The Potential of Wind Power Generation at Gozo North-Offshore

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Abstract

The potential power generation at Gozo North-Offshore was estimated for a hypothetical wind farm composed of 21 x 2MW wind turbines that can be accommodated within the site constraints. Wind from directions that are not influenced by the landmass - 270° (due west) through 0° (north) to 120° (east south-east) would generate 100 GWh annually, or 4.3% of power station generation. The particular direction - north-westerly - contributes 71.5 GWh emphasising the particular local wind regime. Wind from directions that may be affected by the landmass, i.e. 120° (east south-east) to 270° (due west), would have a potential of 48 GWh. It is recommended that the potential be confirmed through wind measurements at a representative point such as the seaward edge of il-Qortin tan-Nadur on the north Gozo shoreline.

Keywords

Offshore wind power, Gozo North, potential electricity generation, directional effects

1. Introduction

In work presented at the Enemalta 25th anniversary conference and subsequently published, Fsadni & Mallia, (2006) discussed the wind electricity-generating potential of farms sited at Luqa, Bahrija and off the north shore of Gozo. Each hypothetical farm was assumed to have a rated power of 18MW, made up of 24 x 750kW turbines. The output from each of these farms was compared to that from the two power stations on an hourly basis throughout the whole year 2001. Wind speed and direction at hourly intervals was available for Luqa from on-site measurements, and for the north Gozo shore from measurements at the University Atmospheric Station at Gordan (Ellul 2002). For Bahrija, a transfer factor from Luqa wind speeds, determined from parallel measurements made in other years (Farrugia 1999) was used.

The convolution of the hourly generated wind power with the electricity demand showed a significant contribution over the whole spectrum of the load duration curves. The results of the simulation for a hypothetical wind farm based on the data from Gordan gave a total energy generation of 75 GWh which corresponded to 3.7% of total electricity generation, but this included wind from all directions as may be deduced from the map in figure 1.

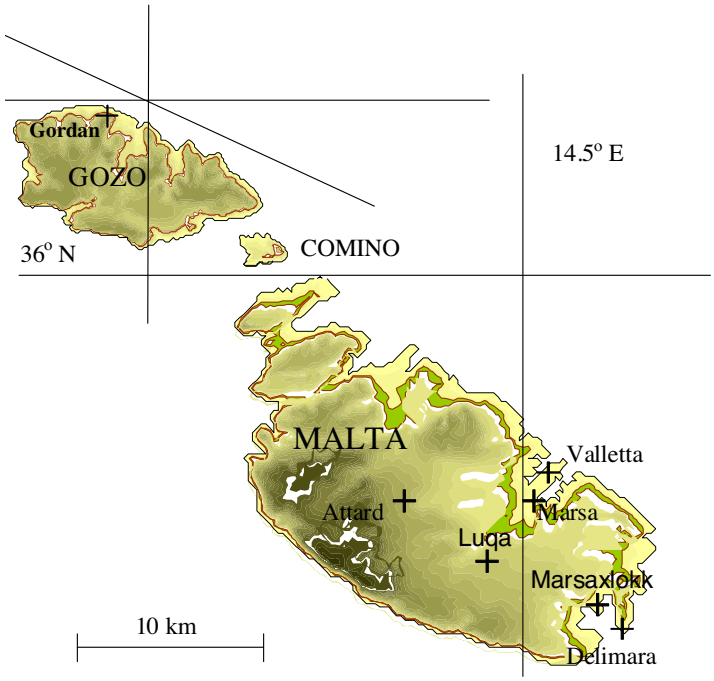

Fig. 1 Map of the Maltese Islands showing the Gordan location on Gozo

Concern was expressed about the influence of the landmass on an offshore wind farm, particularly as the distance of the chosen site (with acceptable sea depths) from land would be relatively small. In the present work the analysis allows for current technology and specific site constraints by treating the generation by wind from directions unaffected by the landmass separately from those affected.

The data used in this analysis originated from an air monitoring station on the Gordan lighthouse on Gozo at a height of 38m above ground level, itself 145m asl. The location is 800m south of a 50m cliff shoreline followed by a rising slope leading to a final cliff of 15 m to a plateau where the lighthouse tower stands. It is exposed to the prevalent north-westerly winds, where the topography is similar to that towards north. The mean speed for 2007 was 8.8 m s^{-1}, somewhat above that measured at 80m height at the coastal Ahrax Point (Sant 2011).

2. Methodology

Three modifications were made to the specifications of the previously assumed wind farm. The first is in the size of turbine as 750kW is reckoned to be too small for offshore applications and the current practice seems to require 1.5MW as a lower limit, with 2MW preferred and 5MW as the present upper limit. So 2MW turbines were chosen. Secondly, we are also suggesting that the maximum depth of water the turbines can operate in be increased from 20m to 30m. Thirdly, the chosen stretch of sea has been restricted to a length of 6km from Xwieni Bay on the west to Mistra Rocks on the east. This combination of length of site and working depth would be extensive enough to accommodate 21 turbines keeping to the standard separation required for 2MW turbines as indicated in figure 2, giving a total of 42MW for the whole wind farm.

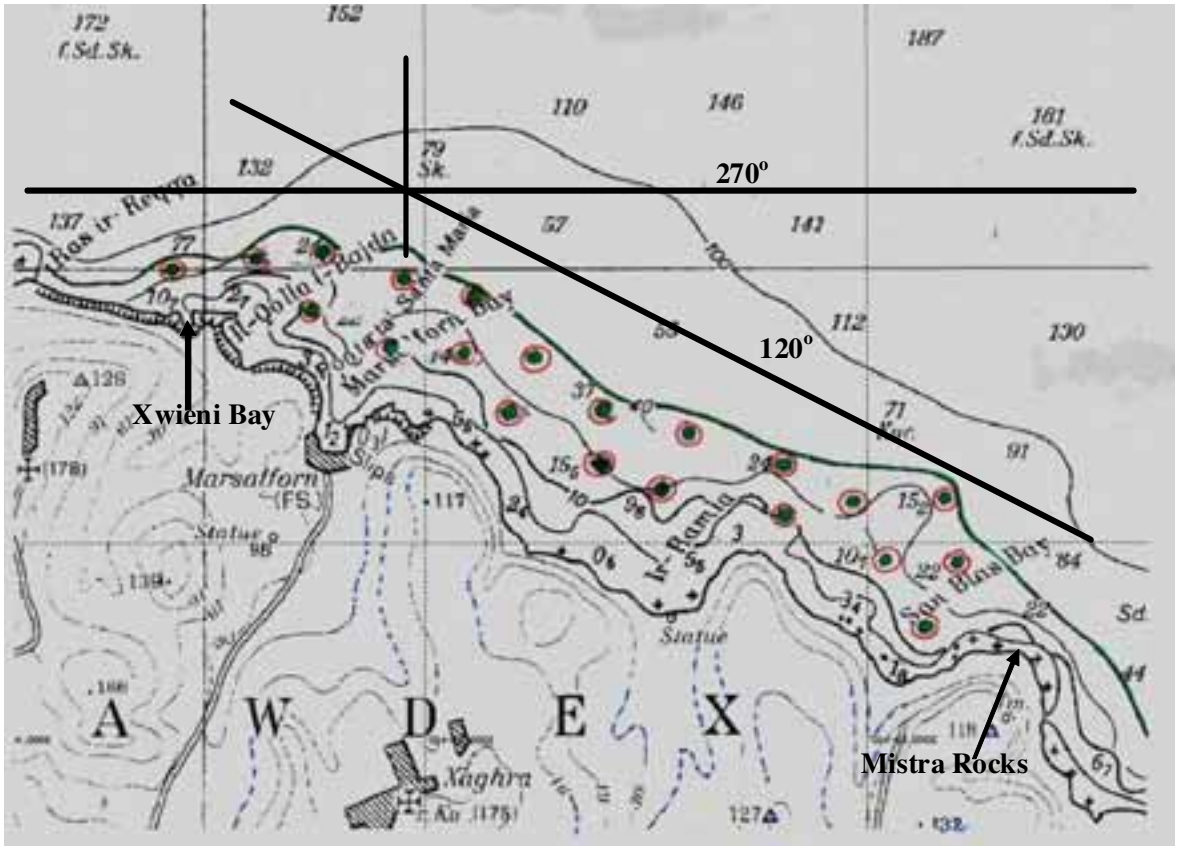

Fig. 2. Depth contours off Gozo north shore with turbine positions (**Θ**)
and selected limits of wind direction, (modified from Winstanley 1957)

A qualitative evaluation of possible effects of the landscape on the wind speed measurements was made using to a detailed analysis (Fisch 2010) for a location with similar topography. This indicated that the wind speed measurements are not seriously affected apart for a limited enhancement due to the slope. In the absence of any actual measurements, the Gordan data was taken to be a good approximation to conditions offshore at the chosen site north of Gozo. The wind coming from the direction 270° through 0° to 120° degrees would reach the turbines directly unaffected by the Gozo landmass.

The same procedure as in the previous work was adopted in determining the wind farm output hour by hour for a whole year, employing a typical 2 MW turbine. A generation curve for the wind turbine was selected from those for a number of turbines on the market. The farm output from 21 x 2MW turbines was determined on an hourly basis for the year 2007 using the wind speeds measured at Gordan.

3. Results

The overall generation was 148 GWh, amounting to 6.4% of power station generation. This result, while appreciable, as in the original work does not allow for any wind shading by the landmass. In an attempt to allow for such an effect by the landmass, the wind power output was binned in 13 bins. Most bins were of 30° except for one 20° degree bin (270° to290°) and one 10° (290° -300°). This latter split of the bin was

done as the direction 270° to 290° may be adversely affected by the landmass. The annual output calculated from this binning resulted in the yields indicated in figure 3.

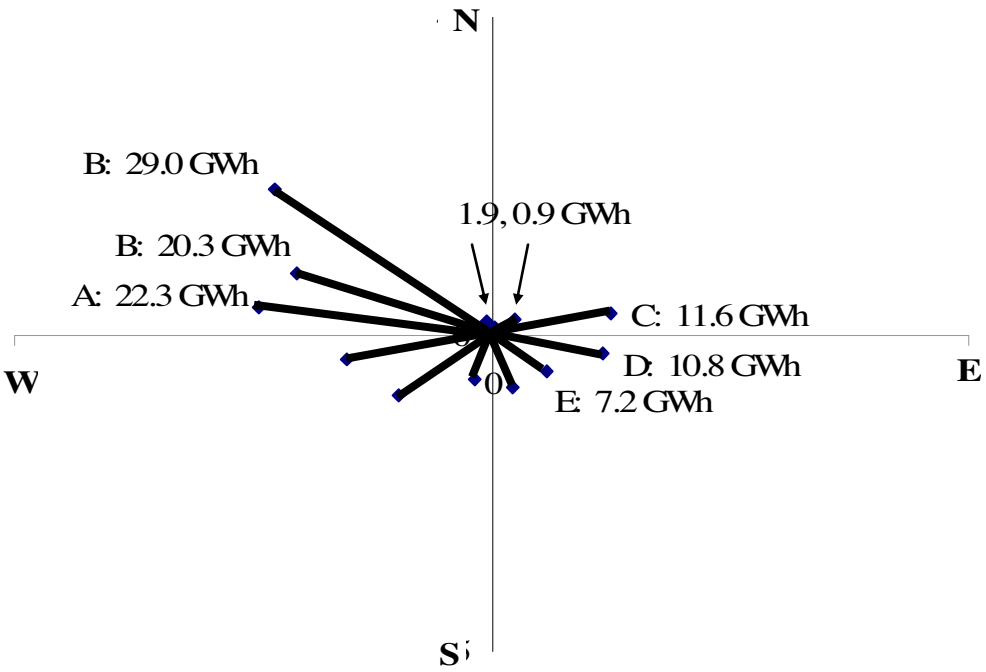

Fig. 3. Yearly energy yield from selected wind directions

These directional yields were added up only for wind directions to which the turbines were directly exposed without any significant interference from the Gozo land mass, as indicated on figure 1. These bins were bounded by directions 270° (due west), through 0° (north) to 120° (east south-east) as given by the energy vectors A, B, C, D, E in figure 3. The results summed up for four relevant directional ranges are given in table 1.

Tab 1: Electricity generation by wind direction

directional bins	**270° - 290°**	**290° - 360°**	**0° - 120°**	**120° - 270°**
GWh	22.3	51.2	26.6	48.6

The total energy generated within the directional limits unaffected by the landmass was 77.8 GWh, or 3.5% of power station generation. If the energy generated within the 270°-390° bin is included the total rises to 100.1 GWh amounting to 4.3 % of power station generation. This re-emphasises that the north-westerlies are still very prominent in the local wind regime despite suspicions to the contrary arising from reports of climate change.

4. Conclusion

The results presented above suggest strongly that the Gozo north offshore is a promising site for a wind farm. The setting up of a measuring mast at a representative point like the seaward edge of il-Qortin tan-Nadur, is urgently required to confirm the potential.

5. References

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