A Methodology for the Identification of the Sustainable Wind Potential. The Portuguese Case Study.

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Abstract—**The exponential grow of the wind sector in Portugal required the development of planning tools for the siting of the wind farms, its connection to the existing grid, as well as the assessment of the country's existing wind resource capable of enabling an economic, social and environmental sustainable development. The methodology developed and presented in this paper was initiated a decade ago with the classification of the existing wind data adequate to wind energy resource assessment as well as the identification of the constraints to the deployment of wind power plants. This GIS based methodology was systematically applied to the Portuguese territory and resulted on the identification of the available optimum sites for wind plant development at the lowest grid connection costs. The methodology may be easily applied to other countries or regions, thus enabling a systematic and objective approach to the wind power deployment.**

Index Terms—**Wind Energy, Resource management, power generation, power transmission, interconnections, geographic information systems**

I. Nomenclature

GIS – Geographic Information System.
NEPs – Number of hours at full capacity [h/year].
DGGE – Direcção geral de Geologia e Energia.
REN – Rede Energética Nacional.

II. Introduction

In the latest years Portugal experienced a remarkable growth of the installed wind power being that deployment closely linked to the legislation framework created by the Portuguese Government to fulfill the European Parliament Directives on Renewable Energy (2001/77/EC) and CO2 emissions (2001/81/*EC*) that followed the signature of the Kyoto protocol. Portuguese deployment plans – assumed both by the governmental authorities and wind farm investors – aim the installation of 3750 MW until the year 2010 and 5100 MW until the end of 2013, respectively 27% and 36% of the total operating capacity in 2007. This sudden growth imposes a pressing on the authorities granting the necessary permits for grid connection and highlights the need to clearly identify and characterize areas with high wind potential still available for this purpose. In this line of work, a decade ago INETI initiated a systematic classification of the wind data available and adequate to the wind resource assessment that enable the development of the EOLOS wind resource databases [1-2], the publication of the first Portuguese Wind Atlas onshore [3-4] and offshore [5] and started the development of the tool for wind deployment planning based on a methodology to identify the sustainable wind potential using GIS - Geographical Information Systems [6] presented here.

This method was then applied to the Portuguese case study [7] what enabled to identify the country's sustainable wind potential – onshore and offshore - as well as to map new areas in the southern mountains with previously unknown wind potential - a virgin territory at the time of the study, in what concerns wind deployment. It is to be referred that the methodology described in this paper is actually being adapted to another niche of the renewable energy, namely the domestic micro generation of electricity using wind and PV systems.

III. A Methodology for Sustainable Wind Energy Identification

The method consists first, on obtaining the spatial continuous mapping of the wind resource, normally referred as a *wind atlas*. The second step consists on the identification of the relevant constraints to the wind power deployment, e.g. environmental restrictions, electric grid capacity and its voltage level, land use classification, terrain slope, roads, railways and other communications networks, among others. As the third and final step it requires the use of a GIS platform and the definition of functions of correlation among the constraints and the resource map. The output of the developed GIS based tool are the geo-referenced regions adequate to wind deployment (according to the input premises) as well as the sustainable wind potential of a country or region, as a linear combination of the wind resource existing in the previously identified regions.
The proposed methodology follows some necessary steps in which functions defined among the sets of spatial data are

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