SEAWIND – project description:

Ebro Delta, Spain, 210 MW (60 x 3.5 MW) arc-layout.

Photomontage showing the WTGs seen from Ampolla based on standard 45 mm focal length camera. Photo point is shown on map with green lines giving the photo angle.

Project description

The proposed project is around 5 km offshore outside the Ebro Delta in northeastern Spain. The project consists of a 4 arcs with 15 WTGs in total 60 WTGs. With 3.5 MW WTGs, 210 MW will be installed. Each WTG is here assumed with a hub height of 95 m and a rotor diameter of 100 m. Calculations show that around 580 GWh could be produced annual, but with very uncertain wind data. The proposed layout has 1183 m spacing (11.8 rotor diameters) between arcs, 600 m in average (410-800) in the arcs (6 RD). The foundation type is assumed to be monopile at a water dept from 5-25 m.

This layout proposal is very special and will have an “origin” from where all WTGs can be seen as parallel rows. This should for sure be the place where an “info building” should be made and this could be an attractive “tourism spot” where many would like to come and see the Windfarm.

The project description and the calculations performed are of initial nature and must be further consolidated.

Facts on layout proposal and estimated investment costs

WTG size layout specification and price

Total installed power	**210**	**MW**	Distanse	in RD
Number of rows	4		1183	11.8
WTGs per row)*	15	Average	600	6.0
Number of WTGs	60		Hub height	RD (m)
Size of WTG	3.5	MW	95	100
Price information in this case are very rough estimates				
Price for WTGs, installed (k€)	**178,500**	**850**	**€/kW**	

Foundation, specification and cost estimate: **210 MW**

Type of foundation	Monopile							
Number of foundations:	60							
Water debt (m)	20	RD	HH					
WTG-size (MW, rotor diameter, hub height)	3.5	100	95	Debt#1	Debt#2	Debt#3	Debt#4	Debt#5
Ice risk (yes/no)	No							
100 year max wind gust (m/s)	?							
100 year max wawe height (m)	?							
Tidal difference (m)	?							
	For all k€	k€ per pcs.	€/kW	Per foundation, debt dependend				
Fixed price. design cost,								
Fixed price, building/shipping facilities								
Fixed ground prepare cost								
Variable ground prepare cost								
Variable, building cost								
Installation cost								
SUM	94,500	1575	450					

Figure 1 Foundation costs are very roughly estimates while no detailed data on water, weather and sea bottom conditions are available so far.

Grid connection:

		Number or length (m)	Voltage(kV)	mm^2	Material	Lines/cable	Prices k€ For all	Per unit or per meter, €	€/kW
Off shore									
	Sea cable, from wind farm to shore	18000	150	630	CU	Cable	9,000	500	43
	In row cables	3549	30	300	CU	Cable	355	100	2
	Rows to collect point cables	8400	30	300	CU	Cable	840	100	4
	Cable roll out/Wash down, variable	29949					1,497	50	7
	Cable roll out/wash down, fixed cost						500	500,000	2
	Total number of WTG connectors	60					1,500	25,000	7
	Off shore HV station	1	150/30 kV				10,000	10,000,000	48
	Connection (electrical work)								
	Other fixed costs						1,000	1,000,000	5
	Other variable costs								
On shore									
	From shore to HV-grid								
	HV station (if needed)								
	Connection (electrical work)								
	Compensation (reactive power)								
	Other fixed costs						1,000	1,000,000	5
	Other variable costs								
Total							25,692		122

Figure 2 No detailed specifications available. Needs detailed analyses.

Total budget for 210 MW wind farm

	k€	*€ per kW*	*Percent*
WTGs	178,500	850	50%
Foundation	94,500	450	27%
Grid connection	25,692	122	7%
Planning and permissioning	28,447	135	8%
Organisation, management	10,668	51	3%
Miscellaneous (e.g. risk)	17,779	85	5%
TOTAL	355,586	1,693	100%

Note: Cost estimates are based on rough scaling of mainly experience from Danish offshore projects.

Expected energy production, and PPA

The energy calculation based on wind data from EU-Windatlas data at Zaragossa mixed with some very short local measurement from Munesia. The mix is used to get a calculated mean wind speed level at 7.7 m/s in 100m h.a.s.l. which is the level indicated by a study performed based on many different sources, that indicate from 6.7 – 8.5 m/s. The WAsP calculation model is used from the WindPRO software tool, where the whole project is modeled. The onshore surface roughness has been taken into consideration in the calculation that shows 583 GWh/year. From this uncertainty, grid losses and availability losses shall be withdrawn – especially due to the lack of local wind data, 25% at present stage is withdrawn, which makes 437 GWh. But this will be too small production for feasibility. Therefore the economic calculations are based on the calculated value – so more precise wind data is a must here.

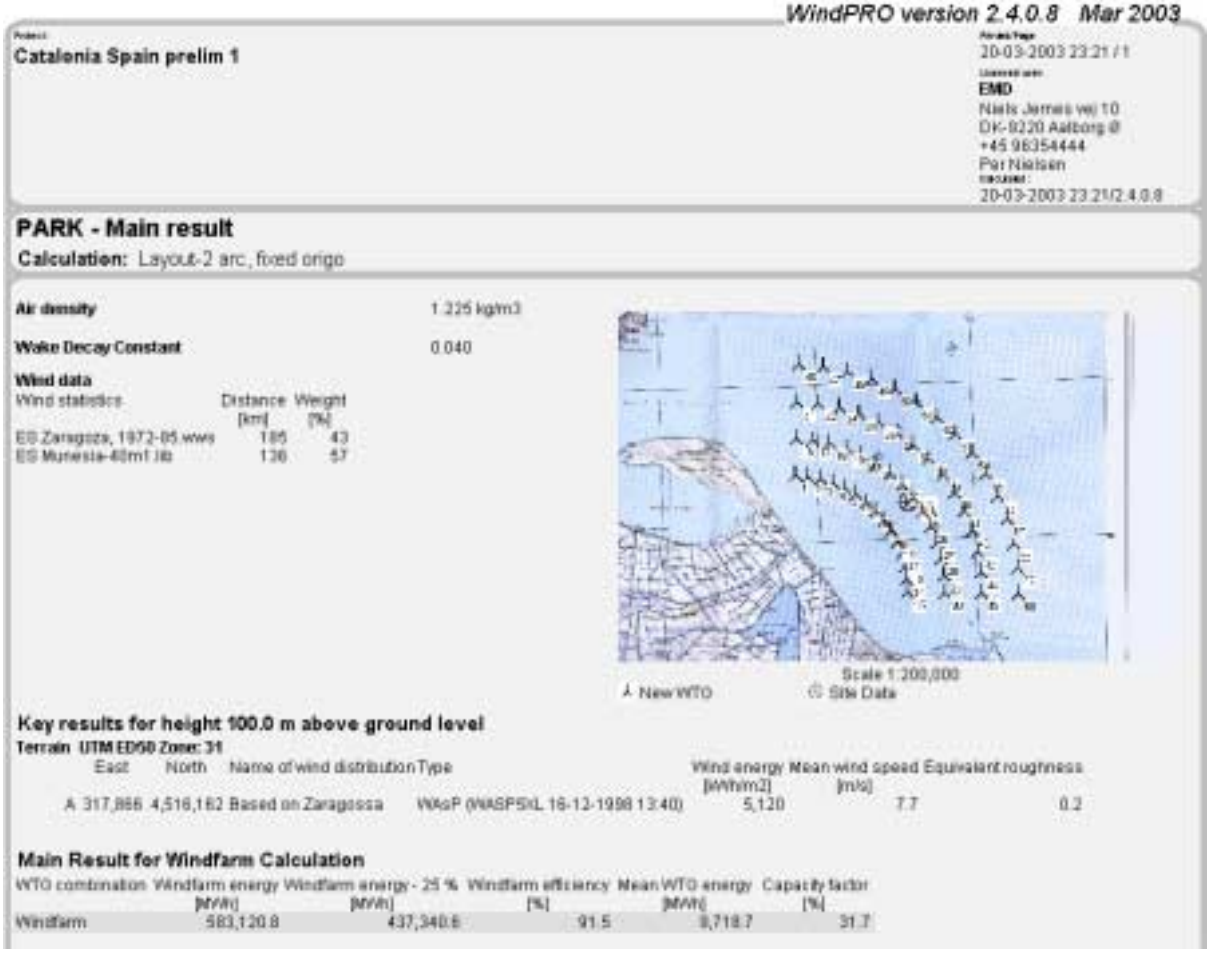

Figure 3 The energy calculation printout from WindPRO software.

Knowledge from existing onshore wind farms near site combined with the Horns Rev (first large Offshore project in North Sea in DK installed end 2002) experience that now start to come, a more certain estimate can be made with relative limited effort. Installation of wind measurement mast at site would be preferable.

Power purchase agreement

In Spain, both a fixed and a variable tariff structure are available. Analyses indicates that a level of 6.3 €c/kWh should be a realistic level. This value is used in the economic calculation with an inflation of 2% per year. But this is an uncertain factor that shall be evaluated further.

Operation costs and economic feasibility

Based on onshore experience following figures have been used in the calculations:

Operation cost	onshore		offshore estimate	
Insurance	5	€/kW/y	10	€/kW/y
Service and maintenance	10	€/kW/y	18	€/kW/y
Adm. and management	3	€/kW/y	5	€/kW/y
SUM/year	18	€/kW/y	33	€/kW/y
	Per WTG:		1.0	€c/kWh/y
Decommissioning	50	k€/WTG	0.7	€/kW/y

Figure 4 Operation cost used in calculation. The resulting 1 €c/kWh match well the DK utilities expectations for the calculated DK projects. The decommissioning costs is set relative low, but there should be good reasons to believe in that instead of decommissioning, repowering would be more likely.

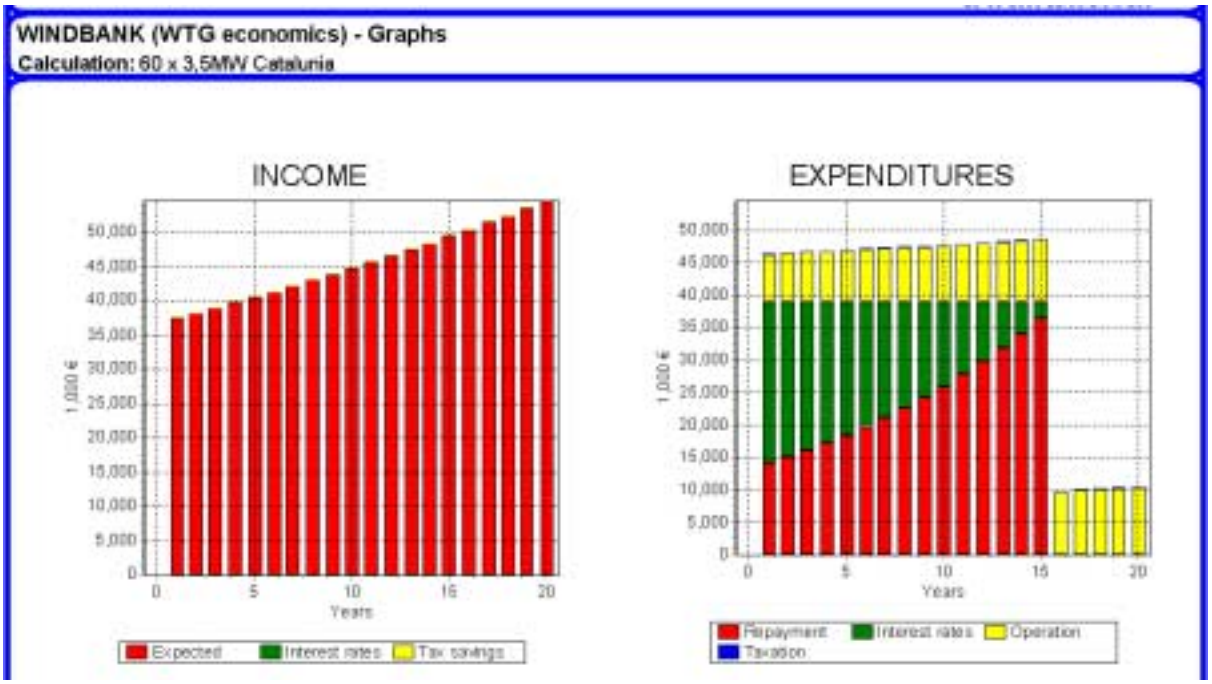

Figure 5 With the above estimated price development a payback time of 16.5 years will be expected. Tax calculations are not included. The feasibility is not looking to promising, more investigations that indicate reduced costs or better energy production will be needed.

RATIOS

		/kW	/m2	/MWh
Preliminary expenses	€	1,693	-	610
O/M costs	average €/years	34	-	12
Energy production	kWh/Years	2,777	-	-

Minimum life span for redemption of loan	16.5 Years
Simple pay back time	12.0 Years
Net present value for share	172 €
Net present value in % of investment	28.1 %
Production price at calculation interest 5.0%	0.06 €/kWh

Figure 6 One share is here 1000 kWh/year, an investment of 610€.

Infrastructure, environmental aspects etc. needs investigations.

Figure 7 A photomontage of the wind farm from the top of the Water tower.

The Environmental Impact Assessment will be a major part of the needed project documentation.

The methodology and presentation of this case study is established as part of ALTENER Contract No. 4.1030/Z/01-103/2001. For further information and discussion please contact the project coordinator Green Globe Energy I/S or EMD on e-mail: hansb@post8.tele.dk or euroscan@post.tele.dk or pn@emd.dk.