CHAPTER 24
PORTUGAL

1.0 INTRODUCTION

During 2005, Portugal reinforced the tendency shown during 2004 of high growth rate of wind capacity installation. Also visible was some simplification of critical administrative processes concerning the implementation of renewable energy projects and, for the second year in a row, Portugal almost doubled the installed wind power capacity.

In the following sections, a synthesis of the actual situation is presented with a main focus on the Portuguese current state of development and trends.

2.0 PROGRESS TOWARD NATIONAL OBJECTIVES

2.1 STRATEGY

The bulk of renewable energy production in Portugal is supplied by hydropower, biomass/waste sources, and recently a steadily growing capacity of wind power. In view of the country's very high dependence on imported fuels in recent years, the government has established a number of policies to increase the level of renewable energy development. The Resolution of the Council of Ministries (RCM) 169/2005 established that the energy policy of Portugal must reduce its external dependency. This gave rise to the establishment of new objectives to attain by 2013 for the electricity produced by RES in general, having the wind as its main component.

During 2005, new legislation was published (Dec. Law 33 –A/2005) concerning the applicable procedures and tariffs for renewable energy production, with a main focus on wind parks. Following the environmental change scenarios (projects SIAM and PNAC –National Plan of Climatic Changes RCM N.o 119/2004 in I SÉRIE-B N.o 179) and the Portuguese ambitious goals both on the installation of RES and on the European Union emissions reduction directive, studies were carried out in order to evaluate the sustainable wind energy resource in continental Portugal. As a result of several studies and the Portuguese government commitment on RES, a new national goal for wind power was established, and 5,100 MW of wind capacity will be available in the electric grid by 2013 to connect wind parks under the Governmental Resolution RCM 169/2005.

Table 1 Key Statistics 2005: Portugal

Total installed wind generation	1,060 MW
New wind generation installed*	529 MW
Total electrical output from wind	1.773 TWh
Wind sector turnover	154 million €
Wind generation as % of national electric demand	3.6 %
Target:	3,750 MW by 2010
* Operating	

Until 2010, the Portuguese goal for the wind sector remains the installation of 3,750 MW of wind capacity. Since the new Dec. Law 33-A (published on 16 February 2005) will be applicable only for new grid connection permits issued after its publication date, the RES investments for installation in 2005 are still regulated by previous legislation and tariffs, mainly the legislation package published in December 2001 within the Decrees of Law 312/01 and 339-C/01; the first covers the technical and licensing procedures and the second the tariffs for renewable energy production. (Table 2)

2.2 Progress in 2005

In the beginning of 2005, the installed wind capacity in Portugal had only reached 15% of 2010 goals, and 2005 was considered a decisive year. If the country had the infrastructures to install 500 MW (approx.), the capacity goals for 2010 would be achieved, once the yearly growth rate at constant capacity was calculated to be 530 MW/yr from 2005 to 2010. This proved to be feasible. Approximately 634 MW of wind capacity was installed in 2005, 529 MW of which had grid connection completed and full official operation permits issued. A full 27% of the capacity goals for 2010 were achieved by the end of the year. This constant growth rate is expected to continue for the next few years. However, in the 2007/2008 period, the limited production capacity of the manufacturers of wind turbines, as well as the necessity to construct new transmission lines (that traditionally face very slow environmental impact assessments) may still affect the full achievement of the national goals.

The accumulated wind capacity and number of turbines installed and operating in Portugal by 31 December 2005 are presented in Table 3.

Due to the high growth rate of the wind sector in Portugal, it should be noted that, although a large number of wind turbines were already installed in wind parks by the end of 2005, they were contractually still under test or commissioning phase. To highlight that fact, Table 3 shows both the installed and fully operational data about the wind sector by December 2005.

In 2005, the electrical energy produced by wind parks was 1,773 GWh, according to the statistics

Table 2 Objectives for national planned capacity in 2010 and 2013 compared to status in 2005

RES type	Operating in 2005 [MW]	Goal 2010 [MW]	Goal 2013 [MW]
Wind	1,060	3,750	5,100
Small Hydro (<= 10 MW)	272	400	400
Biomass	12	150	150
Biomass (with cogeneration)	345	n.a.	n.a.
Solid waste	88	130	130
Biogas	7.1	50	50
Ocean	0.5	50	50
Photovoltaic	2.3	150	150
Eq. Solar thermo (0.7 kW = 1m^2)	193	700	700
Large Hydro (>10 MW)	4,476	5,000	5,000
Geothermal	18	n.a.	n.a.
Total	6,474	10,380	11,730
Source: DGGE, INETI			

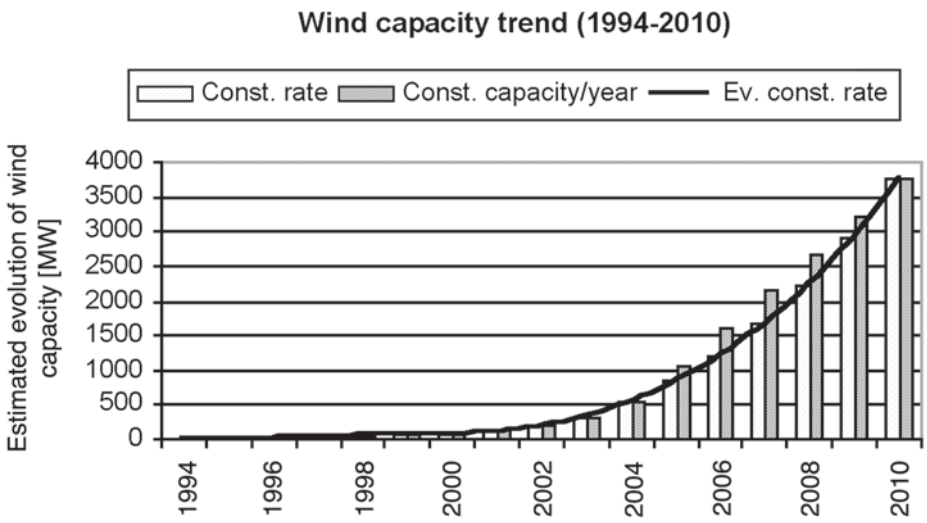


Figure 1 Trend of the wind power capacity installation towards the 2010 national targets.

of the official energy board, DGGE - General Directorate for Geology and Energy, for the continent and the estimated production values for the Azores and Madeira archipelagos.

Uncorrected by the date of entry under industrial production this production would give about 1,764 hours of production at nominal power. Introducing this correction, the value for this equivalent parameter is 2,362 hours of operation at equivalent to nominal power. Figures 2 and 3 show respectively the evolution in the capacity installation and the wind energy production. Figure 4 depicts the location of wind parks in continental Portugal.

A rate of growth of approximately 118% was observed in 2005, significantly higher than in the previous years, after steady growth was initiated in 1999.

A representative number of wind park projects reached their final installation phase during 2005, enabling the installed (and commissioning phase projects) capacity to more than double. The rate of development for the last ten years is displayed in Figure 5.

3.0 BENEFITS TO NATIONAL ECONOMY

3.1 Market Characteristics

During 2005, the unit cost of wind turbines remained constant with the actual mean cost of the conversion equipment, per installed kW, varying

Table 3 Total installed capacity and number of wind turbines in Portugal (2005)

	Wind Capacity [MW]		Total number of wind turbines [turbines]	
	installed	operating	installed	operating
Continent	1,149	1,043	717	672
Azores	7	7	28	28
Madeira	10	10	43	43
TOTAL	1,165	1,060	788	743

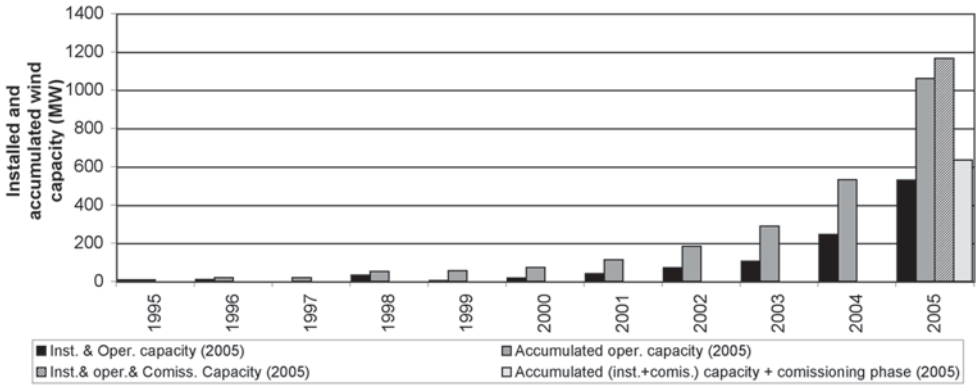


Figure 2 Installed and accumulated wind power capacity (1995-2005).

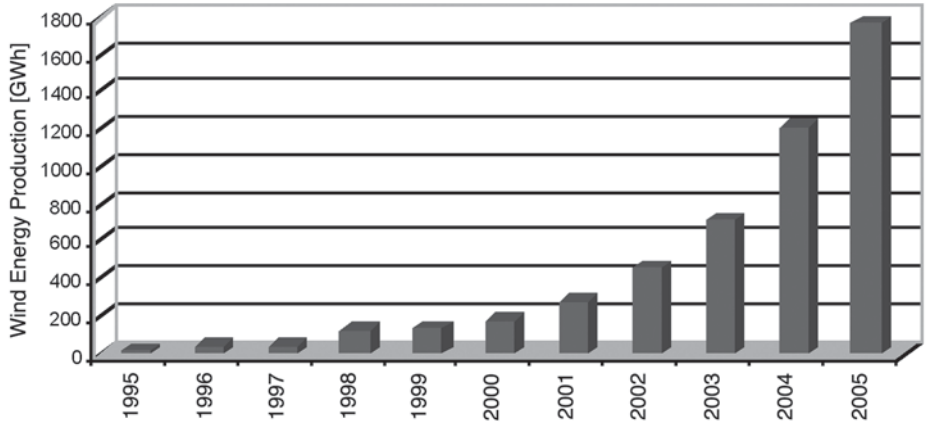


Figure 3 Wind energy production (1995-2005).

in the range from 650 € to 950 €, depending on the country of origin of the turbines, its individual capacity, and the ratio of this capacity to the turbine diameter. The effects of the sector "learning curve" on the unit cost reduction has not been as visible in Portugal as in other countries, due to the tendency to install large wind turbines, sometimes equipped with the larger available rotors, thus with higher individual costs than smaller units.

The major constraints in Portugal, as in 2004, and which are not exclusive of wind park projects, remain the excessively bureaucratic and long authorization system to obtain all the different permits required to install and operate a wind park. In some sites such as in environmentally protected areas, it may take from 4 to 5 years until the first permit is issued to begin construction. The permits required to develop a wind park that tend to be more difficult (and take longer) to obtain continue to be related to the environmental institutions.

3.2 Industrial development and operational experience

In 2005, about 290 wind turbines were installed in Portugal with individual capacities ranging from 0.6 to 3 MW. The shares of installed power by wind turbine manufacturer and wind park developer are displayed in Figure 6.

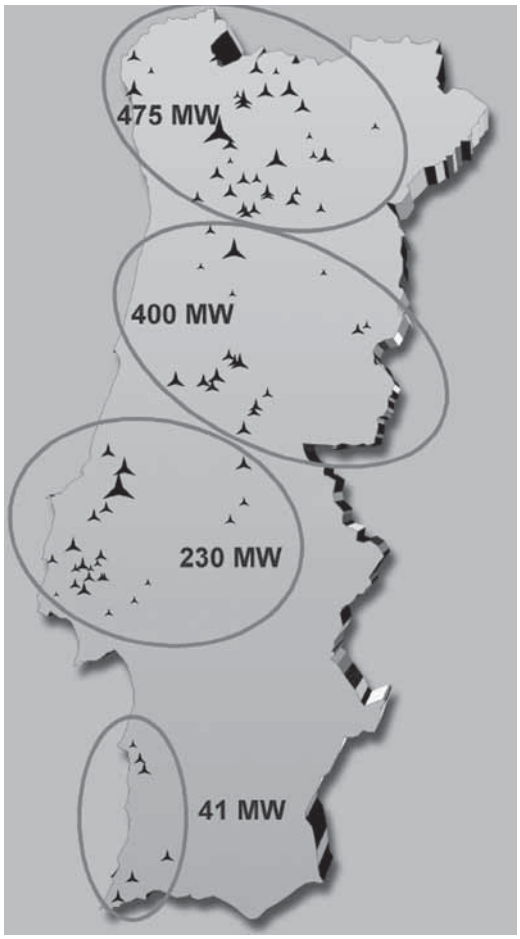


Figure 4 Location of wind parks in Portugal.

According to REN – Rede Eléctrica Nacional, the Portuguese TSO - Transmission System Operator, by the end of 2005 the ratio between the wind power capacity installed and the total capacity was approximately 10%.

There is no industrial production of wind turbines in Portugal. However, there is incorporation of technology for the towers with three Portuguese manufacturers active in this field, and in what relates to electrical equipment, namely power transformers and wind park cabling.

The call for wind park grid connection opened in February 2005 and showed the government's clear objectives to create the needed conditions to develop an industrial cluster in Portugal. Although the initial call was reformulated in July 2005, those objectives were maintained and amplified, including incentives for technology transfer, industrial investment, and job creation in order to increase the social value of this form of renewable energy and distribute locally its externalities.

Actually, the industry in Portugal is mainly focused on tower production for the domestic and foreign markets with three factories currently active.

Operational experience has been good. During 2005, there was one reported serious fire in one

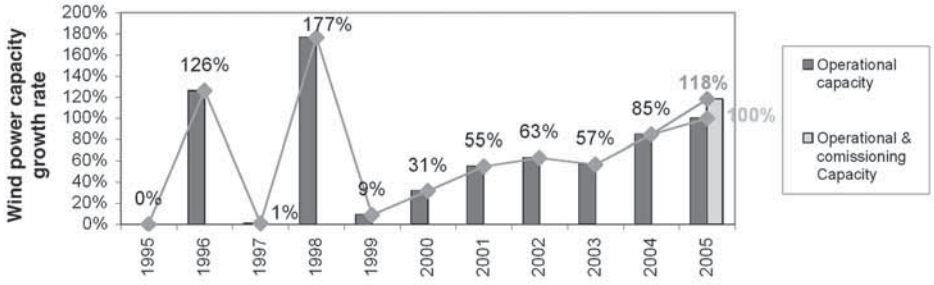
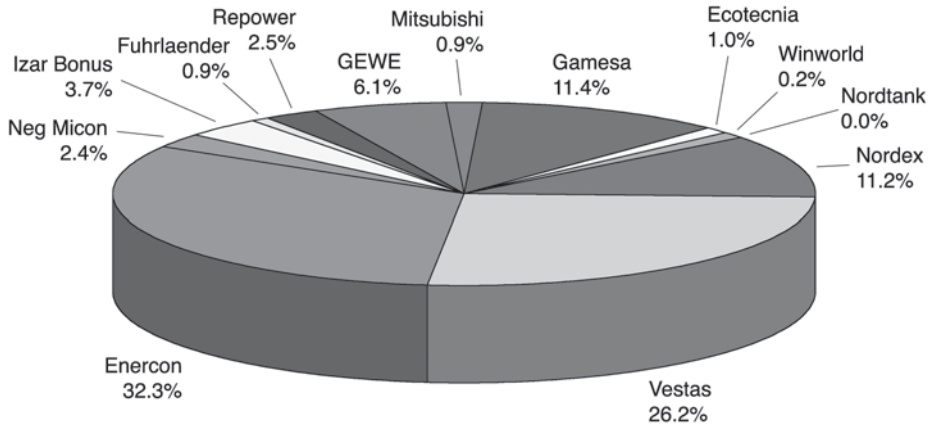
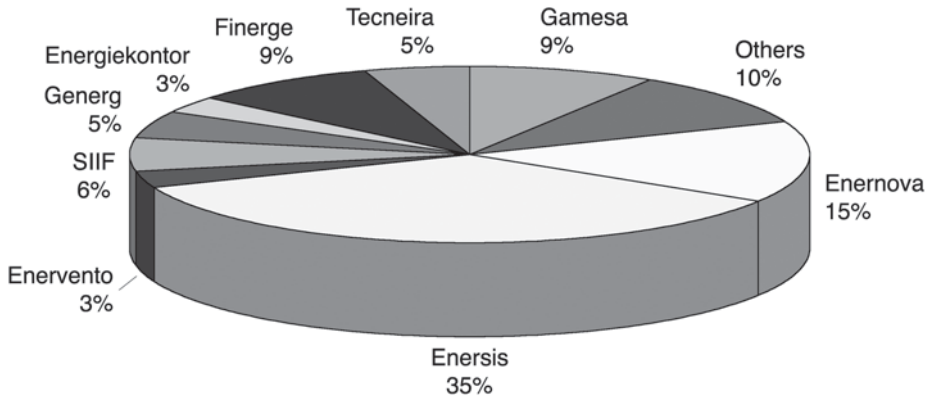


Figure 5 Wind capacity growth rate in the 1995-2005 period.



a) by wind turbine manufacturer.



b) by wind park developer.

Figure 6 Share of installed capacity by (a) manufacturer and (b) developer.

of the wind turbines located north of Lisbon resulting in the replacement of all components except the lower sections of the tower. Another accident with one wind turbine in operation in the extreme south of the country resulted in the total loss of the turbine.

3.3 Economic Details

The trends in the Portuguese wind sector investment are moving towards multi-megawatt wind machines due to high cost and the terrain orography. Although the cost structure of the wind park projects is considered a classified subject by most private investors and financial institutions, the total costs in 2005 are in the range of 900 to 1,100 € per installed kW. Annual contracted costs for maintenance vary between 17 and 19 million €/MW/year.

During 2005, new legislation was published regarding renewable energies tariffs – (Dec. Law 33-A/05). The tariff trend for wind energy based production in the period 1998 to 2005 is depicted in Figure 7.

According to the data published by the Portuguese utility (EDP – Electricidade de Portugal) the net

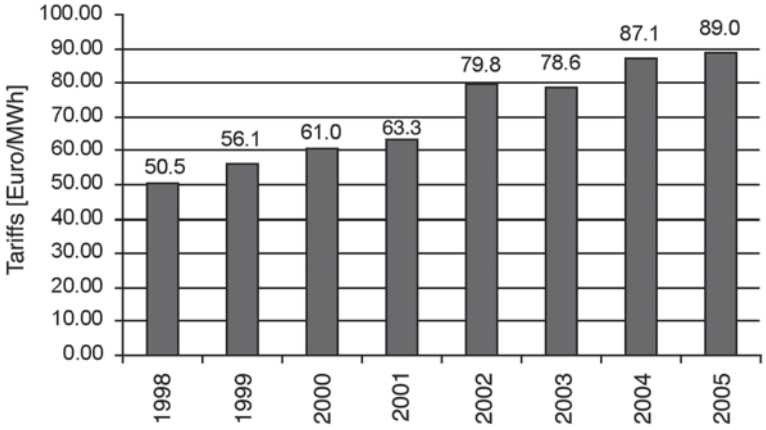


Figure 7 Evolution in tariffs for wind energy based production in the period 1998 – 2005.

electric energy consumption during 2005 was 47,971 GWh which represents an increase of 5.4% with reference to 2004 (4.7% when corrected by the temperature and working days). The wind energy contribution to the total consumption was, according to the Portuguese (TSO) REN, 3.61%.

4.0 NATIONAL INCENTIVE PROGRAMS

The installation of wind power capacity has been stimulated in recent years by a number of national policies, almost doubling its capacity in 2005 and reaching the level of 634 MW. The supporting policies have been provided to promote an increase of national renewable energy production. Following the publication of DL 33-A, in February 2005, an official call for wind park grid connection was opened by DGGE. For administrative reasons, this call was closed shortly after opening, had its main terms revised, and was reopened in July 2005 with a deadline for January 2006. Its evaluation will be programmed during 2006.

Among the changes introduced by DL 33-A with high impact on new wind projects is the reduction of applicable tariffs (~15% at the date of publication in February). This tariff reduction has a practical direct consequence on the reduction of the national sustainable wind power capacity – that preliminary studies indicated to be about 6,000 MW. However, the main factor for wind park developers is the non-actualization of the electricity tariff with inflation, a factor that may drastically limit this sector's revenues for future projects and limits its deployment due to the lack of economical sustainability of new wind power investments.

In what concerns the interconnection of micro-generators and small distributed sources of electrical energy (up to 150 kW) to the low voltage grid, the applicable legislation during 2005 was stated in the Dec.-Law no. 68/2002, which defined mechanisms intended to speed up administrative and technical procedures associated with the implementation of small units.

Although the governmental agreements between Portugal and Spain regarding the constitution of the Iberian Market of Electric Energy (MIBEL) were decided in 2004 and officially ratified by both the Portuguese Assembly and Presidency in the Dec-n.o 19-B/2004 (in I SÉRIE-A N.o 93), the MIBEL is still not operating. The main reason for that is normally attributed to the postponing of some practical measures to merge the two systems

and operate an integrated market as well as the necessity to implement the agreed political decisions.

5.0 R,D&D ACTIVITIES

Portugal does not have a specific governmental program for sponsoring R,R&D activities related to renewable energies in general and wind energy in particular. Research in the wind energy area is funded by several programs under the general topics of Energy, Electrical, and Mechanical Engineering. There are various active research groups, mainly located in Lisbon and Porto.

The National Institute for Engineering, Technology and Innovation I. P. (INETI) is a part of the Ministry of Economy and Innovation is the most active and visible National Laboratory in this area. INETI activities and R&D projects in the wind energy field are partly financed by the national government.

The R,D&D needs and trends in what concerns wind energy in Portugal were identified in the following issues:

- Wind power production forecast;
- Wind resource assessment in complex terrain;
- Wind power production monitoring by economic dispatch and remote operation by clusters of wind parks;
- Local grid planning and wind park power quality assessment according to IEC/CEN standards;
- Wind/hydro production correlation and use of pumping facilities for regulation and storage of excess wind power production;
- Urban and constructed environment for wind power applications;
- Development of low-cost small wind turbines;
- Offshore wind power studies.

The projects currently underway are mainly oriented to the development of wind/hydro common regulation (wind for hydro pumping use under excessively high penetration), due to the high hydro capacity installed in this country and the high correlation between availability (and sometimes excess of) hydro resource and wind during the winter months. This issue is being studied also by INESC in cooperation with the Portuguese utility (EDP).

5.1 National R,D&D Activities

In the North of Portugal (Porto) R&D activities are mainly carried out by research groups based at FEUP - Faculty of Engineering of the University of Porto and INEGI - Instituto de Engenharia Mecânica e Gestão Industrial and are part of the research network established by the Portuguese Foundation for Science and Technology (FCT), namely within the associate laboratory INESC Porto (Instituto de Engenharia de Sistemas e Computadores do Porto) and the Research Centre for Wind Energy and Atmospheric Flows (RCWEAF). During 2005, INESC Porto continued the research activities of project DIPTUNE (Nº POCTI /41614/ESE/2001). Development of techniques for controlling DFIG for the provision of primary frequency control and response to System Operator control requests was further pursued and successfully implemented under PSS/E simulation environments. As an outcome of this project, more papers were published in IEEE PWRS transactions.

5.2 Collaborative Research Offshore Siting

INETI participated in the identification of sites for offshore wind parks installation in the Atlantic coast based on the construction of the Portuguese Wind Atlas. The methodology for this Atlas development was applied to represent the spatial distribution of the wind potential offshore, and the results were then introduced in a Geographic Information system, to enable the selection of areas of interest to install wind parks in coastal areas.

Unlike previous common public opinions, the preliminary results of this work (Figure 8) enhance some interesting areas for developing

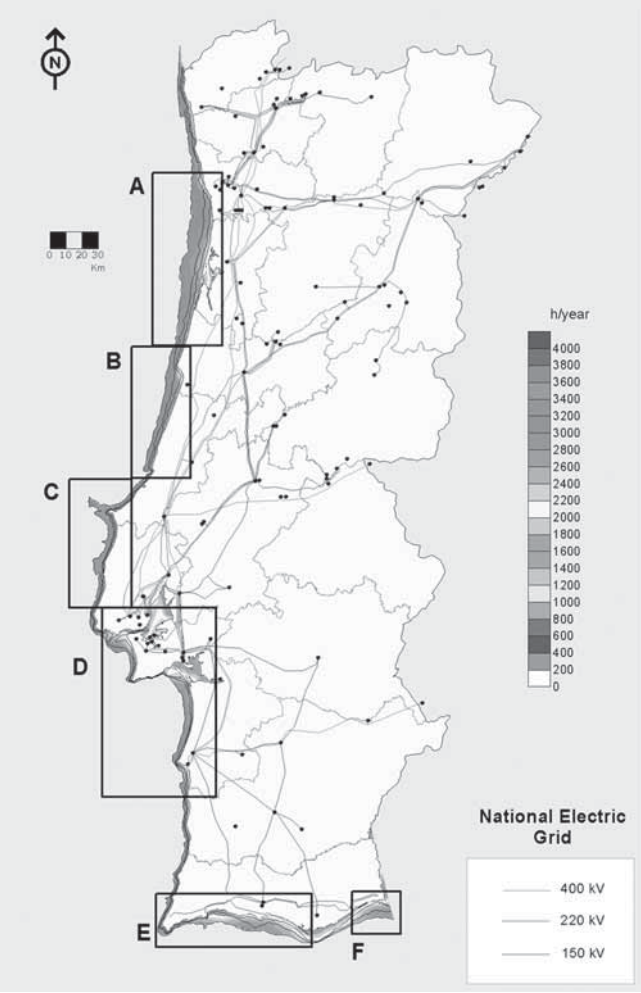


Figure 8 Offshore Wind Atlas preliminary results, with a 1,500-kW wind turbine for h=60m.

offshore wind parks. A more sophisticated study must be realized in order to deal with the presence of navigation channels, bridges, and other hydrodynamical estuarine phenomena (in the case of area D).

6.0 THE NEXT TERM

Results obtained in the offshore preliminary studies lead INETI to start a new monitoring campaign in a coastal region, in order to perform a validation study on the Offshore Wind Atlas for Portugal. Therefore a high resolution resource assessment campaign in the most relevant coastal areas of continental Portugal is being prepared with outputs "combined" from long term mesoscale simulations and microscale models to estimate a rigorous and highly accurate assessment for offshore wind power in Portugal. Although the sustainable wind resource is not as high as in the North of Europe due to the sharp bathymetry of the continental platform, some sites were already identified and are currently under study by potential developers.

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Reference

(1) According to General Directorate for Geology and Energy (DGGE).

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