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Valuation of Investments Applied to Civil Engineer

Offshore Wind Parks

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Extended Abstract

INTEGRATED MASTERS IN CIVIL ENGINEER

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1. Introduction

Portugal is a country with a large exclusive economic zone and one of the largest ones in Europe and seems to have a huge economic potential in all investments related to the sea. Portugal has also the History, customs and traditions associated with the sea. Plus, Portugal has a considerable level of energetic dependence on fossil fuels, a factor that makes it vulnerable and dependent on political and social stability of the countries that sell to Portugal those goods. It raises the external public debt to buy that kind of goods which is not desirable, even more when Portugal has other energetic resources that are able to provide the same service, or at least are able to mitigate such dependence. Since we are talking about the energy's sector, all the economy of a country, its living and proceeding of daily activities, depend on it, so the economic, the political and the social vulnerability is big.

In this dissertation it will be calculated and estimated the profitability of investments in Offshore Wind Parks. It could also be referred the wave´s energy and the deep stream's energy, which could be alternative maritime's investments in Portugal. However, they will not enter in this dissertation. So, it will be assessed if Portugal has chances to replace some of the energy's imports and then may take advantage of local resources. If that could be possible, Portugal could thus reduce the energy bill to the outside, to improve the trade balance by reducing the external debt, and secondly to increase economic activity by creating businesses and industries in these sectors, and creating jobs, and so on. Portugal would be better isolated against possible fluctuations in market prices for oil and natural gas, often affected by events unrelated to the Portuguese government and the Portuguese State.

2. Work's Methodology

The main goal of this thesis is the analysis of economic profitability of investments in development of offshore wind energy.

So, the following actions were carried out:

- Research of reports, studies, presentations about the subject in companies, organizations, universities and associations where this theme was discussed, and analyzed in a technical way about the performance of this type of renewable energy projects and economic data such as pricing of initial investment and operating and maintenance costs of such type of projects;

- Analysis of the collected data and selection of the most relevant;

- Search for a theoretical book about investment valuation necessary for the calculations of economic profitability and also to introduce in the dissertation some theory about economic indexes of investment valuation. It was used the next four indexes: NPV (Net Present Value), the Payback Period, IRR (Internal Rate or Return) and IP (Index of Profitability).

- Calculation of economic profitability for each different investment;

- Analysis of the results obtained;

- To draw conclusions about the profitability of projects and their applicability in Portugal;

- To draw conclusions on the limitations of the valuation.

Thus, in the end of the dissertation it will be possible to understand the potential interest these types of investments can inspire, including to Portugal.

3. Results

The results of the economic calculations were helpful to understand the profitability of these types of investments. In this thesis three different phases were contemplated: the test phase, the pre-commercial phase and the commercial phase. For each phase four or five different scenarios were considered. In each scenario different conditions were contemplated so that it could be seen the effect of the variation of the turbine's power, the price of the project, the evolution of initial and living costs of the project through the course of the different phases and the existence of feed-in or not.

3.1 Scenario Example from Test Phase

This is the scenario 1 from the test phase. In this scenario the offshore wind platform is composed by a turbine with 2 MW, and its initial cost is 23 M€. It was admitted that in this phase the industry has not yet developed some cost reductions via new efficient materials or has not yet developed the increasing of the turbine power.

- **Scenario 1 – Turbine with 2 MW costing 23 000 000 €**

Table 1 – NPV without Feed-In from Scenario 1 of Test Phase of Offshore Wind Energy.

Year	Income without Feed-In(€)	Costs (€)	Cash-Flow without Feed-In (€)	Cash-Flow Accumulated without Feed-In (€)
1	548.538,67	256.000,00	292.538,67	- 22.726.984,41
15	829.713,95	379.478,51	450.235,44	- 19.798.416,36

Table 2 – IP, IRR and Payback without Feed-In from Scenario 1 of Test Phase of Offshore Wind Energy.

Economic Data without Feed-In		
IR	TIR (%)	Payback
0,139	-	-

Table 3 - NPV with Feed-In from Scenario 1 of Test Phase of Offshore Wind Energy.

Year	Income with Feed-In(€)	Costs (€)	Cash-Flow with Feed-In (€)	Cash-Flow Accumulated with Feed-In (€)
1	838.618,67	256.000,00	582.618,67	- 22.456.263,39
15	1.268.485,98	379.478,51	889.007,47	- 16.673.691,36

Table 4 - IP, IRR and Payback with Feed-In from Scenario 1 of Test Phase of Offshore Wind Energy.

Economic Data with Feed-In		
IR	TIR (%)	Payback
0,275	-	-

So, in this phase of testing and experimentation the investment is not attractive, it is not profitable, doesn't provide a return on investment and the multiplication of income. The NPV calculation's tables are full in Appendix I.

Nor even with the Feed-In taxes the investment becomes profitable and recoverable. In both the IP is below 1 which means that the positive cash-flow generated by the project is less than the money invested - 23 M €. It was desirable to be superior to 1 so that the money had been recovered and further multiplied. The IRR is negative on both, and in order to nor loose nor make money, the IRR would have to be equal to TA = 7,15% (TA is the discount rate, to calculate the present value of money). For an IRR superior to 7,15% the investment would be attractive because it would generate wealth. There is no payback on both, the return on investment is not made during the period of service life of 15 years. The NPV is therefore negative. Would have to be zero to recover at least all the money invested, and would have to be positive in order to have recovered all the money invested and still have generated wealth.

It's possible to see the difference between having feed-in or not. The NPV at the end of service life without feed-in was about 19,8 M € and with feed-in was about 16,7 M € . The difference between the two values is about 3 M €. This can make the difference when the power of the turbine associated with economies of scale increase income and reduce global prices for projects, turning projects to positive NPV's values.

4. Conclusions

First of all it must be said that all calculations should be evaluated cautiously because many of the data used are estimations or predicted values. Although there are already many devices installed of offshore wind energy's source, these devices have not traveled yet a whole service life and it is difficult to predict what will happen in 10 or 15 years at the end of the projects of investment.

Although the degree of certainty is not 100%, this dissertation is careful and has some caution on the values used for calculations.

In the test phase of offshore wind investment, the investment is not attractive, is not profitable. It does not provide the return on investment; much less allow the multiplication of income in all scenarios. Not even with the feed-in taxes the investment becomes profitable and recoverable. In all scenarios the IP was below 1 which means that the positive cash flow generated by the project was less than the money invested, both the initial capital investment and the running costs over the service life of the project. A value of IP superior to 1 was a sign of recovery of invested capital throughout the lifetime of the project and a sign of profit. The IRR in all was below the minimum value which would be synonymous of zero profitability, that is, don't make money or lose money, the IRR would be equal to TA = 7,15%. For more than 7,15%, IRR investment would be attractive because it would generate wealth, fact that has not happened in the Test Phase. The payback period or the recovery of invested capital was higher than the lifetime (15 years) in all scenarios of the test phase. The NPV was therefore negative. NPV would have to be zero to recover at least all the money invested over the lifetime of the project, and it would be positive to have recovered all the money invested and still have generated wealth. There was a difference between having Feed-In or do not have. The NPV at the end of service life without feed-In was always lower than the situation of having feed-In. This can make a difference when the power of the turbine coupled with economies of scale increase revenues and reduce global prices for projects. That would bring projects with positive NPV values. Moving from scenario to scenario, and increasing the turbine's power, the money recovered by the investor was increasing too, that is, the difference between the NPV at the end of service life and the initial capital invested was increasing, which shows that the higher the turbine's power, the higher the speed of recovery of the investment resulted by a higher electricity production, i.e., income.

In the pre-commercial phase of offshore wind investments, investment remained unattractive. The economic indicators remained as in the previous phase. However there has been a slight improvement. The NPV, at the end of the useful life of the project, rose slightly compared to Test Phase, in all scenarios, clearly influenced by the reduction of the initial price of the project (via substitution of more efficient materials as admitted), better known by the initial investment cost . And the IP rose slightly from the previous phase for the same reason, in all scenarios. But the IP remained below 1, which is not the goal for those who want to invest and take income and create wealth through investment. The payback period continued to exceed 15 years of life, in all scenarios. And the IRR remained below TA, which is also not desired for all scenarios. This phase has not yet demonstrated that offshore wind can be economically viable, although it had some positive signs.

In the commercial phase of offshore wind investments, the investment has already demonstrated a certain technical and economic maturity and in some scenarios proved to be attractive in the eyes of the investor. In this phase was added 13% of reduction of the overall project cost per MW turbine. This reduction was starting from 2 MW. It was assumed therefore that the overall cost of the project grew proportionally from the 23 M € of the 2 MW platform and then added a 3% reduction via efficiency of materials used and the reduction of 13% for each MW of turbine more than 2 MW. This expense reduction project can be explained by the gain from economies of scale due to the development of this industry over the years.

One of the fastest conclusions to be drawn is that in the test phase or in the pre-commercial phase all investments hardly become profitable, often with the Feed-In included. However it is obvious that the industry can gain economies of scale over time, either by increasing the number of orders, either by the experience and efficiency's gains, either by technological developments with materials' substitution by other more efficient, either by power gains and gains from higher electricity production of the devices, which means that the initial investment cost goes down over time, operating costs also, and revenues go up. All this generates higher cash flows over time which facilitates the investments to be profitable, with positive NPV, Payback within the period of service life, with a profitable IRR and an IP superior to 1. Sometimes, even without Feed-In investment is profitable. What is also an indicator that even if the values are a bit far from reality, and may have some degree of deviation from the real values that will be in the future, there is a margin for the investment to remain profitable, assuming some values may be worst compared to those presented in this dissertation.

Offshore wind energy is energy to take into account for the future, as well as other energy sources such as solar, onshore wind or hydropower. All together they are likely to work together in a cluster of renewable energies to the service of humanity, walking in a direction to use less fossil energy.

And if offshore wind energy has a potential market that it is in progress around Europe, and now it starts to be considered that is possible to build wind farms that will become the next "oil fields" of Europe, Portugal, due to the size of its Economic Exclusive Zone, should be awaken to this potential and point its strategy accordingly. Through this potential, Portugal could walk towards self-sustainability and energy independence.

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Appendix 1 – NPV from Scenario 1 of Test Phase of Offshore Wind Energy

	Year	Income without Feed-In(€)	Income with Feed-In(€)	Costs (€)	Cash-Flow without Feed-In (€)	Cash-Flow with Feed-In (€)	Cash-Flow Accumulated without Feed-In (€)	Cash-Flow Accumulated with Feed-In (€)
2012	1	548.538,67	838.618,67	256.000,00	292.538,67	582.618,67	- 22.726.984,41	- 22.456.263,39
2013	2	564.994,83	863.777,23	258.406,40	306.588,43	605.370,83	- 22.459.951,91	- 21.928.997,30
2014	3	581.944,67	889.690,54	266.158,59	315.786,08	623.531,95	- 22.203.263,94	- 21.422.156,88
2015	4	599.403,01	916.381,26	274.143,35	325.259,66	642.237,91	- 21.956.519,77	- 20.934.950,86
2016	5	617.385,10	943.872,70	282.367,65	335.017,45	661.505,05	- 21.719.334,17	- 20.466.618,63
2017	6	635.906,66	972.188,88	290.838,68	345.067,98	681.350,20	- 21.491.336,86	- 20.016.429,04
2018	7	654.983,85	1.001.354,54	299.563,84	355.420,01	701.790,70	- 21.272.171,90	- 19.583.679,27
2019	8	674.633,37	1.031.395,18	308.550,76	366.082,61	722.844,43	- 21.061.497,14	- 19.167.693,72
2020	9	694.872,37	1.062.337,04	317.807,28	377.065,09	744.529,76	- 20.858.983,67	- 18.767.822,95
2021	10	715.718,54	1.094.207,15	327.341,50	388.377,05	766.865,65	- 20.664.315,33	- 18.383.442,71
2022	11	737.190,10	1.127.033,36	337.161,74	400.028,36	789.871,62	- 20.477.188,21	- 18.013.952,91
2023	12	759.305,80	1.160.844,36	347.276,59	412.029,21	813.567,77	- 20.297.310,18	- 17.658.776,71
2024	13	782.084,98	1.195.669,69	357.694,89	424.390,08	837.974,80	- 20.124.400,41	- 17.317.359,62
2025	14	805.547,53	1.231.539,78	368.425,74	437.121,79	863.114,05	- 19.958.188,97	- 16.989.168,62
2026	15	829.713,95	1.268.485,98	379.478,51	450.235,44	889.007,47	- 19.798.416,36	- 16.673.691,36
2027	16	854.605,37	1.306.540,56	390.862,87	463.742,50	915.677,69	- 19.644.833,15	- 16.370.435,32
2028	17	880.243,53	1.345.736,77	402.588,75	477.654,78	943.148,02	- 19.497.199,58	- 16.078.927,06
2029	18	906.650,84	1.386.108,88	414.666,41	491.984,42	971.442,46	- 19.355.285,15	- 15.798.711,49
2030	19	933.850,36	1.427.692,14	427.106,41	506.743,96	1.000.585,74	- 19.218.868,33	- 15.529.351,14
2031	20	961.865,87	1.470.522,91	439.919,60	521.946,27	1.030.603,31	- 19.087.736,13	- 15.270.425,49