European Association for the Development of Renewable Energies, Environment and Power Quality

International Conference on Renewable Energies and Power Quality (ICREPQ'09)

Valencia (Spain), 15th to 17th April, 2009

Study for the installation of offshore wind farms in Canary Islands

M.Martínez, A. Pulido, J. Romero, N. Angulo and F. Déniz

Department of Electrical Engineering
E.T.S.I.I., Las Palmas de Gran Canaria
Campus Universitario de Tafira – Edif. Ingenierías, 36017 Las Palmas (Spain)
Phone/Fax number:+0034 928 451987, e-mail: apulido@die.ulpgc.es, mmartinez@die.ulpgc.es

Abstract. The future of wind energy development in Europe and worldwide is undoubtedly the offshore wind farm. Spain is the second European country in installed wind power, with significant own technology, now Spain is preparing to begin the development of offshore technology with the release of specific legislation and an environmental analysis of the entire national coastline.

At present there is no offshore farm in Spain, but in 2030 the MITyC wait that the power of wind farms will reach to 40 GW on land and 4 GW offshore.

The Canaries are one of the best places in Spain in terms of value of the resource, but with a limited land area 7529 km2, a high rate of population (2,070,465 people in January 2008), a high degree of protected land 42.2% of the territory, and a huge dependence on foreign petroleum for 99% of energy consumed.

You have to look to the offshore wind as an opportunity to extract energy without occupying valuable and scarce land, using own resource and diversifying the energy basket.

Discusses the possibility to use this technology in each of the seven islands, establishing a procedure for identifying possible places and how the national rules affect us.

Key words

Wind Turbine, offshore, criteria for implantation, power system

1. Introduction

The benefits of offshore wind farms are the not occupation of land, high value of the resource and less turbulence. The drawbacks are the high cost and difficulty installation and maintenance.

This is primarily to establish the search criteria of areas, and have been divided into three categories: Technical, Environment and Territorial, longer trail so the distances among turbines are bigger.

Once they are passed all three filters to the shoreline of each of the seven islands.

With the first filter we see places where technically could locate a wind farm because of the resort, with little depth and access to coast to be viable. Within this section is to differentiate areas with depths less than 50 m, and 200m.

To remedy this, today the offshore turbines are produced almost no maintenance, fully automated, with all its components sealed to withstand corrosion and with a lifespan of 50 years.

The second filter will be the environmental analysis. We will support at the level of environmental sensitivity developed by the Environmental Ministry, and also consult the Territorial Plans Island looking for protect sites in the sea or in coast, and there are several marine LICs in the islands, in addition LICs coast, ZEPAs and IBAs (the 20% of the territory are *Important Birds Areas*).

Heritage will search planes of interesting patrimony, and will be considered in each case the visual basin of the site. On the other hand, the Canary Islands is an important area of transition from migratory birds, try to identify their routes of passage through the islands.

The third type of filter is Territorial, it will identify limited and protected lands, used like National Park, Reserve integral, tourism ...

Once identified potential areas will be considered the current state of technology, its evolution and will likely draw as much power would be installed in areas identified with the technical constraints of today's technology and the regime of wind and characteristics in each area.

It was subsequently consulted studies by the Government of the Canary Islands on which power can be injected into the electrical systems of each island today. As well as the constraints imposed by current legislation at both the autonomous and national levels. However indicated that REE and Endesa Generation are making great efforts to strengthen the electrical systems island through its grids, introducing different energy storage systems. In order to increase the level of penetration of not manageable renewable energy, like wind or photovoltaic.

Finally the relevant conclusions will be drawn.

The structuring of work and the sequence of it has been thoroughly tested for the study to have full value despite

reclassifications of land, changes in legislation or technology.
In the other hand, The Climate Change could affect to the wind resource.

2. Sectoral Analysis

It will analyze the first technical possibility of having a marine wind farm, bathymetry, accessible from the ground, and value of the resource.

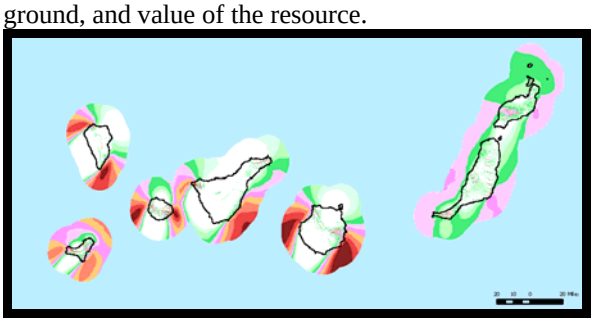

Fig. 1. Wind map 40 m height

In the figure above shows the map of winds on the islands, at a height of 40m, in any way the value of the resource is available in UTM coordinates, at different heights and with its Weibull parameters, in a simulation contracted by the Canary Government through the ITC. [1].
Bathymetry will have to determine the depth of each zone. At present, there are parks more of 40 m deep, so it has defined the height of 50m in the first instance, but in the near future will be possible to descend deeper, so it is defined in the second instance those areas to a depth of between 50 and 200 m. It is shown as an example the bathymetry and level lines on the island of La Palma.

Fig. 2. Bathymetry and level lines of La Palma
It is noted the close proximity of the curve bathymetric depth of 1000m of the coast, the islands have no marine platform, volcanic peaks that are emerging from the abyssal depths, and there are depths of several kilometers between the islands.
With the map clinometer onshore will be observed for the possibility of accessibility to the coast area of the possible location of the offfshore wind farm.
It is not considered the proximity to transmission lines, then the resources should be exploited where it exists, also it´s scheduled the creation of a ring island transportation in several islands and in any case to reinforce the existing elecric grid to facilitate the integration of natural resources . Under the Canary legislation [2] on Installation of Wind Farm requires overturn wind energy to a network of at least 66 kV from 6MW of power.

3. Environmental Analysis

Fig.3. Lics and Zepas in El Hierro

We found that the LICs have been discarded and marine areas near the shore protected areas: LICs, ZEPAs and IBAs. These maps appear in the references [4] and [5].
We have been extracted information on places of interest near-shore assets such as archaeology sites, buildings or places of historic interest (BICs), from the PIOs.
The map before is El Hierro, and there it appear Lics and Zepas in this island.
In other case we can see the environmental sensitivity analysis conducted by the ministry of environment, in this case is the island of Gran Canaria.[3]

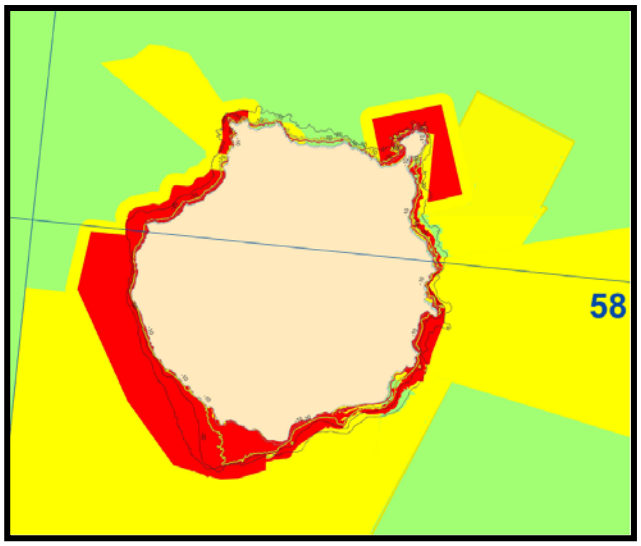

Fig.4. Gran Canaria environment sensitivity Map

It distinguishes three zones: the red is the forbidden area, yellow areas have limitations, and finally the optimal areas are green.
The document set the minimum distance to the coast is 8 km in order to mitigate the visual impact.

4. Territorial Analysis

We study the maps of occupation and classification land, like national parks, reserves, protected natural monument and other classifications have been ruled out. We considerate the ship routes.
We have refused to put installations in front of this places, because on land is necesary a substation and a electric line.

5. Regional and national legislation

At the regional level we have Decree 32/2006 [2] but no mention offshore wind farms. Canary islands is formed with six isolated systems with independent and fragile grids, The Canary´s government had published top values of wind power in each island. [6]
The allocation of power is a complex problem, The Canary´s government had published a competition, so the winners will build the wind farm in their select places, it might not be the best option, the resolution of the contest was consisting issued to install the full power until 2015.
Currently the Canary Government has promoted the development of the Plans Territorial Special Infrastructure Energy for each island, they indicate areas for installation various technologies, always in accord with The Energy Plans of Canary PECAN(2006), So the territory will have more logical arrangement.
In this arrangement does not appear the offshore wind, whose jurisdiction lies with the state of Spain.
It is mentioned that without zoning or make any forecast.
At the national level is counted with the RD 1026/2007 [7], input determines a minimum size and states: "*The sea wind generation facilities it seeks to locate in the territorial sea, will have an installed capacity exceeding 50 MW minimum*".
Except in the systems of Gran Canaria, Tenerife and Lanzarote-Fuerteventura made up, the rest would be excluded from such a possibility, as a power too much for them, like La Palma, La Gomera and El Hierro, because are smaller systems. In terms of legal issues are excluded.
On the other side of the Electricity Law stipulates that the installations that generate over 50 MW are required to put their energy into the national market.
The industry minister can change this, and gives authorizations to singular installations without this requirements.
The Royal Decree has been refused by the autonomous regions of Galicia and the Canary Islands, the response from the Government had not been expected dismissed because the statute of autonomy conferred powers on the territory, never at sea under the exclusive competence of the State.

6. Features about electric power Systems

The seven islands are formed by six independent power systems, as the islands of Lanzarote and Fuerteventura with a submarine cable are connected.
Generation in the case of La Gomera and El Hierro is composed of ten small diesel each. It Sum 13 and 22 MW simultaneously.
Generation park of La Palma and Lanzarote-Fuerteventura have various diesel´s groups, gas turbines powered by gas-oil, would be 83 MW and 420 MW.
And in the two capital's islands are have steam turbines, diesel groups, two gas turbines and combined cycle plants operating with gas oil, by the people to reject the deployment of gas plants on the islands, powers are in Gran Canaria 873 MW and 915 MW in Tenerife. [8]
The reserve level is very high and the number of groups that make up the generation by the difficulty or support system to replace the failure of a large number.
Each island has a load shedding plan, before the possibility that a fault in causing a drop in frequency and lead to a collapse.
Today the wind power installed de139, 7 MW, divided as follows:
Gran Canaria 76,3 Tenerife 36,7
Lanzarote-Fuerteventura 11,6 La Palma 5,8
La Gomera 0,36 El Hierro 0,1
With these conditions the government of the Canary Islands has set a ceiling implementation of wind energy by 2015, each island in the following [2]:
Gran Canaria 411 Tenerife 402
Lanzarote-Fuerteventura 162 La Palma 28
La Gomera 8 El Hierro 14
Total 1.025 MW
In order to increase the integration of renewable energy systems in the island has made a study on each island to determine the best location for the pumping plants, although it is true that the islands are not an abundance of water, but they have large drops, and all systems are planned deployment of pumping power, except in the Lanzarote-Fuerteventura system, because this islands are the oldest and most eroded. Moreover Endesa Generation is considering introducing sodium sulfide batteries in order of megawatts, which would provide additional stability to the electrical systems.
Given the uniqueness of the island power system, requires exceptional arrangement and a coordinated effort between the Ministry of Environment with competition in the sea and the Canary Islands Government with competition in energy planning, involving the electric companies operating in the islands to better define the energy mix land and sea in each of the six island systems, using a public tender for the allocation of wind power

7. Suitable surface

In four islands are not found any site that passed the three filters, so no one could locate offshore wind farms. Not so in the islands of La Gomera, Gran Canaria and Fuerteventura.

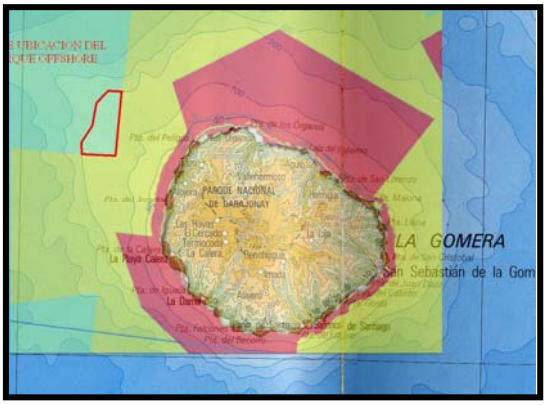

Fig. 5. Suitable surface in La Gomera

La Gomera does not support the power of 50 MW the minimum in law, so it´s impossible this implant, however, in the figure 4 we can see this area, highlighting with a suitable red contour.

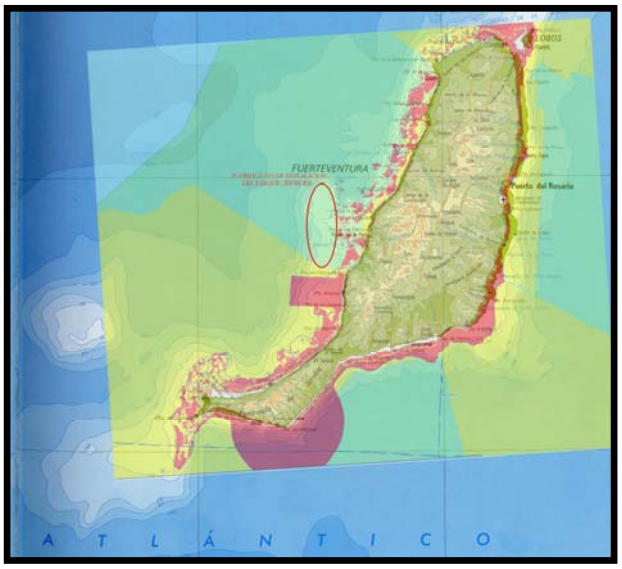

Fig. 6. zona apta en Fuerteventura

Fig. 7. zonas aptas en Gran Canaria

8. Conclusiones

Only in the electrical systems of Lanzarote-Fuerteventura and Gran Canaria could be installed offshore wind farms, but not with current technology, since we are talking about areas where the depth exceeds fifty meters, with less than two hundred meters.

The trend towards the introduction of wind farms in deep water has led to designs that are prototypes today, but certainly given the energy crisis it will soon be available, many countries already provide for the development of offshore wind to observe large-scale [9] in figure 8 we can see some sketches on which to work.

So in each of the spots marked about 324 MW could be installed, considering 3MW power units and 90 m diameter blade.

Because the units should be separated into the sea rather than land for extending the trail, we made a provision of distance between machines in the same row three diameters and between rows ten diameters. The rows look at the direction of prevailing winds on the islands that is the Northwest.

.

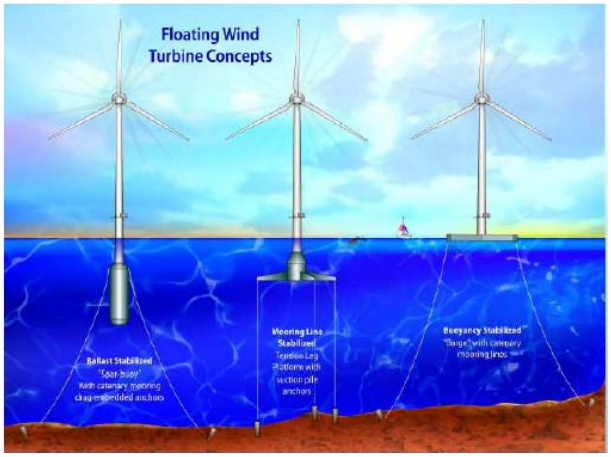

Fig. 8. Bocetos para eólica marina en profundidad

With these assumptions and given wind speeds in those zones and the curves of production of a turbine of this 3 MW, we have determined that some 4,250 hours per year in the case of Gran Canaria and Fuerteventura 3950 hours per year. At present there are two wind farm in Canary islands excess of four thousand hours of operation per year. [8].

This would represent an injection of energy 1280GWh/year in the case of Fuerteventura and 2754 GWh / year for Gran Canaria.

What remains is to implement such systems in electrical devices to support this arrangement providing regulation capacity and energy storage.

References

[1] www.itccanarias.org

[2] DECRETO 32/2006, de 27 de marzo, por el que se regula la instalación y explotación de los parques eólicos en el ámbito de la Comunidad Autónoma de Canarias.

[3] http://www.mityc.es/Electricidad/Seccion/InstalacionesEolicas/Descripcion/

[4] http://www.interreg-bionatura.com/

[5] http://www.seo.org/ibas.cfm?idComunidad=4

[6] ORDEN de 27 de abril de 2007, por la que se convoca concurso público para la asignación de potencia en la modalidad de nuevos parques eólicos destinados a verter toda la energía en los sistemas eléctricos insulares canarios.

[7] REAL DECRETO 1028/2007, de 20 de julio, por el que se establece el procedimiento administrativo para la tramitación de las solicitudes de autorización de instalaciones de generación eléctrica en el mar territorial.

[8] Estadísticas energéticas de Canarias. 2007. Consejería de Empleo, Industria y Comercio del Gobierno de Canarias.

[9] Informe sobre Plantas Eólicas Marinas CENER. Félix Avia Aranda