DEVELOPMENT OF OFFSHORE WIND FARMS IN ROMANIA

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Abstract: This article shows the possibility of developing offshore wind farms in Romania, and the necessary steps till installation of wind turbines phase.

Keywords: Wind energy, generators, wind turbines, offshore

1. EUROPEAN STRATEGY

The development of potential in Europe for using renewable energy will contribute to security of energy supply and will reduce dependence on fuel imports, reduce emissions of greenhouse gases, improve environmental protection, create new jobs and strengthen efforts towards a knowledge based society. The rapid development of wind technology has continued in recent years.

Turbine sizes are increasing and currently are built very large wind farms are subject to feasibility studies in many countries. The first commercial offshore wind farm was put into operation in 1991, consisting of 11 Bonus (now Siemens) 450 kW turbines, located in water depths ranging from 3 to 5 meters, approx. 1.5 km from shore in south East of Denmark.

Since then several offshore wind farms have been installed in Denmark - with capacities from 5MW/10 turbines (1995), 166 MW/72 turbines (2003).

In the last 5-8 years countries like Sweden, Holland, Germany and especially England, have developed offshore wind energy on a large-scale. The round three in England is setting a target of 30 GW offshore wind capacity between 2015 and 2020.

The projects size has increased from 5-10 turbines to 100-150 and turbines are now installed in water depths exceeding 35 m.

As is apparent in the table above, the projects are increasing in size. Today only very few offshore wind projects being planned or under construction are smaller than 100 MW.

Table 1

Installation year	Number of turbines	Capacity [MW]	Maximum water depth [m]	Distance to shore [km]
1991	11	5	5	1,5
2001	20	40	6	3,5
2003	72	166	10	10
2005	30	90	10	10
2010	66	330	25	45
2012	130	400	16	25
2015	400	1500	35	40
2020	1000	6000	50	55

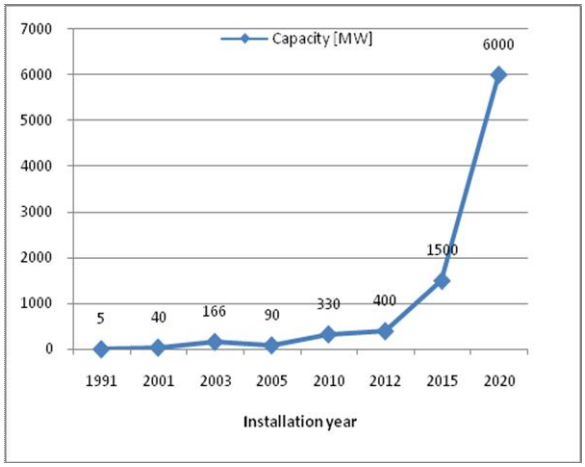

Fig. 1 Capacity of offshore wind farms by the year of installation

2. THE WATER DEPTH IN THE BLACK SEA

The water depth varies from 0 m near the beach to about 21 m at 12 km offshore. The average height of waves in the last 50 years is approx. 7.5 m - which come mainly from the north-east and south.

Tide activity is weak and water level variation, in general, are small:

- high water level due to tide 0.1 m;

• seasonal variations 0.2 m;
• barometric pressure and storm surge 0.8 m - 1.0 m.

In general, current speed is low, up to 0.3 knots. During strong winds from the north, the current velocity will increase.

In the northern part of the Black Sea, ice is found in the coastal areas extending from the northern shores and south to between the river Danube Delta and Constanta in average winters.

3. WIND MEASUREMENTS

Wind speed measurements should be made a minimum of one year and must be analyzed by specialized companies. After analysis of wind measurements we can choose the type and power of wind turbines that can be installed. Also, these measurements show the prevailing wind direction according to which is optimized the final architecture of the park.

On-shore measurements are not sufficient for accurate estimates of offshore wind potential even if mathematical modeling is used.

The possible choices for offshore wind speed measuring are:

-installation of a measuring tower offshore which means very high costs;

-mounting of a sonic device for measuring wind speeds (Figure 2) on a floating platform which can simultaneously measure wind speeds at several heights ranging from 30 to 200m (Figure 3).

Fig. 2. Sonic device for measuring wind speed

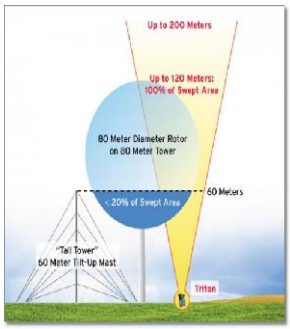

Fig. 3 Measuring range of the sonic device

4. OFFSHORE

An offshore wind farm is more difficult to develop than an onshore wind farm because it requires the construction of special foundations to support the turbines.

Bellow we present two types of foundations for installation of wind turbines:

- monopile foundation Figure 4;
- Gravity-based structure foundation (GBS) (Figure 5).

It is known that gravity-based foundations are about 10-20% more expensive than monopile foundations - mainly due to much higher levels of installation costs. This is due to fact that concrete structures are much heavier than steel monopile therefore are more difficult to transport and handle, larger equipment is required and a longer period for implementation. A foundation based on the gravity of average size will require about 2500 tons of concrete and 3,500 tons of ballast, while a monopile foundation for the same turbine will require approximately 250 tons of steel, plus a transitional intermediate piece of about 180 t.

Fig. 4 Monopile foundation

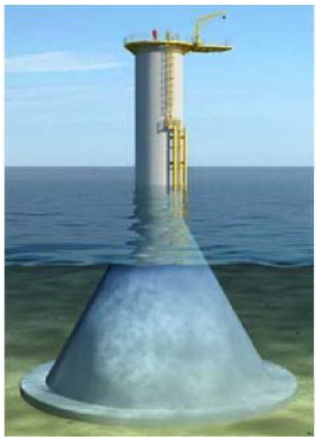

Fig. 5 Gravity based foundation (GBS)

4.1 Costs

The costs for developing an offshore wind park, for connecting to the grid (which usually includes an offshore substation), operating and maintenance costs, combined with significant costs to mobilize equipment and construction vessels, have as result the fact that small

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projects are costlier per installed megawatt, and this influences also the cost of energy produced.

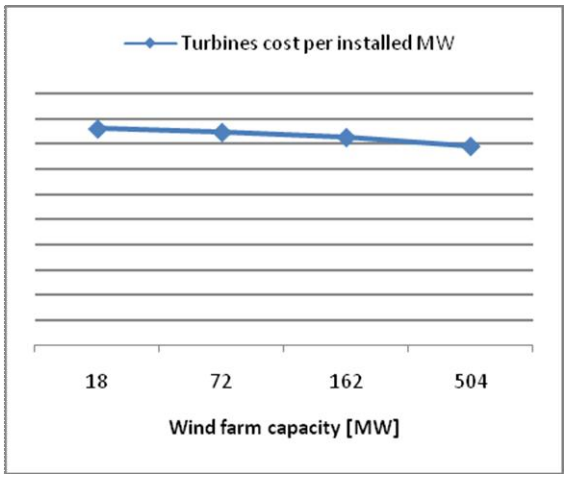

Fig. 6. Variation of turbines cost per installed MW versus wind farm capacity

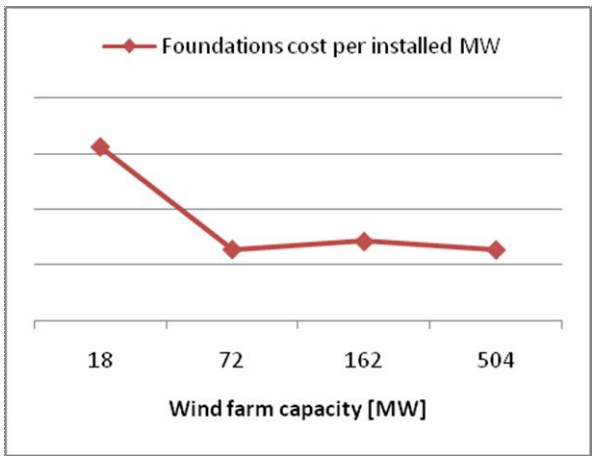

Fig. 7. Variation of foundations cost per installed MW versus wind farm capacity

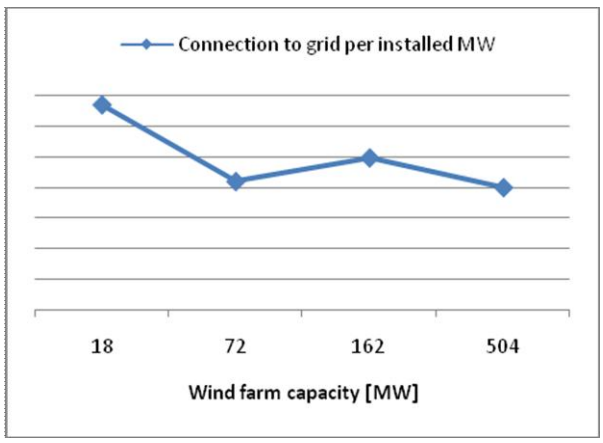

Fig. 8. Variation of connection to grid cost per installed MW versus wind farm capacity

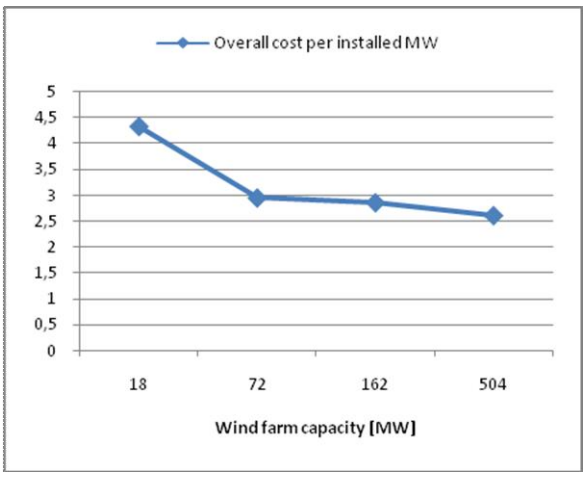

Fig. 9. Variation of overall cost per installed MW versus wind farm capacity

5. CONCLUSIONS

Exhaustion of viable locations for onshore wind projects in Romania makes opportune the development of offshore projects on the coast of Black Sea, taking advantage of available areas, wind speed, lack of turbulence and environmental impact.

An offshore wind farm in the Black Sea has several factors in its favor:

- Water depth and distance from shore and port facility construction, operation and maintenance.

- Soil conditions and water depth, wind and wave conditions are likely to allow the use of monopole or GBS foundations – which both are well established foundation types for offshore wind farms, for which manufacturing and installation methods are well known, tried and tested.

- Price forecast for feed-in tariffs shows that energy prices are favorable and similar tariff regimes have allowed other offshore projects to be viable.

- Preliminary studies indicate that wind resource is at the same level as for some existing offshore projects.

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