Table 1 shows the Portuguese actual situation and the expected in 2010 concerning to renewable energies production.

Table 1. Portugal renewable energy targets

Resource	In 06/2007 (MW)	In 2010	
		E4 Programme	RCM 63/2003
Wind	1908	3000	3750
Large Hydro	4515	5000	5000
Small Hydro <=10 MW	290	500	400
Biomass	381	100	150
Biogas	8.2	50	50
Solar PV	2.3	50	150
MSW	88	130	130
Waves	0	50	50
Total	7193	8880	9680

Today, renewable energy represents actually 32% of the total installed power capacity.

2 Wind Power actual situation

As Table 1 shows, the wind capacity installed in Portugal reached 1908 MW in June 2007, distribute by 144 plants and 1070 wind turbines, as presented in Table 2.

Table 2. Installed wind capacity in Portugal

	Turbines	MW
Actual situation	1070	1908

56% of the wind capacity installed is in plants with capacity above and equal 25 MW, as showed in Table 3.

Table 3. Classification of the wind projects according to their size

Size (MW)	Number of wind parks	% June	Capacity (MW)	% April
[0 to 1]	23	16%	16	1%
]1 to 10]	62	43%	299	16%
]10 to 25]	41	28%	615	32%
]25 to 50]	13	9%	458	24%
> 50	5	3%	520	27%
Total	144	100%	1839	100%

The wind production has been remained above of the 2 120 hour's equivalents for MW, with in 2006, 41% of the generated energy in installations with more than 2 250 hours as can be seen in Table 4.

Table 4. Production hours in wind parks with stabilized production in 2006

Hours	MW 2006	% 2006	GWh 2006	% 2006
Total	999	100%	2 119	100%
> 3000	10	1%	32	2%
> 2750 ≤ 3000	26	3%	73	3%
> 2500 ≤ 2750	86	9%	228	11%
> 2250 ≤ 2500	219	22%	537	25%
> 2000 ≤ 2250	262	26%	570	27%
> 1750 ≤ 2000	221	22%	423	20%
≤ 1750	175	18%	255	12%

The INETI Renewable Energies Department [1] developed a Portugal wind potential database - EOLOS2.0 that presents the physical and energy characteristics of the atmospheric draining in a set of 57 places in Portugal Continental, and a simplified calculation sheet that in function of the investment, allows evaluation of the economical viability of any given project.

The Engineering Faculty of the Porto University in collaboration with the Mechanics Engineering and Industrial Management Institute, INESC (Porto) and the Research Centre for Wind Energy and Atmospheric Flows (RCWEAF) has developed the "software" VENTOS, that is used for computational simulation of the wind draining behaviour on complex soils with or without arborisation [2]

In [3], a geographic information system (SIG), describes a methodology to build a Portugal wind energy potential database.

These projects are important, because they allow to determine the wind energetic potential in several areas of the country.

The wind power generation is distributed in the districts and autonomous regions as Fig.1 illustrates.

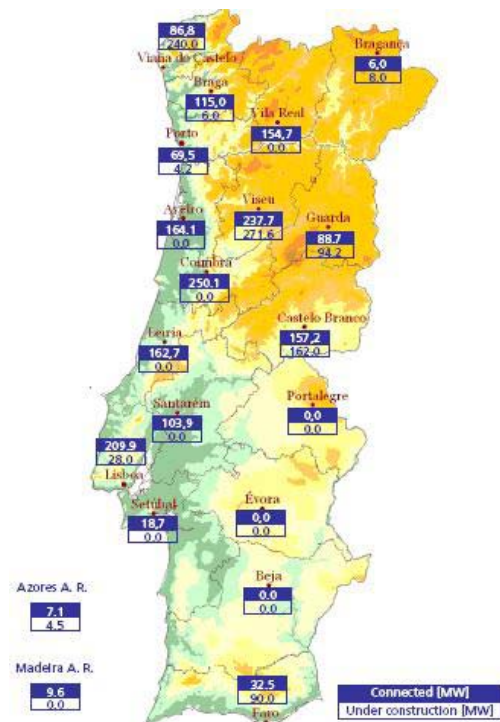


Fig. 1. Wind power distribution [4]

As can be seen in Fig. 1 the wind power production is mainly centralized in the interior zones of the country.

This fact is related with the geography and the spatial wind speed distribution of Portugal, as showed in Fig. 2 and Fig.3.

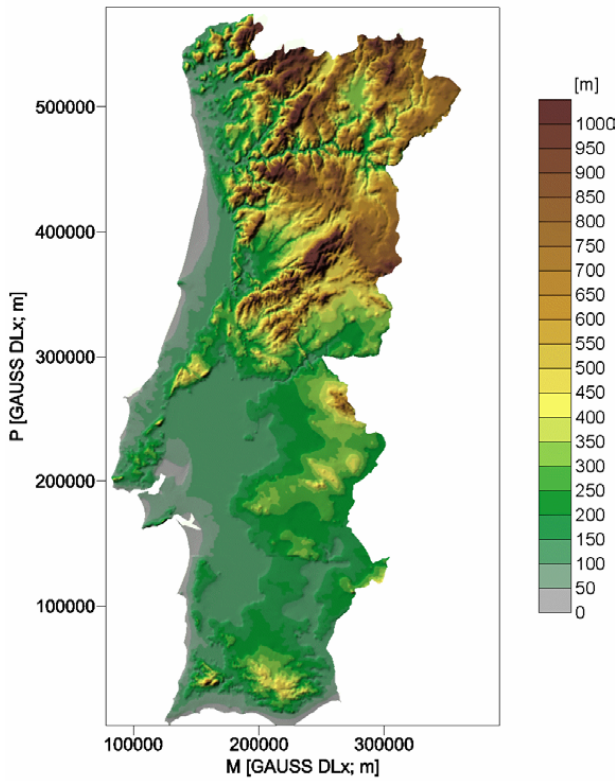


Fig. 2. Altitude map of continental Portugal [3]

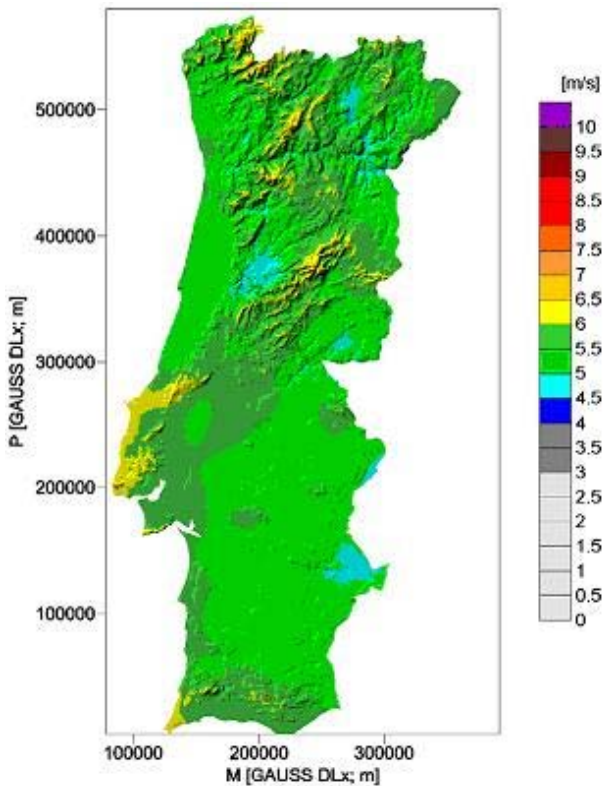


Fig. 3. Spatial wind speed distribution in Portugal continental, at (h=60m) [3].

One of the major concerns and difficulties in the development of wind plants is the drainage of the produced electric energy.

The Portuguese territory presents a great inequality in the distribution of the population, industry and other activities with large energy consumption..

A huge population concentration in the coastal regions has, as consequence, the concentration of transmission and distribution lines of electricity in these areas, contrarily to the reduced number and capacity of the transportation lines in the interior regions. The areas with greater wind potential are concentrated in remote regions, mainly in the interior, and that leads to the existence of low wind power production limits that can be injected in the net. This limitation brings the necessity to build large and expensive lines to connect the pre-existing net to the new wind plants.

The Fig. 4 illustrates the actual and under construction high voltage lines.



Map References:

Voltage	400kV	220kV	150 and 130 kV
In operation			
In Future operation			

Fig. 4. High Voltage System in Portugal [5]

In spite of having 832km of Atlantic coast, in Portugal there are not wind sea plants. The waters of the Portuguese continental platform are relatively deep in some zones, but very beaten for strong and continuous north wind, throughout the year without cyclonic frightening and the typical turbulence of the terrestrial spaces, therefore ideal under the wind point of view.

Having many available places, Portugal cannot use to advantage the vast space of the Bugio, the zone of Peniche, the Baía de Monte Gordo, the coast of Aveiro. All the Algarvia coast is propitious to the installation of wind towers, although the regimen of the winds not to be so intense as of the Atlantic coast, but the depth is bigger and is a zone of intense maritime traffic there.

In many countries people are becoming accustomed to the sight of turbines on mountains and stretching into the sea. However, a relatively new sight is that of wind turbines mounted on, or integrated into buildings. In Portugal, unfortunately, in nowadays, there are few projects in this area.

Portugal is a country with scarce energy resources, mainly those that assure the energy necessities of the majority of the developed countries (as the oil, the coal and the gas). Such situation of scarcity leads to higher exterior energy dependence (87.2% in 2005) [6].

The wind availability and speed are the main factors for the economical evaluation of electric energy production projects with this renewable resource. Therefore it is important to proceed to an evaluation of the resource before initiating the projects. In most cases, a wind production system needs a wind annual average speed of 15 km/h, (4.2 m/s) [7].

3 Future Perspectives and Conclusions

A recent governmental law DL 225/2007 from 31 May, allows an 20% increased in the total injection attributed power in installed wind plants.

There are 82 projects under construction with attributed connection points, in a total of 1801MW. The Government launched in 2005 an international competition for the attribution of 1.700 MW of licenses for wind energy production separated in two phases. The first phase it is already finished and it will create 48 new wind plants, until 2009, all over the country in a total of 1200MW that will generate 2700 GWh of clean electricity per year, avoiding the emission of 1 million of CO2 tons. It will represent 25% of the national wind energy

production in 2010, been the equivalent to the domestic electric consumption of 2.3 million inhabitants [8]. They will also be create several industrial clusters that will allow to Portugal not only to produce the necessary turbines for is own consumption but also to export the technology.

The second phase will attribute 400 to 500 MW. Until 2013 it is expect the sum of approximately 6100MW of wind energy installed in the country (Table 5) [9].

Table 5. Estimated Power in 2013

Nature	Estimated Power (MVA)
Actual installed Power	1 839
To be installed	3 201 to 3 301
Total	5 046 to 5 146
20% of over-equipment	1 009 to 1 029
Total	≈ 6 100

Comparatively with another EU countries Portugal, in the last few years, have highly increased is wind energy potential.

The Table 6 below shows the installed wind power capacity of the top 10 countries at the end of 2006. The actual total for Europe is 48.545 MW and as can be seen, this group makes up 94%, even though there are now 27 countries in the EU [10].

Table 6. Top 10 Wind Power Capacity in EU Countries in 2006

Country	(MW)	Growth in 2006 (MW)
Germany	20 622	2 233
Spain	11 615	1 587
Denmark	3 136	11.5
Italy	2 123	417
UK	1 963	634
Portugal	1 716	694
France	1 567	810
Netherlands	1 560	356
Austria	965	145.6
Greece	746	172.5
Total	46 013	7060.6

It has been made a big effort from the authorities to ensure that the environmental compromises assumed are fulfilled. As showed, Portuguese market should be well on the way to meeting the government target of more than 3.750 MW by 2010.

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