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Wind Energy Investment in Greece: Case Study of an Aegean Island

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Abstract: Considering that traditional energy sources such as fossil fuel are about to deplete during the following decades, governments try to turn to renewable energy. It is commonly known that Greece has a natural advantage of abundant solar energy and wind power due to its geographical location and characteristics. The main focus of this study is to examine how wind energy potential across the Aegean Sea and continental Greece can provide a promising field for investments in Greece, considering the economic crisis, current trends and future perspectives. We firstly focus on current legislation framework considering that laws associated with such types of investment in Greece are very complex and rapidly changing. Furthermore, a case study for a hypothetical investment plan concerning a wind park located in an Aegean island will be presented. RetScreen which is a software made by the Canadian government, will be used as a decision support tool for analyzing the potential investment scenario and a financial report will follow with estimation of the overall cost, depreciation, upcoming benefits, and payback period of the investment. Data analysis concludes that wind parks still prove to be an economically viable investment, although incentives considering the guaranteed price per kwh and faster investment times must be provided by the government.

Keywords: renewable energy; wind power; wind park; investment plan; Retscreen

1. Introduction

Energy is separated in two different types: a) non renewable (coal, oil, natural gas and b) renewable (solar, wind, hydro and wave). Fossil fuel global reserves are constantly depleting thus their use is expected to decrease during the following decades. For this reason, clear, sustainable and environmental friendly resources of energy are constantly increasing; especially wind energy and solar energy (Sahin, 2004). In addition, renewable energy is considered a key factor in controlling global climate change. Wind energy is the energy that the wind provides due to the movement of air masses into the atmosphere. It is the world's fastest growing energy source and is considered a clean, renewable source of energy. This form of energy has been used for centuries in Europe and recently in the United States and other nations (Raidur, Islam, Rahim, Solangi, 2010). The constant growth in wind power capacity is supported by economic models in renewable energy investments and further motivated by supply security reasons, fuel diversity concerns, ecological awareness and economic reasons (Akdag, Guler, 2010). An issue that is arising is the examination of the environmental benefits of renewable energy systems (Crawford, 2009). Large and small wind turbines produce electricity for

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industrial applications, home owners and non interconnected sites. Among various renewable energy sources, wind energy in particular has achieved maturity in the energy market (Raidur, Islam, Rahim, Solangi, 2010). Thus, the collaboration between environment and economy is still as relevant as ever before (Mohanty, 2011).

2. Historical Background

From the early stages of human history, wind power has been used for the propulsion of ships. Many civilizations like Chinese, Persians, Greeks and Egyptians used windmills for grinding grain and pumping water. Windmills entered Western Europe during the twelfth century from the Ottoman Empire. Specifically windmills were used for pumping water from flooded areas and transferring it to sea, in Netherlands. In Greece, windmills for water pumping purposes, were mainly used in East Crete. The first wind turbines were used in regions occupied by Alexander the Great and Persians (Hills, 1991). During 17th century the discovery of stream turbines began replacing windmills but even until 1860 multiple flap windmills continued to be built in Chicago for pumping purposes. In 1891 a Danish named Poul LaCour created the first electricity-generating wind turbine (Gipe, 1995). In 1900, Denmark was able to produce electricity from wind power. And during the year 1940 a test turbine with two blades was constructed in USA. But wind energy was not considered significant until the '70 when people realized the important role of energy and the environmental problems of our planet and tried to recreate the wind turbine (Ntanos et al, 2009). Subsequently, between the years 1973 to 1986, wind energy market passed off from domestic and agricultural use to grid interconnected wind farm applications. The first wind energy penetration outbreak was held in California where over 16,000 machines were installed between 1981 and 1990, as a result of the incentives given by the USA government. In northern Europe, wind farm installations increased constantly during the 80s and the 90s. The high cost of fossil fuel based electricity and the excellent wind resource led to the creation of a small and stable market. Eventually, in 1990 most market activity shifted to Europe, bringing wind energy at the front line of the global scene with major players from all world regions (Kaldellis, Zafirakis, 2011).

3. Literature Review and Theoretical Background

In Greece, the legislation is based on five basic laws for the exploitation of renewable energy.

Firstly, L.3468 (2006) addressed electricity production from Renewable Energy Sources and co-generation. With this law, production of electricity from Renewable Energy Sources was promoted as a priority, with specific rules and directions. In 2009, L.3734 is harmonizing with the promotion of co-generation based on demand in the internal market, creates a legal framework, and adjusts absorption of energy from photovoltaic plants. It sets promotion of co-generation and addresses energy projects such as the Hydroelectric Project in Mesochora and other provisions.

Besides this, L.3851 (2010) made a further effort to simplify and shorten the process of approval for new renewable energy projects by aligning certain lengthy individual steps and eliminating others. Of particular importance in this context is the fact that a Production License is no longer required. This exemption from the Regulatory Authority for Energy or other relevant declaratory act exists for photovoltaic and solar thermal power stations up to 1 MW.

The last legislative amendment is L.4001 which passed in August 2011, which launched major changes in the structure and operation of the electricity market with the establishment of independent operators for the transmission system, the distribution network, and independent functions in Electricity Market.

Even more, the authorization process for wind farms contained in L. 3851 of 2010 about accelerating the development of Renewable Energy Sources to deal with climate change, introduced some additional critical settings (Metaxas & Associates - Advocates & Legal Consultants, 2012).

According to the latest legislative framework about turbine investments in Greece, small investments are now more lucrative than the bigger ones. The produced electric current is completely bought by the "Independent Administrator for the transportation of electric current" («A.Δ.M.H.E.»). For turbine investments of capacity up to 50kWp, the benefit is 0,25€/produced KWp, but for larger investments it is only 0,08785€/produced kWp and 0,09945€/produced kWp (if the investment is located to any island that is not connected to the Central Network). (Green Energy & Building Solutions, 2014) The return is vastly reduced compared to the past ten years, and this is another result of the economic crisis in Greece, because the Greek Government has no more the monetary fluidity to support renewable energy resources. That means that, payback period of large investments is much longer compared to smaller ones, which are mainly private investments.

It must be noted that HEDNO S.A. (Hellenic Electricity Distribution Network Operator S.A.) has announced that it suspends the grid connection requests of small wind turbines (power up to 50kW) at the interconnected Network of the country until the publication of a Ministerial Decision which sets specific requirements, restrictions and conditions of this program (HEDNO, 2013). Hence the scenario we examine addresses a hypothetical investment considering that grid connection is allowed by HEDNO.

4. Analysis

For the purpose of a hypothetical scenario, we select the Aegean island Milos in Cyclades. The Canadian Government's Software "RetScreen" program will be used as an analysis tool. This program includes a meteorological database from NASA. According to the information from this database, the island of Milos has the highest average wind speed in Greece: 6,7 m/s.

Figure 1. Map of Milos Island-Investment Location.

4.1. Investment Characteristics

As soon as "ΑΔΜΗΕ" provides high prices (250€ per produced MW) for wind parks up to 50 KWp (as we said before, for wind parks above 50 KWp the given price is 87,85€ or 99,45€), we decide to examine a scenario of investment in a small wind park, which will include a single wind turbine of 50 KWp nominal power. It must be mentioned that Public Electricity Company of Greece («ΔΕΗ») is planning on building 89 turbines there and 260 more in other Aegean islands. For the investment site we select the South West side of Milos island, where the highest mountain top "Profitis Ilias" is located at an altitude of >700 meters. (Milos Island,2014). As we know, the high altitude can positively affect the flaps' movement, as a result of faster air's speed. Located west from the mountain top there is a small sierra which ends up on the mountain top "Hondro Vouno", at an altitude of >600 meters, where it is the exact location we suggest to install our turbine. (Coordinates: Width 36°40'49.67"N, Length 24°22'21.94"E). Fortunately, there is access in the point via a dirt road, so it would be easy for the trucks and the bulldozers to transport the turbine and do all the other procedures. We should also mention that, easterly of "Profitis Ilias" on the position «Koutsounorahi" (altitude: >300 meters) another wind park is already located from the company "Aioliki Milou AE", which consists of four wind turbines with a total power of 850 KWp. (Energy Register, 2014).

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- In this side of the island there are no houses or other buildings.
- The turbine cost will be subsided by the Greek Government up to 50%, depending on geographical criteria (Ethnos, 2014).
- The noise of the turbine is about 50-55 db in a distance of 30 meters, (Argosy, 2014), 35 db in a distance of 50 meters. At 65 meters the turbine's noise is about the same as the wind's noise, and at 150 meters it does not heard anymore (Karouzos, 2014).
- Project's Timetable:
    - Turbine order and supply – preparation on the installation place: 10/10/2014
    - Installation of the mounting: 10/11/2014
    - Assembly of the turbine: 1/12/2014
    - Calibration and wiring of the turbine: 15/12/2014
    - Connection of the other parties 1/1/2015
    - Review and test: 15/1/2015
    - Start of the commercial business: 1/2/2015

4.2. Wind Turbine Characteristics

For the upcoming investment, we suggest the model Argosy Wind AW 50kW. This model has low starting speed (2,7 m/s) and high torque curve at low wind speeds, compared to its competitors. These features offer an annual production of about 178 MW on average wind speed of 6,7 m/s. We suggest using the highest of the three available pillars which is 36.6 meters, in order to exploit the most out of the height. There is also a warranty provided by the manufacturer, including full coverage of the product for 5 years (Argosy, 2014).

Figure 2. Argosy Wind Power.

4.3. Economic Analysis-Evaluation

We use Excel to make these scenarios about the investment, analyzing three different cases: a) 50 kw financed by loan on 50%, b) 50 kw and finally c) 500 kw in a hypothetical scenario of installing 10 wind turbines. It is obvious that the smaller investment would give greater efficiency, as they have about 2,5 times higher revenue. The following tables and graphs present the potential costs and revenues.

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Initial Cost*:	110.000 €
Expected life:	20
Expected annual MW for 6,7 m/s:	179
Expected Annual Revenue for 6,7 m/s**:	44.818 €
Loan Amount:	55.000 €
Loan interest rate:	0,06
Years of loan payback:	10
Total Amount of Payback:	76.844 €
Tax Rate:	0,26
Total Taxes:	158.472 €
Annual Service and Operating Expenses :	5.000 €
Total Profit / Loss:	451.034 €

**Expected Purchase Cost of Wind Turbine + Other Costs (Transport and installation, Earthmoving-Road, network interface, studies and advisory services)*

*** 250 €/MW*

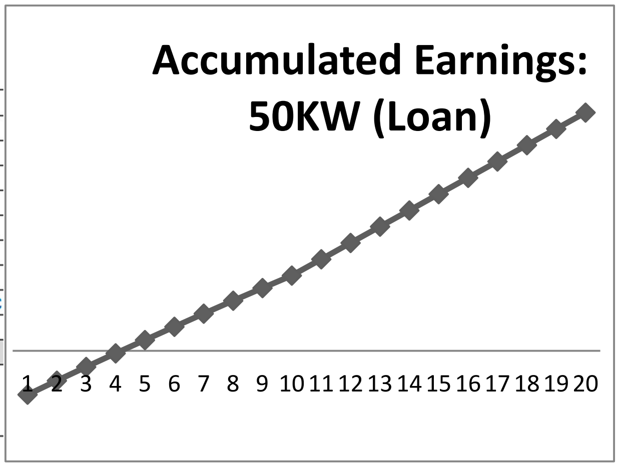

Table 1-Figure 3. Economical Analysis of 50Kw (loan).

Initial Cost*:	110.000 €
Expected life:	20
Expected annual MWp for 6,7 m/s:	179
Expected Annual Revenue for 6,7 m/s:	44.818 €
Loan Amount:	- €
Loan interest rate:	0,06
Years of loan payback:	10
Total Amount of Payback:	- €
Tax Rate:	0,26
Total Taxes:	178.451 €
Annual Service and Operating Expenses	5.000 €
Total Profit / Loss:	507.899 €

**Expected Purchase Cost of Wind Turbine + Other Costs (Transport and installation, Earthmoving-Road, network interface, studies and advisory services)*

***250€/MW*

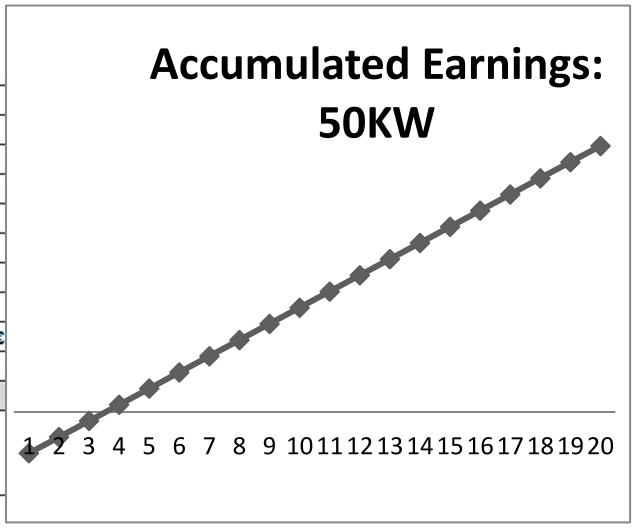

Table 2-Figure 4. Economical Analysis of 50 Kw (without loan).

Initial Cost*:	1.000.000 €
Expected life:	20
Expected annual MWp for 6,7 m/s:	1.793
Expected Annual Revenue for 6,7 m/s: **	178.284 €
Loan Amount:	- €
Loan interest rate:	0,06
Years of loan payback:	-
Total Amount of Payback:	- €
Tax Rate:	0,26
Total Taxes:	407.077 €
Annual Service and Operating Expenses :	50.000 €
Total Profit / Loss:	1.158.603 €

**Expected Purchase Cost of Wind Turbines + Other Costs (Transport and installation, Earthmoving-Road, network interface, studies and advisory services)*

*** 99,45 €/MW*

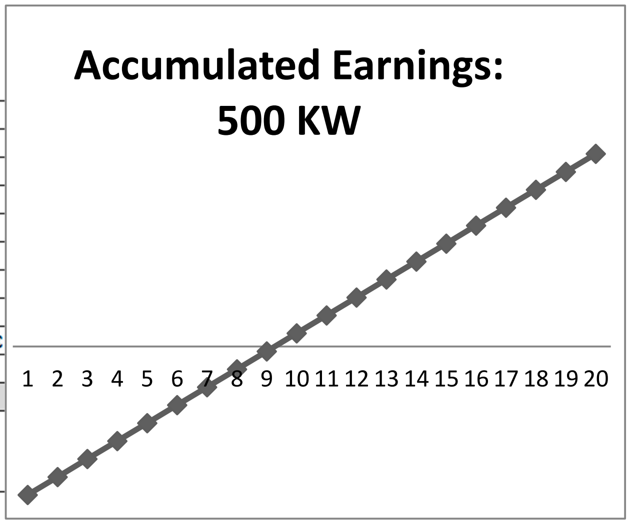

Table 3-Figure 5. Economical Analysis of 500Kw (without loan).

5. Conclusions

Wind energy, has a major role in human history. In this paper, we refer to a hypothetical wind turbine investment scenario the Greek Aegean Island Milos. We suggest that the current legislative

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framework (electricity price and grid connection time) plays an important role in the viability and profitability of renewable resources investments. After the analysis, we conclude that wind power is a viable and profitable investment in Greece where the shortest payback period is calculated for small investments up to 50KW. It must be noted that during the time of the article HEDNO S.A. (Hellenic Electricity Distribution Network Operator S.A.) has paused all network connections requests for small wind turbine applications, hence no private investment on wind parks can proceed.

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