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Identification of Risk Factors for Wind Energy Investments in Turkey

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Abstract
As the non-renewable energy sources are rapidly being depleted, policy makers in many countries have started to attach more importance to renewable energy sources in order to satisfy the growing energy demand. Turkey is one of the fastest growing countries in the world with rapidly growing demand for energy. New investments are needed in the renewable energy sector in order to satisfy this increasing demand. The Turkish government leans towards renewable energy but does not have enough funds to invest in power plants that can produce renewable energy. As a result, the Turkish government has used the Built Operate Transfer (BOT) project delivery system to produce renewable energy. One of the popular renewable energy sources in Turkey is wind. Investments to produce wind energy can be feasible options for investors, but the risk factors stemming from the macro environment as well as project level risks should be identified. The objective of this study is to identify the risk factors for wind energy investments in Turkey. For this purpose, the risk factors are determined by extensive literature survey, thereafter several interviews are conducted with experts to finalize checklist. The findings of this study are expected to guide the investors in Turkey.

Keywords
Project, wind, risk factor, renewable energy, investment

1. Introduction

Energy is one of the indispensable things for people and society. With the rapidly increasing industrialization and population, the world's energy demands have been increasing year by year (Ellabban *et al.* 2014). According to the International Energy Agency (IEA, 2007), the energy demand in the world increased 48% between 1990 and 2010. And also it is expected that the global energy demand will increase dramatically until 2030 (Fig. 1).

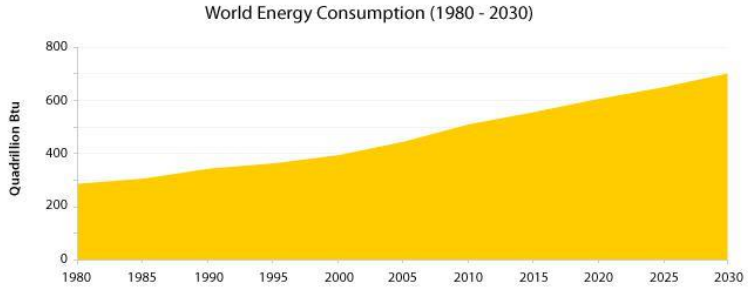

Figure 1: Projected Growth in Global Energy Demand (IEA, 2007)

As the energy is a scarce commodity, finding new energy sources is one of the biggest challenges of the 21st century. The energy sources can be categorized under two main headings as non-renewable and renewable. Non-renewable energy sources include coal, natural gas, petroleum and nuclear energy, on the other hand, renewable energy sources include wind, sunlight, biological materials, geothermal heat and rain (Ellabban *et al.* 2014). In contrast to non-renewable energy sources, renewable energy sources are plentiful, however, the current level of their development and management is inadequate to meet the demand of the world's increasing population (George *et al.* 2007). As the non-renewable energy sources have begun to decrease, all countries have started to give more importance to renewable energy sources in order to supply their energy demand. Turkey is one of the country that has leaned towards renewable energy. The Turkish government leans towards renewable energy but does not have enough funds to invest in renewable energy power plants. Instead of constructing renewable power plants they have used a Built Operate Transfer (BOT) system for constructing renewable energy power plants. In a BOT system, the investments are made by the investors. As a result of this situation, investors are interested in constructing different types of renewable power plants in Turkey. Wind energy is one of the popular renewable energy sources in Turkey. Turkey has approximately 2959 Megawatt (MW) installed wind power capacity at 2013. In recent years, as a consequence of the government's encouragement of investors towards renewable energy investments, the number of wind power plants has dramatically increased. In Figure 2, the total capacity of installed wind power plants in Turkey for each year is shown.

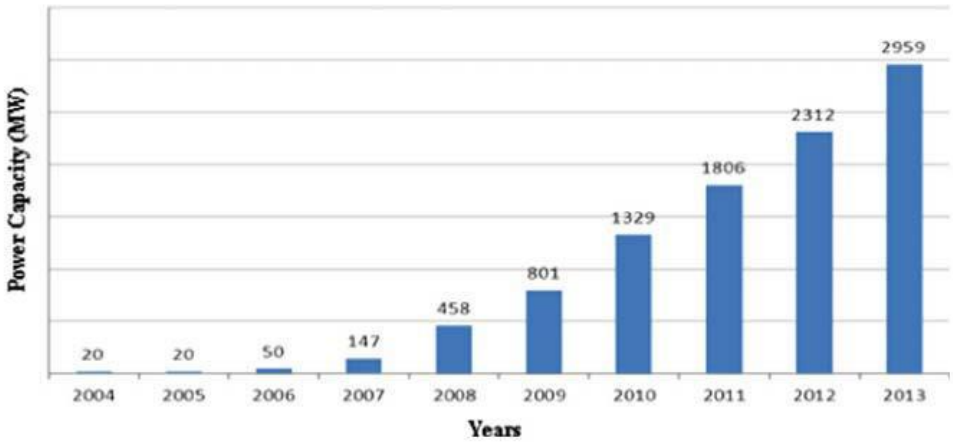

Figure 2: The Total Capacity for the Installed Wind Power Plants (Kaplan, 2015)

The dramatic increase in the installed wind power capacity in the last five years can be easily seen. The Turkish government announced its target for installed wind power capacity as 20,000 MW by 2023. Therefore, wind power plants can be profitable investment alternatives for contractors, however the risk assessment should be carefully carried out before making the investment. This study aims to identify the risk factors, probabilities, and impacts to guide the future investors. As a result of this identification, a risk matrix is constructed where one can find all risk factors, probabilities, and impacts for wind energy investments in Turkey.

2. Background Research

Several research studies have been conducted to assess the implementation and the potential of renewable energy sources. Mezher *et al.* (2011) showed the oppourtunities and challenges for the different types of renewable energy projects in Abu Dhabi. Brown and Whitney (2011) provided a summary of U.S.

electricity generation potential from different types of renewable energy sources. Evrendilek and Ertekin (2003) assessed Turkey's potential on renewable energy based on its growing energy demand and limited amount of fossil fuels. Furthermore, several research studies focused on economical, enviromental, and social impacts of renewable energy sources. (Abbasi *et al.* 1999; Akella *et al.* 2011; Sakellariou and Mulvaney 2013). Considering the choice of wind power as a renewable energy source, studies have been conducted to evaluate its potential, challenges associated with its implementation, pricing, and policies adopted. Shikha *et al.* (2004) showed the challenges for wind power plants in India, Wang *et al.* (2011) investigated pricing policy of wind power in China, Kissel and Krauter (2006) investigated wind energy policies in Brazil. Other research studies focused on offshore wind energy (Barthelmie and Pryor 2006; Wang *et al.* 2013; Monaldo *et al.* 2014; Sempreriva *et al.* 2009). Although there have been quite research studies related to renewable energy sources and wind power plants, there is not any specific study in the literature that guides to the investors in the sense of identification of risk factors for wind power plants in Turkey. Therefore, this study aims to guide the investors who interested in wind power plant investments in Turkey.

3. Methodology of Study

In order to identify the risk factors related to wind power plants, first of all, an extensive literature review was performed. This literature review, based on the works of; Schaufelberger (2005), Al-Azemi *et al.* (2014), Ibrahim *et al.* (2006), Abedgeno and Ogunlana (2006), Mane and Pimplikar (2013), Zhang (2005), Karim (2011), Wang *et al.* (2000), and Askar and Gab-Allah (2002) . With the help of this literature review, 15 possible risk factors are listed (Figure 3). These risk factors are clustered as external and internal risk factors.

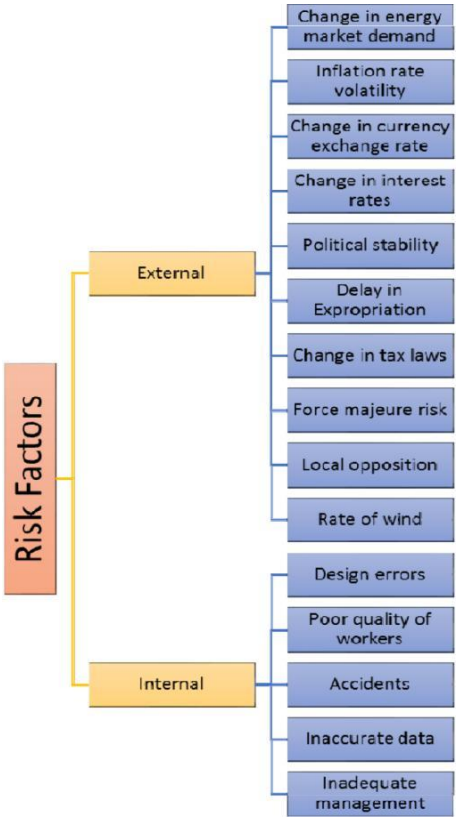

Figure 3: Risk factors for wind energy investments

The internal risk factors are possible to control or avoid, on the other hand, external risk factors are impossible to control. In the second step, as the risk factors have impact on cash flow parameters of wind energy investment, cash flow parameters related to wind power plants are identified (Figure 4). This identification process was performed by examining previous feasibility studies related to wind energy investments. As it is not in the content of this paper, the parameters are not examined in detail.

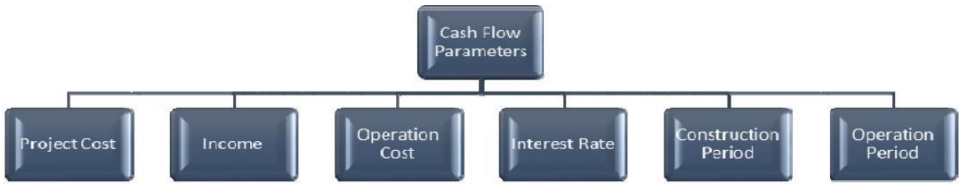

Figure 4: Cash Flow Parameters for Wind Energy Investments

After the identification process, a questionnaire contains all the risk factors and cash flow parameters was prepared. In order to identify the impact and probability of the risk factors, four different investment companies were contacted (Table 1). All companies invest in the field of renewable energy production in Turkey. Company A constructed and is now operating five wind power plants with a total capacity of 73 MW, Company B constructed and is now operating three wind power plants with a total capacity of 38 MW, Company C constructed and is now operating six wind power plant with a total capacity of 124 MW, Company D constructed and is now operating seven wind power plants with a total capacity of 155 MW.

Table 1. General profile of the companies that participated in the study

Company	*Wind Energy Production Capacity (MW)*	*Experience (years)*	*Number of wind power plants constructed and in operation period*	*Other types of renewable power plants constructed and in operation period*
Company A	73	12	5	Hydroelectric, Solar
Company B	38	11	3	Biomass, Solar, Hydroelectric
Company C	124	21	6	Geothermal, Hydroelectric
Company D	155	19	7	Hydroelectric, Solar, Geothermal

As can be seen in Table 1, all four companies are directly involved in construction and operation period for different types of renewable power plants, and each of them have experienced more than 10 years. The experiences and variety of companies helped in identifying the impact and probability of risk factors. The prepared questionnaire was applied to one executive manager and four project managers of each company. Before the questionnaire was applied to the participants, all possible risk factors were shown,

and they were asked if they want to add any other risk factor. After that process, the questionnaire was applied to all participants. In the questionnaire, they were asked to assess the probability and impact of each risk factor from zero to three, where "zero" shows risk factor has *no* probability and impact, "one" shows risk factor has *low* probability and impact, "two" shows risk factor has *medium* probability and impact, and "three" shows risk factor has *high* probability and impact.
As the questionnaire was performed by 20 participants, 20 different results were obtained. These 20 results need to be reduced to a single result. For the reduction process, the Delphi Method was used. In this technique the questionnaire was answered by the participants in two or more rounds. After each round, the questionnaire that includes all the participants' answers are given to the participants and they are asked to revise their earlier answers in the light of the other participants' answers. By performing this process, the range of the answers are minimized in each round, and also the degree of consensus for the results is increased in each round. After all rounds are completed, the mode of the answers are determined as a final result of the questionnaire.

4. Results

In order to show the results of questionnaire, a risk matrix that demonstrates probability and impact of the risk factors on cash flow parameters is constructed (Figure 5) . In the matrix, each row shows a risk factor, and each column shows a cash flow parameter. As can be seen in matrix, the results are given as two letters where the first letter ("L" for low probability, "M" for medium probability, "H" for high probability, and "N" for no probability) shows the probability of the risk factor and the second letter ("L" for low impact, "M" for medium impact, "H" for high impact, and "N" for no impact) shows the impact of the risk factor on cash flow parameter. For instance, the probability of the risk factor "*Change in energy market demand*" is medium, and the impact of this risk factor on "*Income*" is high.

TYPE	Cash Flow Parameters / Risk Factors	Project Cost	Income	Operation Cost	Interest Rate	Construction Period	Operation Period
EXTERNAL	Change in energy market demand	[M,N]	[M,H]	[M,N]	[M,N]	[M,N]	[M,N]
	Inflation rate volatility	[M,M]	[M,M]	[M,M]	[M,H]	[M,M]	[M,M]
	Change in currency exchange rate	[H,M	[H,M]	[H,M]	[H,H]	[H,N]	[H,N]
	Change in interest rates	[H,M]	[H,N]	[H,L]	[H,H]	[H,M]	[H,M]
	Political stability	[L,L]	[L,M]	[L,L]	[L,M]	[L,L]	[L,L]
	Delay in Expropriation	[M,L]	[M,L]	[M,N]	[M,N]	[M,H]	[M,H]
	Change in tax laws	[L,M]	[L,M]	[L,L]	[L,L]	[L,N]	[L,N]
	Force majeure risk	[M,H]	[M,H]	[M,H]	[M,M]	[M,H]	[M,H]
	Local opposition	[M,H]	[M,L]	[M,L]	[M,N]	[M,H]	[M,H]
	Rate of wind	[L,N]	[L,H]	[L,N]	[L,N]	[L,N]	[L,N]
INTERNAL	Design errors	[M,M]	[M,H]	[M,M]	[M,N]	[M,L]	[M,L]
	Poor quality of workers	[L,H]	[L,L]	[L,M]	[L,N]	[L,H]	[L,H]
	Accidents	[M,M]	[M,M]	[M,M]	[M,N]	[M,M]	[M,M]
	Inaccurate data	[M,N]	[M,H]	[M,H]	[M,N]	[M,N]	[M,N]
	Inadequate management	[M,H]	[M,H]	[M,H]	[M,N]	[M,H]	[M,H]

Figure 5: Risk matrix for wind energy investments

If the results are examined, it can be easily seen that "change in currency exchange rate" and "change in

interest rates" are the risk factors that have the highest probability of occuring while making wind power plant investments in Turkey. According to the participants, the reason for this situation is Turkey's strong but vulnerable economy. So, investors should pay extra attention to these two risk factors. On the other hand, "political stability", "change in tax laws" and "rate of wind" are the risk factors that have the lowest probability of occuring. Which means that investors can give less importance to these risk factors while making a wind energy investment.

If one examines the impact of risk factors on cash flow parameters, one can easily see that "inadequate management" and " force majeure risk" are the risk factors that have the highest impact on all cash flow parameters. All participants especially agree that inadequate management is one of the main reasons why investors fail in wind energy investments.

4. Conclusion

In conclusion, this research provides general information about the global energy demand. Different kinds of energy sources are stated, and also the Turkish government's available and targeted installed power capacity for wind energy is clarified. In this study, all the cash flow parameters related to wind power plants are determined with the help of previous feasibility studies related to wind energy investments. All of the external and internal risk factors for the wind power plant projects are determined by performing an extensive literature review. The impact and probability of each risk factor in wind power investments is clarified. In light of these risk factors and impacts, the risk analysis of wind power plant projects in Turkey can be easily performed. These risk factors can also be the basis of the further risk analysis studies of the other renewable (hydro, solar, biomass, geothermal) power plant projects in Turkey.

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