31 Portugal

Source: Luis Marinho

1.0 Overview

In Portugal, 2012 was an atypical year in Portugal with regards to energy. Due to the efficiency measures implemented in recent years, but also due to the economic recession, electricity consumption in Portugal dropped 3.6% to 49.1 TWh. This represents a reduction of 6% of electricity demand in the last two years (1). It was also an extremely dry year, the fifth driest hydro year of the past 80 years (63% below the normal climate). Therefore, due to the reduced hydro production, the renewable contribution for the energy mix decreased 17% compared to 2011.

The wind sector continued to grow with a wind generation of 10,011 GWh, which accounted for 20% of the country's electric demand (1). Portugal's wind penetration is now only surpassed by Denmark. Portugal is reaching the renewable contribution target for 2020; therefore the rate of capacity installation has slowed considerably. During 2012 only 147 MW of new wind capacity was installed compared to 315 MW in 2011. Despite slowing its deployment pace, Portugal reached the capacity of 4,517 MW. This represents 23% of renewable electricity generation's installed capacity, which accounts for 58% of the total installed capacity (2).

The first offshore wind floating system (the second in the world) installed in the north of Portugal (near Aguçadoura coast) operated smoothly throughout the year and produced more than 1.7 GWh in the first half of 2012 (3).

2.0 National Objectives and Progress

2.1 National targets

The capacity targets currently in place were established in June 2010 by the former government through the Plano Nacional de Acção para as Energias Renováveis (NREAP) (4). This plan established a course of action needed to reach an installed minimum capacity of 6,875 MW by 2020, where 6,800 MW will be installed onshore and 75 MW offshore.

2.2 Progress

In 2012, the new wind generation capacity follows the capacity's saturation trend of the last few years as displayed in Figure 1. A net capacity of 147 MW was added in 2012 (149 MW of new capacity installed and 2 MW decommissioned). This value was the lowest installed since strong wind deployment was initiated in 2004. Cumulative installed capacity until 2012 is distributed over 223 wind farms with 2,408 wind turbines operating across the country, one of them being a floating offshore wind turbine (2). The wind capacity generated 10,011 GWh in 2012 which corresponded to 20% of the Portuguese electricity demand and 50.2% of the renewable generation (2).

The average production at full capacity was 2,313 hours in 2012. The wind energy production by classes of number of hours at full capacity (NEPs) was concentrated in wind farms with NEPs between 2,000 and 2,500 hours (58%). Although the wind index was below 1, the wind parks with NEPs below 2,000 hours reduced their share in 2012 from 19% to 14% and on the higher production range, the wind parks with NEPs from 2,500–2,750 hours and above 3,000 hours experienced an increase of 8% with respect to 2011(2).

With 2012 being such a dry hydro year, it is no surprise that the renewable energy contribution decreased by 6.7% with respect to 2011, meeting 38.4% of this year's electric demand. The largest share of renewable production came from wind energy, which accounted for 50.2% and was 13% above 2011, with the reduction of 17% from hydro power plants (32.3%). The remaining sources were able to increase their contribution where the biomass sector represented 15.7%, and PV grew from 1.1% to 1.8% (2).

2.3 National incentive programs

In 2010, NREAP was approved, providing the strategy and incentives for renewable energy investments in Portugal. The targets defined in that plan are set to 2020 and foresee a quota for the renewables contribution for several economic sectors. The plan considers 2005 as a baseline, where the contributions

Wind generation grew to 10,011 GWh, which accounted for 20% of the country's electric demand.

Table 1. Key National Statistics 2012: Portugal	
Total installed wind capacity	4,517 MW
New wind capacity installed	147 MW
Total electrical output from wind	10.01TWh
Wind generation as % of national electric demand	20%
Average capacity factor	28%
Target:	Onshore: 6,800 MW Offshore: 75 MW by 2020

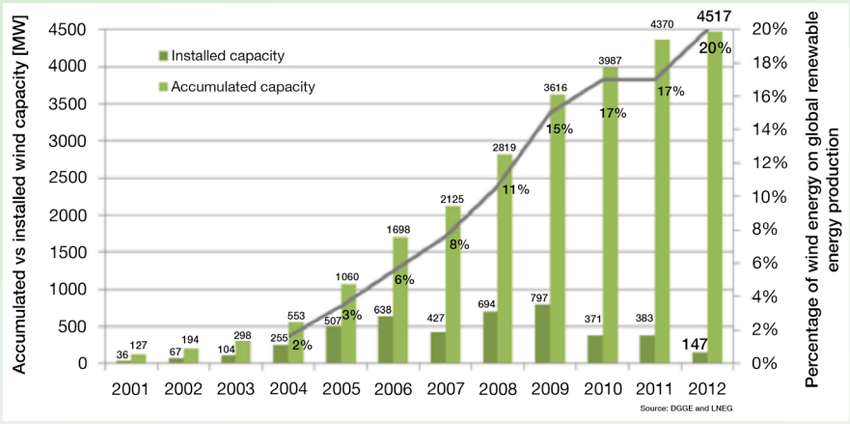

Figure 1. Installed versus accumulated wind capacity (bar graph) and percentage of wind energy production (line graph)

from renewables were 0.2% in transportation, 31.9% in heating and cooling, and 29.3% in electricity. The targets for 2020 are to raise those contributions to 10% in the transportation sector, 30.6% in heating and cooling, and to 60% in electricity (4).

Renewable energy installations for micro-generation and mini-generation continue to be the object of incentive programs in Portugal. The micro-generation law was established by the Decree-law 118-A/2011 that regulates the micro-production of electricity from renewable energy sources (up to 11 kW) and provides a simplified framework and licensing regime for connecting renewable energy producers to the distribution grid (5). In 2012 the reference value for micro-generation's feed-in tariffs (FITs) was 326 EUR/MWh (429.7 USD/MWh) and the annual capacity's cap allowed was 10 MW, in accordance with the Ordinance 284/2011 (6).

Although the mini-generation program was established in 2010 the Decree-law 34/2011 was not published and did not set its rules until March 2011 (7). This program introduces the opportunity for small companies to install renewable-based production centers of up to 250 kW. In 2012, there was a drop in the reference tariff of 14%, reducing the values from a maximum of 250 EUR/MWh (329.5 USD/MWh) to 215 EUR/MWh (283.4 USD/MWh) and a maximum value of 30 MW for annual grid connected power (Ordinance 285/2011) (8).

2.4 Issues affecting growth

In the first month of 2012, the Portuguese government suspended the capacity attribution for grid connection. This decision was justified by the need to reevaluate the legal framework for electricity generation (9). The decision had little direct impact on the deployment of wind projects since the existing and ongoing ones had their permit for grid connection already attributed several years ago.

On the other hand, Portugal reached wind penetration of 20% of the annual consumed energy—a very high value and the second highest in the world, surpassed only by Denmark, the pioneer country in wind deployment.

A limiting design parameter of electric systems like the Portuguese is the extremely high penetration of renewable, non-dispatchable sources (e.g., wind power or river run-off hydropower). On 14 December 2012 at 2:45 PM a new record was set for instantaneous wind penetration of 3,754 MW with 90% of power connection and a wind energy production of 84 GWh (54% of the consumption). The highest daily wind contribution to consumption was recorded on 14 April 2012 with a value of 65%. On 28 October 2012 at 5:30 AM the instantaneous wind penetration of 3,271 MW was recorded with a wind contribution to demand of 86% (1). Figure 2 depicts the wind generation profiles on i) the maximum demand day; ii) maximum daily contribution from wind; and iii) highest instantaneous production.

3.0 Implementation

3.1 Economic impact

In 2012, the wind industry in Portugal, together with the wind deployment activity (147 MW), supported an estimated 3,200

jobs. In 2012, wind generated electricity produced an estimate income of 984 million EUR (1.29 billion USD) and allowed the saving of 3.6 million tons of CO_2 emissions.

3.2 Industry status

In 2012, following the trend of recent years, Enercon consolidated its leadership of the Portuguese manufacturers' market. Of the 70 wind turbines installed in 2012, 44% corresponded to expanding the capacity of existing wind parks (under a process referred as "overcapacity"). Of the remaining 39 new wind turbines, 77% were Enercon, followed by Vestas with a 13% share, and Gamesa with10%.

By the end of 2011, the first offshore wind system, WindFloat, composed of a semi-submersible structure and a Vestas V80 wind turbine with 2-MW capacity was deployed at Aguçadoura. This site is located 6 km offshore of Póvoa de Varzim with a water depth of approximately 50 m. This project is being developed by WindPlus as a joint venture with A. Silva Matos (ASM), Energias de Portugal (EDP), Fundo de Apoio à Inovação (FAI), InovCapital, Principle Power, and Vestas Wind Systems A/S. Using the Windfloat technology, the consortium submitted a proposal for a floating offshore wind park to the European Programme NER 300 targeting the installation of five floating systems. This proposal was approved during 2012.

3.3 Operational details

Reviewing the 223 wind farms installed in Portugal by the end of 2012, 52% have an installed capacity below 10 MW, 40% have a capacity between 10–50 MW, and the remaining 8% are above 50 MW (2). During 2012, four new wind parks were connected in the Portuguese territory: one with a capacity of 2 MW at the North region, two with 8 MW in the Center, and 48 MW at the south of Portugal (1). The remaining capacity (96 MW) was installed under the "overcapacity" process. From these, nearly 42% of wind farms have a capacity between 10–50 MW, 47% above 50 MW and 10% below 10 MW. The tendency to deploy large wind farms was maintained in 2012 (2).

Due to the intrinsic characteristics of the Portuguese territory, the wind turbines operate in two different environments—the coastal or the mountainous region. In 2012, the coastal region had atypical wind availability and production. The Laboratório Nacional de Energia e Geologia (LNEG) indexes show a pronounced decrease on the coastal region with a wind availability of 12% under the average (0.88) and 16% under average on production (0.84). These values are the lowest since 1999. For the mountainous region, the scenario reversed last year's tendency, with production growing 10% (index 1.02) reaching a wind index close to the average (0.99). Data from the Portuguese Operation of Power Systems TSO (1) is in the line with the results presented from LNEG, indicating a range between 1.27 and 0.68 for wind generation indexes, when considering the period between 2001 and 2011.

3.4 Wind energy costs

During 2012, the average cost per MW installed was 1.35 million euro (1.78 million USD/MW), including projects, constructions, grid connections, land contracting and others.

According to the Portuguese energy regulator (ERSE), the mean tariff paid to the wind power plants increased 5.2 EUR/MWh reaching 98.3 EUR/MWh (129.6 USD/MWh) in 2012 (10).

4.0 R, D&D Activities

4.1 National R, D&D efforts

The national R&D efforts during 2012 were mainly focused on offshore wind energy, development of tools and methodologies to maximize the penetration of renewable energy, and promoting energy sustainability. These activities are taking place at the principal institutes and universities of the country financed through national or European programs. The main R&D activities underway in Portugal are described in the following paragraphs.

Project FP7 NORSEWInD: made up of 15 organizations between research institutes and industrial organizations with the Portuguese participation of LNEG funded by EC FP7. The project aimed to characterize and evaluate the wind resource on the northern seas and was concluded in 2012.

Project FCT Roadmap: a Portugal-based project funded by the Portuguese Science and Technology Foundation (FCT). Its purpose is to identify the constraints and barriers to the development of marine energies in Portugal.

Project FCT Fluct.Wind: a Portugal project funded by FCT with the coordination of LNEG. One of the main goals is to create a tool that will serve as a warning to the power system operators for possible severe wind power ramps.

Project IEE SEANERGY 2020: an EC-IEE project to evaluate and further develop the maritime spatial planning on the European space with the PT participation of LNEG. The project was concluded in 2012.

Project TWENTIES: a project to deal with transmission system operation with large penetration of wind and other renewable electricity sources in networks by means of innovative tools and integrated energy solutions. It is funded by EC FP7 and has the Portuguese participation of INESC-Porto.

Project MARINA: a project that brings together companies, technology centers, and universities from twelve EU countries. It is led by Acciona Energy and funded by EC FP7 with the Portuguese participation

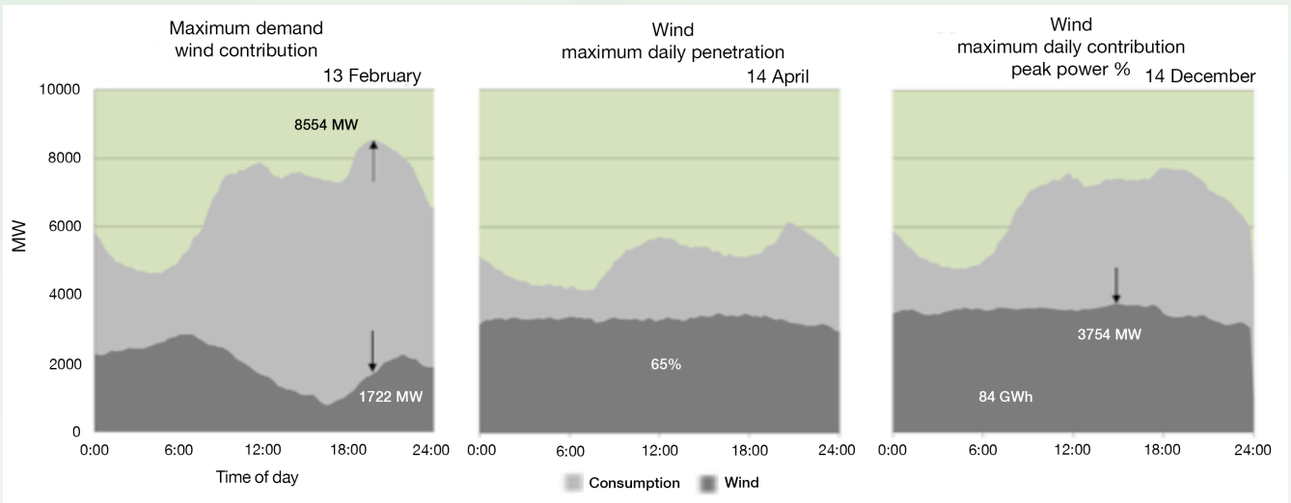

Figure 2. Record wind power penetration and energy generation during 2012 (1)

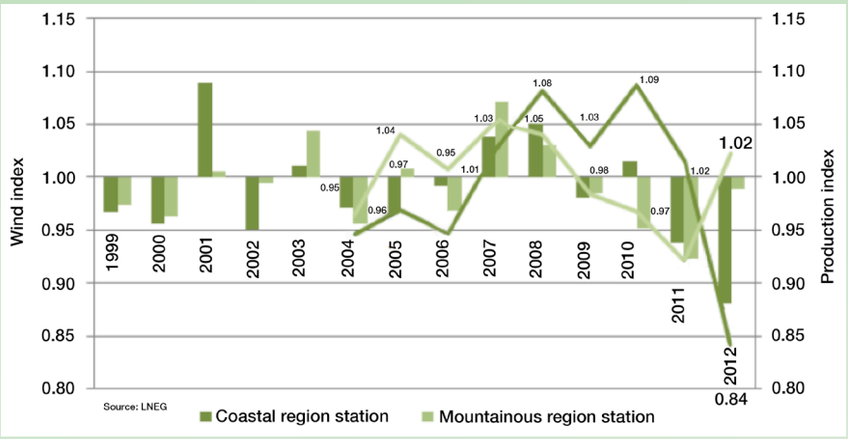

Figure 3. Wind (bar graph) and production indexes (line graph) on coastal and mountainous regions of Portugal

of University do Algarve. The objective is to develop deep water structures that can exploit the energy from wind, waves, tidal, and ocean current energy sources.

Project FP7 DemoWFloat: a project to demonstrate the sustainability of the WindFloat technology deployed in Portuguese Atlantic waters. A consortium of European and North American partners will address the challenge of wind resource assessment in oceanic deep waters. It is funded by EC FP7 and has the participation of LNEG and several Portuguese and international partners involved in a consortium led by EDP.

Project ESFRI WindScanner: the project intends to establish in several European countries a network of innovative R&D for the acquisition of three-dimensional components of the atmospheric flow and characterization of wind turbulence. It is funded by EC FP7 and has the Portuguese participation from LNEG and Porto University.

Project TROPOS: the project aims to develop a floating modular multi-use platform system for use in deep waters, with an initial geographic focus on the Mediterranean, tropical, and sub-tropical regions. It will be flexible enough so as to not be limited in geographic scope. It is funded by EC FP7 and has the Portuguese participation from WavEC.

Project Atlantic PC: the project seeks to develop cooperation and joint approaches to facilitate the identification of new market niches and redefine educational and training programs as per the needs of the offshore and marine energy sector in the Atlantic Area. It is funded through the European Regional Development Fund (ERDF) and has the Portuguese participation from WavEC.

Project OTEO: a Portugal project funded by the System Support for Collective Actions (SIAC) and has the participation of Instituto de Engenharia Mecânica e Gestão Industrial (INEGI), EnergyIN, Oceano XXI and WavEC. The project established a strategy to apply the Portuguese and international knowledge of offshore energy and support technologies increase the competitiveness and the entrepreneurship in this sector.

Project KIC-OTS: a technology project focused on the needs of the market, which was created under KIC-InnoEnergy, a company funded by the European Institute of Technology European Commission. The aim of the project OTS is developing a range of projects and services targeted to current and future needs for offshore renewables parks. This project has the Portuguese participation of WavEC.

Project WindMETER: the project was developed to fill a gap and meet a growing opportunity in the wind energy market, as fiber optic sensors play an increasing role in the structural health monitoring of wind turbines. The project is co-funded by the Portuguese National Strategic Reference Framework (QREN) and is led by the consortium INEGI (technological consultant) and Fibersensing (industrial partner).

4.2 Collaborative research

Portugal and LNEG are active partners in international research efforts. The country participates in IEA Wind Task 25 Design and Operation of Power Systems with Large Amounts of Wind Power, and IEA Wind Task 27 Labeling Small Wind Turbines. During 2012 Portugal joined the IEA Wind Task 30 Offshore Code Comparison Collaboration Continuation (OC4) through Wavec and Centec. This participation is co-sponsored by EDP-Inovação. In addition to the IEA Wind activities, LNEG is the Portuguese representative in the European Energy Research Alliance Wind Program (EERA-Wind), an initiative funded by leading European research institutes. EERA aims to strengthen, expand, and optimize EU energy research capabilities.

5.0 The Next Term

Despite the European economic crisis, 2013 is expected to be a promising year for the offshore wind power sector. For the ongoing R&D activities, the next term will bring some important milestones. The DEMOWFLOAT project will begin to demonstrate the sustainability of the WindFloat technology. Combined with the NER300 European incentive, for projects with impact on the reduction of carbon emissions Portugal will deploy five turbines in a floating offshore wind farm with an estimated capacity of 25 MW. This will constitute the first floating offshore wind park in the world.

The trend in 2012, for the onshore wind market will be maintained and it is expected that the key players will continue to invest in the emergent markets like Brazil, Africa, and Eastern Europe. On the economic sector, in the beginning of 2013, it is expected that the FITs will be reviewed through a new Decree Law

In particular for renewable energy installations for micro-generation, the ordinance nº 431/2012 of 31 December 2012 was published, which establishes a new FIT for these systems as well the new capacity limit for 2013 (11).

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