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Project Management in the Wind Energy Field. Case Study: Evaluation of Wind Energy Projects through the Net Present Value

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Abstract. *Wind energy has become one of the main sources of green energy having reached a peak of 220 GW installed wind capacity in 2020 in the European Union according to the TPA report (2021). With the expansion of wind energy installments, project management in the field also had numerous challenges in terms of estimating wind energy projects worth implementing in terms of capital and operating costs, as well as benefits. The present article presents the main method of evaluating wind energy projects, namely the net present value applied on specific costs and benefits of a wind energy installment in order to determine whether it is worth implementing or not. The paper contributes to the scientific literature by applying this method of analyzing wind energy projects before installment, a characteristic that is compulsory for project management in the field in order to adapt the project if needed in terms of costs or revenue streams.*

Keywords: wind energy, project management, green energy.

Introduction

Wind energy has become one of the main sources of sustainable green energy in the past 15 years. The main sources of renewable energies are wind energy, solar energy and biomass in the last years (Tantau and Fratila, 2017), the production of clean energy and diminishing of waste and pollution being ultimately parts of corporate social responsibility nowadays (Bratianu, 2015). Sustainability goals nowadays address the aspiration for a better life while keeping the people, planet, profit goals of companies, institutions and people in a balance through observing limitations in nature (Fonseca et al., 2020). The increase of wind turbine projects installments has increased yearly with a peak in 2020 of 743 kw globally according to the TPA report (2023). Besides challenges, such as the urbanism certificates, planning of the site of the wind turbines installments through either buying property or lending superficies rights, obtaining approvals and other such legal matters, the project management of such a wind energy company has to plan the costs required for the project, as well as the revenue streams and expected revenues in order to determine whether the project is worth implementing or not.

Wind energy projects require a significant amount of costs, especially as an initial investment, while the operating costs are usually considered as low, for example the costs of procuring the wind turbines represents approximately 67% of the total investment, for 1 MW of wind energy production implying a cost of approximately 1,3-2 Million Euros (TPA report, 2012). Other costs for wind energy companies are the costs regarding connection to the electrical grid, developing the necessary infrastructure, such as roads in some cases in remote areas, operating costs for maintenance and repairing of wind energy turbines for example, while the main available revenue streams are from selling energy and depending on the land, green certificates or feed in tariffs.

The high demand of installation of wind energy turbines, as well as other sources of sustainable energy, such as solar energy was determined also by regulations stimulating the

DOI: 10.2478/picbe-2023-0010
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replacement of polluting energy with clean energy, such as the European Union targets, which imposed a 20% share of renewable energy in energy consumption by 2020, and 32% by 2030 (International Renewable Energy Agency, 2022).

In Romania in 2015 the subventions regarding green certificates for wind energy producers and other renewable energy producers was significantly decreased (gov.ro), affecting the medium and long term planning of wind energy companies, most of them deciding to either stop or reduce the amount of wind energy projects in the country, leaving them with selling energy as a main revenue stream and reducing the green certificates revenues. Thus, the costs and revenue streams and expected amounts, legal regulations, local issues regarding the placement of wind energy turbines in terms of landscape damage, ensuring the necessary amount of wind speed and ensuring maintenance and operating activities for a continuous production process are some of the main issues wind energy producers have to face.

The objective of the present paper is to analyze one of the main elements of project management for wind energy projects in terms of deciding whether or not to implement a wind energy project based on a net present value analysis. In the current paper a net present value analysis simulation was implemented based on a real used model in wind energy companies, which was obtained through an interview with a German wind energy company. In order to keep the confidentiality of the study participating company, as required by them, the net present value analysis simulation was calculated using average expected costs and revenues depending on the number of wind turbines of the projects, estimated average operating costs and revenues, that occurred in the wind energy field in different periods, as to ensure a practical approach of the application.

Literature review

Wind energy is one of the main sources of green energy today, being produced in many countries by wind energy companies, but also by consumers in certain lands in the last few years on a small scale. In 2021, wind energy was the main source of domestic electricity production (Germany Trade & Invest, 2023). Competition of companies drives the trend of innovation, as well as technology development and the consumer preferences, stimulating companies to improve their products and services and this applied to the wind energy field as well (Dima et al., 2018).

Between 2000 and 2018 installed wind energy capacities have increased exponentially as shown in Figure 1 with the increase of legal subventions globally for this field and with the legal requirements of producing renewable energy and replacing polluting sources of energy. In 2020 a peak of 743 kw of wind energy installments was achieved globally according to the TPA report (2023). Through the advantages of wind energies are non-polluting sources, relatively standard legal forms required for the approval process of the wind energy project installment, vast available surfaces with proper wind conditions in many countries and regions, high potential of revenues from selling wind energy as legal regulations require more sustainable energy, the possibility of installing wind turbines also onshore and offshore, relatively clear and predictable costs of the wind energy projects.

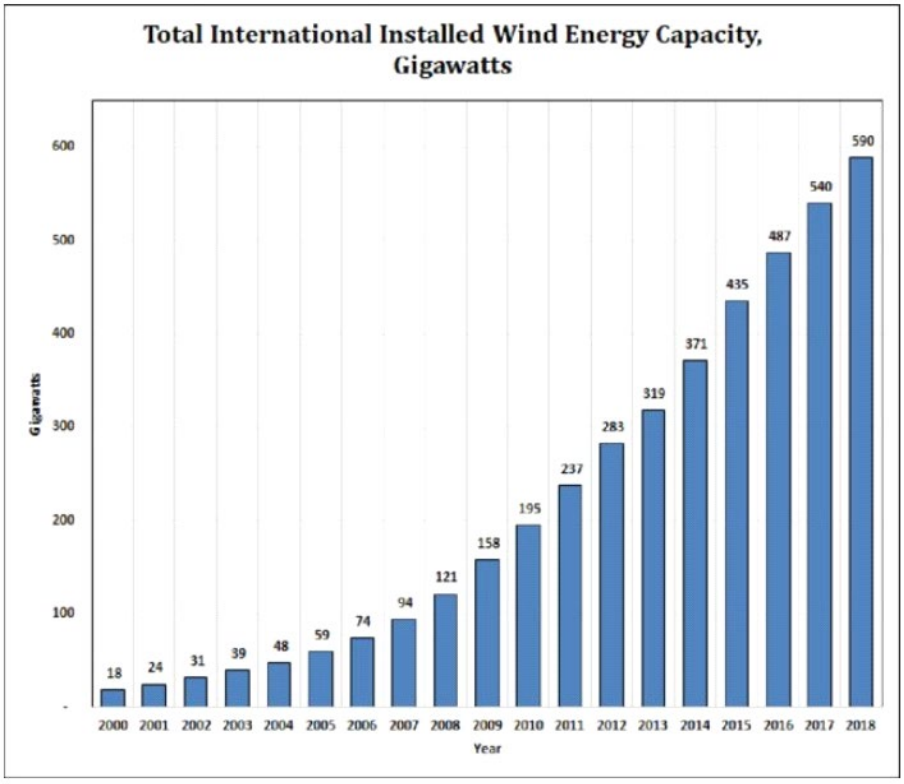


Figure 1. Total installed wind energy capacity (GW) 2000-2018

Source: Dorell and Lee, 2020.

The preference for wind energy as a clean source of energy derives also from the benefits of wind energy itself, which is non-polluting, as well as from the fact that wind energy projects have lower operating and maintenance costs after the initial investment, such costs being on an average of 57-51 Euros/mwh/year, expecting these to decrease in the next years due to reducing costs of technology especially (Koch et al., 2019). Wind energy turbines technologies have become more efficient over time in terms of the amount of production of wind energy, in terms of their height and amount of wind energy production and in terms of technology costs decrease. According to Johnson and Solomon (2019) it is expected on average for an average wind turbine to not be producing for about 14% of the time only, as shown in Figure 2.

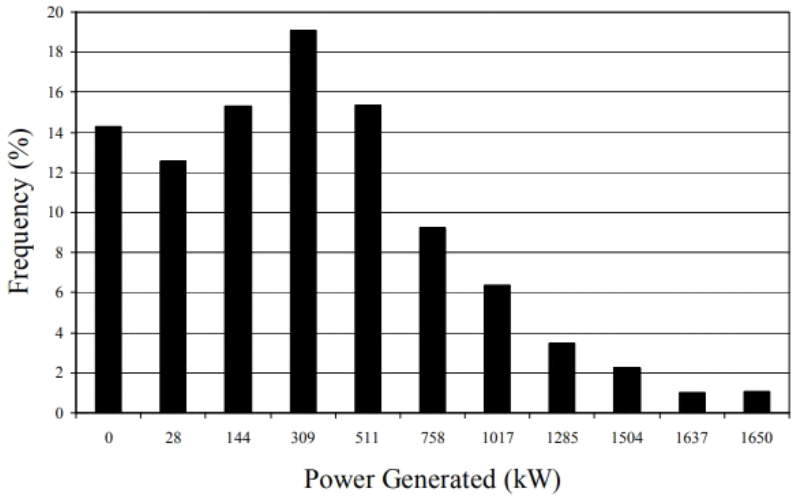


Figure 2. Estimated frequency of power generation on average for wind turbines

Source: Johnson and Solomon (2019)

In terms of costs for a wind energy project these differ depending on the size of the wind energy project, namely number of wind turbines and their characteristics, costs increasing as the height of the wind turbines increase. On average it is estimated that for 1 mw of wind energy electricity producing capacity a cost of approximately 1.3 million dollars is required (Blewett, 2021).

The main method for analyzing the estimated costs and revenues, as well as the planning of implementing or not a project over a period of time was the net present value, which was however scarcely analyzed in a few papers from the scientific literature (Johnson and Solomon, 2019, Delapedra-Silva et al., 2022), but mostly from a theoretical perspective and not based on inquiry of a renewable energy company. The present paper presents a practical net present analysis simulation of wind energy projects, which is based on a real model used in wind energy companies.

Methodology

Before installing a wind energy project wind energy companies need to analyze the estimated worth of the project throughout the whole period of the project duration in order to adjust project characteristics if needed in terms of costs or revenue streams. This is done in order to protect the wind energy project from value decrease over time, which could diminish the real value of the expected returns over the years and thus diminish the real earnings obtained with the wind energy project, potentially leading to losses and not gains. The most used method which was confirmed also through an interview with a German wind energy company is the net present value. The name of the company will not be revealed due to confidentiality reasons, as the participating company member specifically asked this. Numbers in the tables simulating the application of wind energy projects are also fictional, but based on real general costs and benefits expected from similar wind energy installments and do not reflect the costs and benefits of the participating company's wind projects.

The formula of the net present value is:

$$NPV = \frac{\text{Cash flow}}{(1+i)^t} - \text{initial investment}$$

where:

i = Required return or discount rate

t = Number of time periods

where Cash flow of the period is the amount obtained by subtracting the amount of money earned and the amount of money spent on the project over a period of time, i is the discount rate, t is the period of time in years (Pattavina, 2007).

A net present value of over 0 implies a gain, which could mean the project would be worth considering, but depending on earnings needed by the management to make a profit as well over a period of time. A net present value of less than 0 implies a loss, meaning the project would be declined, while a value of 0 would imply there is no gain or loss, but it would be worth considering investing in some other project perhaps bringing more earnings.

During the interview the company member presented an applied model of the wind energy project management method, which confirmed the general net present value but applied to the wind energy installments. Thus, in the findings part of the paper a similar model will be represented based on realistic costs and benefits expected for a wind energy project.

Results and discussions

As mentioned the results part presents an applied methodology of the net present value for a 10 year long wind energy project. The costs were estimated according to average practical costs in the wind energy projects from European Union reports mentioned throughout the practical part in order to avoid presenting any costs reflecting real costs of the participating company as well as any other wind energy company due to confidentiality reasons. The present article presents a real net present value application model on wind energy projects, which project management from such companies apply before deciding whether to invest in a project or not. Regarding the sales price per MWH for wind energy the average price in Euros was considered for 2021 (exchangerates.org.uk).

For this simulation it was assumed there is an initial capital cost of 900000 Euro in the beginning whereas in the next years there is no capital cost, only operating costs.

Table 1. Estimations based on the net present value for a wind energy project with a capital cost of 900000 Euro discount rate 0.005 for a 10-year period (operating costs of 1340000 Euros per year)

Capital cost	900000				
Annual output mwh per year	67000				
Decision time frame	10 years				
Operating costs Euro per mwh per year	20				
Total operating costs per year	1340000				
Sales price Euro per MWH (average price 2021	24				
Annual revenue	1608000				
r	0.005				
Year	Capital cost	Operating cost	Revenue	Annual cash flow	Discounted
0	-900000			-900000	-900000
1		-1340000	1608000	268000	266666.7
2		-1340000	1608000	268000	265340
3		-1340000	1608000	268000	264019.9
4		-1340000	1608000	268000	262706.3
5		-1340000	1608000	268000	261399.3
6		-1340000	1608000	268000	260098.8
7		-1340000	1608000	268000	258804.8
8		-1340000	1608000	268000	257517.2
9		-1340000	1608000	268000	256236.1
10		-1340000	1608000	268000	254961.2
				Net present value	1707750

Source: Authors' own research.

For Table 1 it was assumed there is a 900000 Euro initial investment for 10 wind turbines, each producing 6700 MWH per year on average, while the wind energy company has to decide whether or not to invest in this project. In this case it is assumed that there are some approximate sales prices of 24 euros per MWH, the average estimated price per MWH in 2021 according to the Land-Based Wind Market Report (2022). For this case operating costs of 20 Euros per MWH per year on average were considered, as reports expect decreasing trends of operating costs in the following decade. Thus, in this case the estimated annual revenues would be 1608000 Euros and the operating costs per year in total 1340000 Euros. After applying the net present value formula and summing the discounted cash flows values a net present value of 1707750 Euros is obtained, which is a positive value significantly higher than 0 implying the wind energy project could be worth considering the implementation.

Table 2. Estimations based on the net present value for a wind energy project with a capital cost of 900000 Euro discount rate 0.005 for a 10-year period (operating costs of 3350000 Euros per year)

Capital cost	900000				
Annual output mwh per year	67000				
Decision time frame	10 years				
Operating costs Euro per mwh per year	50				
Total operating costs per year	3350000				
Sales price Euro per MWH (average price 2021)	24				
Annual revenue	1608000				
r	0.005				
Year	Capital cost	Operating cost	Revenue	Annual cash flow	Discounted
0	-900000			-900000	-900000
1		-3350000	1608000	-1742000	-1733333
2		-3350000	1608000	-1742000	-1724710
3		-3350000	1608000	-1742000	-1716129
4		-3350000	1608000	-1742000	-1707591
5		-3350000	1608000	-1742000	-1699096
6		-3350000	1608000	-1742000	-1690642
7		-3350000	1608000	-1742000	-1682231
8		-3350000	1608000	-1742000	-1673862
9		-3350000	1608000	-1742000	-1665534
10		-3350000	1608000	-1742000	-1657248
				Net present value	-17850377

Source: Authors' own research.

In the case of table 2 the same data is applied only the operating costs per year per mwh are significantly higher, it was assumed there are high costs of 50 Euros per mwh per year in this case, cumulating a total of 3350000 Euros per year operating costs, which would lead to a net present value of -17850377 for the 10-year period meaning a loss. This would imply that the management would have to consider either to reduce the costs or to find other revenue streams if necessary and/or to think about the length of the project.

Thus, the project management can project depending on their expected costs and earnings multiple estimations based on the net present value afterwards if it is the case endeavoring to reduce operating costs or capital cost and/or increase revenues.

Conclusion

As a conclusion, wind energy projects are complex projects requiring not only a significant initial investment, but also significant operations and maintenance activities, which involve a thorough planning of costs. In terms of using the net present value analysis used for the planning of a wind energy project, the wind energy company can focus on the costs sources reduction or /and on revenue streams planning in order to make a feasible and profitable project for the company. While some revenues are depending on the market, such as the revenues from selling electricity, other revenue streams such as subventions from the states can be either increased or decreased based on regulations and offer an uncertain source of income for companies in the field, making it compulsory in many situations that they plan revenues on a medium or long term only based on selling electricity on the market.

The wind energy companies have developed large amounts of onshore and offshore projects in the European Union and globally, making this clean source of energy one of the most used. This is especially due to the fact that after the initial investment the operating and maintaining costs afterwards have decreased over time, while the efficiency and duration of wind turbines has increased. The novelty of the present paper lies in the fact that it presents a real type of simulation for wind energy projects based on inquiry at a wind energy company, which was scarcely researched in previous literature, thus contributing to the scientific research regarding wind energy companies strategies.

As a main future research objective, further analysis of wind energy projects revenue streams and cost structures based on the technological development of wind turbines, legal regulations and market characteristics in more countries will be considered. Also, the evolution of the wind energy markets in Romania and in the European Union in terms of reducing CO2 emissions through new wind energy installments especially and the prices of wind energy produced electricity in the context of decreasing costs of technology and increase of the demand for such clean sources of energy through regulations are other factors intended for future papers analysis.

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