CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Department of Economics

Faculty of Economics and Management

Bachelor thesis

Economic analysis of wind energy in the Czech Republic: A case study of chosen firm

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BACHELOR THESIS ASSIGNMENT

Motyčková Šárka

Economics and Management

Thesis title

Economic Analysis of Wind Energy in the Czech Republic: A Case Study of a Chosen Firm

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Objectives of thesis

Compare and evaluate economy of wind power plants in the CR using specific examples in a form of a case study.

Methodology

Data collected within literature review will be analysed using a chosen methods of financial analysis such as: Cost benefit analysis, Pay back period, Internal rate of return (IRR)

Schedule for processing

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1/2013 analysis
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The proposed extent of the thesis
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Keywords
wind energy, power station, analysis of power station, budget, reneable recources, expenditures, ecological energy, sustainable development

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Recommended information sources

Wind power: Renewable energy from home, farm and business; Paul Gipe
Wind energy: Fundamentals, resource analysis and economics; Sathyajith Mathew
Větrná energie v České republice; Stanislav Cetkovský, Bohumil Frantál, Josef Štekl a kol.

The Bachelor Thesis Supervisor
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ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE
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Affirmation

I declare that the bachelor thesis on topic:"Economic analysis of wind energy in the Czech Republic: A case study of a chosen firm" was written individually by me, by help of specific literature and other sources which are included in the review of used material, and by the help of consultations with supervisor Ing. Petr Procházka, MSc, Ph.D.

In Prague ....

Signature

Acknowledgement

I would like to thank Ing. Petr Procházka, MSc, Ph.D. for methodical direction, practical remarks to writing the work and finally for his kind manner.

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Economic analysis of wind energy in the Czech Republic: A case study of chosen firm

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Ekonomická analýza větrné energie v České republice: Případová studie v dané firmě

Summary

This thesis deals with economic aspects of installing wind power plant in the Czech Republic with a closer look on process of returning our investment. It points to benefits of wind power plants and possible threats in this business sector.

The theoretical part focuses on the basic knowledge of wind energy usage in history, brief description of the engine and its main parts and wind potential of the Czech Republic. Then there are compared various impacts on surroundings of a wind power plant, either possitive or negative externalities in general and there will be mentioned different cultural opinion about this phenomenon.

The practical part of this work is in form of a case study with comparison of each calculation method used. For a better understanding of this issue it has been chosen comparison between two models of wind turbines that will be compared with various methods of investment evaluation.

Keywords: wind energy, power station, analysis of power station, budget, renewable resources, expenditures, ecological energy, sustainable development

Souhrn

Tato práce se zabývá ekonomickými aspekty instalování větrné elektrárny v České republice s bližším zaměřením na návratnost naší investice. Poukazuje na výhody větrných elektráren a případné hrozby v tomto podnikatelském sektoru.

Teoretická část je zaměřena na základní znalosti o využití větrné energie v minulosti, krátký popis stroje a jeho hlavních částí a větrný potenciál České republiky. Poté jsou porovnány různé vlivy větrné elektrárny na její okolí, pozitivní i negativní externality obecně a budou táké zmíněny různé kulturní přesvědčení o tomto fenoménu.

Praktická část této práce je napsána ve formě případové studie s porovnáním užitých metod výpočtu. Pro lepší porozumění tohoto problému bylo zvoleno porovnání dvou modelů větrných elektráren, které budou porovnávány různými metodami hodnocení investic.

Klíčová slova: větrná energie, elektrárna, analýza, rozpočet, obnovitelné zdroje, výdaje, ekologická energie, udržitelný rozvoj

Table of contents

1. INTRODUCTION

The purpose of following thesis is to give a reader fundamental knowledge about wind power in general and wind potential of the Czech Republic. Specifically, it focuses on possiblity of usage of wind engeneering in our country and general conditions under the relevant state legislation that need to be solved before wind power plant is brought into operation. Further in this thesis will be discussed questions about costs, benefits and return on investment.

Up-to-dateness of this topic unquestionable. There has been writen and said many arguments in favor or against. The wind energy is discussed in politics, scientific conferences and even schools. Ubiquity of this topic demonstrates how difficult it is to solve it. Due to possible catastrophic global climate change, the majority of European countries committed to a gradual increase in energy production from renewable sources. Perhaps the most dynamically developing sector of green energy has become a wind energy. Using of this clean source of energy raise many controversies, though.

Even this alternative technology is without influence on the environment and therefore it is necessary to find a compromise between their undeniable contribution and negative impact on the landscape, environment and quality of life for the local residents. Installing of wind power plants is an effective tool for nations that has agreed on gradual increase in green energy production, and especially it causes entrepreneurial investor interests as well as source of income for participating community.

Although it might seem that the construction of wind power depends only on suitable climatic and technical conditions of the area, experiences from abroad and the Czech Republic show that key factors are political and social acceptance. The implementation of the project involves many objective, but also very subjective point of views and opinions of especially various interest groups (investors, residents, local and regional politicians, environmentalists etc.).

2. OBJECTIVES AND METHODOLOGY

The main aim of this bachelor thesis is to give a reader fundamental knowledge about wind power, wind potential in the Czech Republic and presentation of arguments for and against. The thesis deals with economic aspects of renewable energy resources with focus on wind energy. It will be discussed questions about costs, benefits and return on investment.

In theoretical part will be discussed the basic knowledge of wind energy in history, brief description of how power plant works, weather conditions and wind potential in the Czech Republic, suitable locations for wind power plant, wind power plant and its impacts on landscape and nature. It will be discussed produced noise and so-called stroboscopic effect as well as pros and cons of wind power plant in general.

The practical part of the thesis is the real investigation work of the author. Comparing two models of wind power plant Vestas V90 and Vestas V80. The main aim is to found out more profitable and suitable type. This finding will be documented with expenditures and profits of each power plant. The case study is focused on calculation methods of returning expenditures through profits. The calculation will focus on main methods of evaluation of investment as pay-back period, discounted pay-back period, internal rate of return and cost benefit analysis. It will be discussed trustworthy of each mentioned method.

The aim of the batchelor thesis is to either confirm or reject both types of wind power stations and suggest the best solution for an enterpreneur including not only costs and benefits of the first year, but also flow of money during next years. Almost all data from practical part are provided by employee of selected company that author does not wish to named because of versatility of data.

3 HISTORY OF WIND POWER PLANTS USAGE

3.1 Early windmills

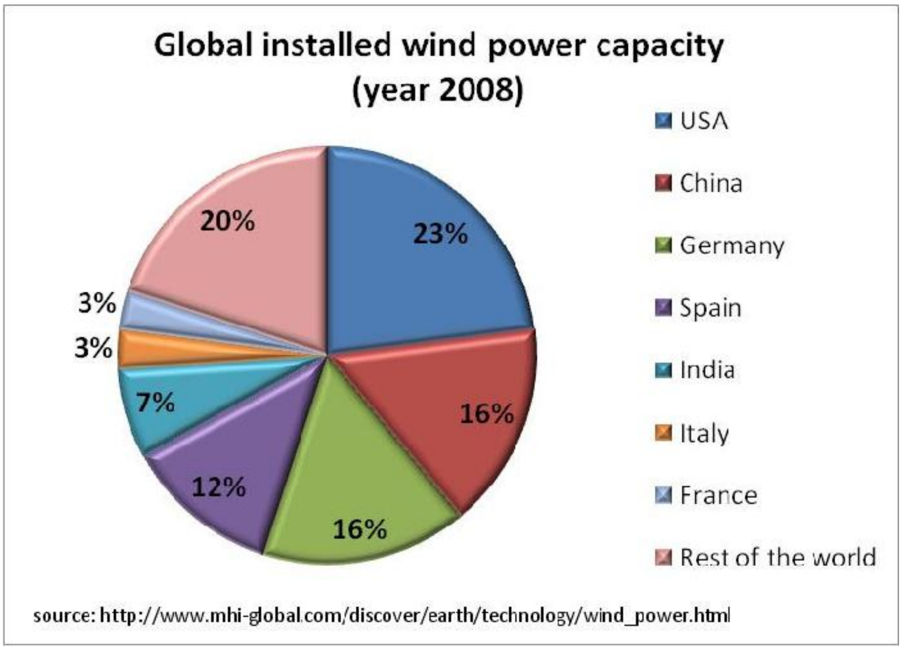
The wind energy was used already in ancient times owing to wind mills. The first maschine was designed to use wind to work. They were used to pump water and to grind grain info flour. Their origin is in most cased said to be Persian or Arabian. The oldest wind mill in Alexandria that are preserved untill today are nearly 3000 years old.[1] According to some historians were windmills brought to Europe by soldiers returning from Crusades who carried the idea of the structures home from middle East. The first written evidence of wind mill in Europe is from year 833 and in the Czech Republic in 1277 in the garden near Strahov monastery.(ČEZ a.s., 2013)

3.2 Generating electricity

The first stimulus for development of the wind power energy in the Europe was energy crisis in 1973 which was caused by embargo of OPEC countries for import an oil to developed countries. Under a pressure of rapidly growing prices of oil, many nations were forced to search for another alternatives of gaining renewable energy. (Cetkovský et al. 2010, pg. 15) The pathfinder in development of wind power energy in Europe was Denmark in 1970's. This development was also caused by the shock that crude oil is limited. At the beginning, the research was uneasy and expensive, for a long time generating electricity from wind seemed to be inapplicable in praxis. In the 1980's the research in wind power technologies has for Denmark payed off, thanks to sustainable support Denmark today is one of the leading countries and its profits from wind energy creates a significant level in its GDP. (ČEZ a.s., 2013)

Wind power plants became more efficient, reliable and grow higher. This has a great influence in profits and the technology is more affordable for locations not only near a coast. As the technology and conditions for installing wind power plants grow positive Germany is taking a chance in 90's. As the introduction of favorable conditions for the purchase of wind energy and for authorizing the contruction of wint power plants, in this period of time came an unexpected expansion in installing wind power plants and this shows how the practical, cheap and clean it is. (Cetkovský et al. 2010, pg. 16-18)

Nowadays, there is a boom in installing wind power plants due to perfection of the technology, high reliability, low noisiness, higher performance as well as decline of price. The demand for wind energy going higher with the importance of taking care of environment and climatical changes. The lead in this business is taking over China and the USA that has the highest installed capacity as it show following graph from GWEC (Global wind energy council).[online databasis, mhi-global com.]



Picture 1 - Global installed wind power capacity

3.3 Future plans

As for future development, construction is expected to drop in areas where wind energy pushed first. Construction of the plant is gradually inland lack quaff and limits energy systems. More intensive development can be expected in the U.S. and overseas in the future in developing countries. Soon, it is expected larger installation of so called off-shore wind power and there are expectations in further technological progress. (Cetkovský et al. 2010, pg. 16-18)

4 IMPORTANCE OF WIND ENERGY AS A RENEWABLE RESOURCE

Energy is an essential part of our life. We use energy from moving to breathing. Energy makes our lives easier and more comfortable. A fuel run our vehicles and heats our homes. This energy is mainly supplied by fossil fuels, such as coal, oil or natural gas. Global demand for all forms of energy is expected to grow rapidly. However, due to increasing urgency of problems associated with usage of fossil fuels, wind engeneering has become one of the fastest growing industrial branch. Alternative energy sources can help meet the needs of future world without harming the environment or using up all of the resources.

All renewable resources have an advantage of infinity, they are part of natural processes of The Sun, wind, water and geothermal energy. The wind is kinetic energy, in motion, which is for everybody for free. This helps to reduce our dependence on non-renewable materials imported from countries with mostly unpredictable political situation. The wind power energy is eco-friendly and this has a great importance nowadays when creation of energy produce various unwanted waste compounds e.g. carbon dioxide. Other benefits include safe use. The creation of energy from renewable sources of energy may also cause an accident, but damages are much smaller than accidents from conventional sources. Such as the extraction and transportation of oil and natural gas. In addition, agricultural land under the wind power plant could be without any restrictions cultivated for crop as well as pastoralism.

Even though building of wind power plant may seem it is influenced only by climatic conditions this process is in fact determined by political and social factor mainly from side of residents. In case of the Czech Republic wind energy will grow in importance when shortage of brown coal is to come.

5 HOW WIND POWER PLANT WORKS

The aim of wind power plant is to transform kinetic energy into electric power. The simplest design of the maschine must have three crucial parts: rotor, shaft and alternator. When the Sun heats the Earth atmosphere it creates warm air. As this warm air spread through and rises up, it is replaced by cold denser air, this creates wind. In the past our ancestors used the power of the wind to pump water or grind grain. Today, people are capturing the wind energy and turning it into electricity. The modern windmills we use are called wind turbines. When the wind is not blowing we rely on back-up generators to supply power.(Fitzgeralt, 2010, pg. 14-15) The most projects nowadays are focused on larger scale projects such as commercial wind farms. Used on a large scale, wind power can have a significant effect on the growing global need for energy and also efforts to stop global climate changes.

5.1 Rotor

Today's turbines are versatile sources of electricity. Rotor, the blades that are similar to aircraft wings, is aerodynamically designedto capture the maximum energy from the wind. The wind turns the blades with use of buoyancy force, which spin a shaft connected to a generator that makes electricity. The buoyancy force can keep a plane in the air and spin the rotor. A wind turbine consist of a pole or tower, blades and a box called a nacelle. There are many shapes and different sizes of wind turbines, but two basic designs are horizontal axis and vertical axis.(Gipe, 2009, pg. 1) The horizontal axis design is more common. Two or three rotor blades are attached to the tower by a shaft that is parallel to the ground. Blades have to be turned to face the wind. The turbine is designed to do this automatically. In the vertical axis design blades are at a right angle to the ground. This type of wind turbine enables to chatch the wind from whatever direction. Irrespective of the design, the rotor has to be attached to a tower. The higher you get from the ground, the stronger the wind blows. The towers for commercial purposes is usually more that 90 meters tall with blades between 50-90 meters long. As the flow of wind fluctuate the blades of rotor are taking different possitions to catch the optimal strength of the wind and maximize the profit from wind.(Fitzgeralt, 2010, pg. 14-15)

5.2 Overspeed control

Having enough wind is important but there needs to be some means of control the rotor in strong winds, because too much wind actually damage the turbine. More than 30 years ago, Danes have learned that all wind turbines must have an aerodynamic overspeed control to limit power in an emergency. The Danish wind turbine owners‘ association compeled Danish manufactures to obey this requirement, otherwise they simply refuse to buy any wind turbine that did not had it. The turbine owners did this action because by this time they had lost too many wind turbines to winter gales. Their action was probably one of the reasons the Danish wind industry grew and dominated the world for more than two decades. By insisting on their requirement the comsumers saved Danish wind turbine manufactures. This is the reason that in the USA there are so many old Danish wind turbines still operating while only a few American turbines from the very same period remain in use (Gipe, 2009, pg. 1-3)

5.3 Alternator vs. generator

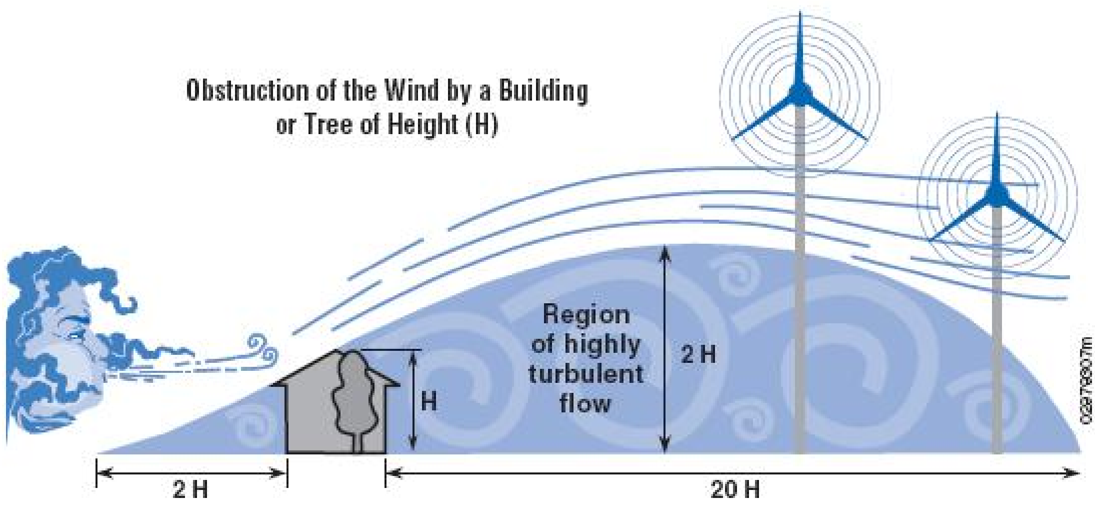
A generator is a machine that converts mechanical energy ito electrical energy, either AC or DC. The generator that produces AC is called alternator. Alternator that produce DC electricity is known as generator. Most modern wind turbines contain alternators. Some of these turbines are also equipped with rectifiers, devices that convert AC to DC electricity that is then sent down the tower.(Chiras, 2010, pg. 83-85)

Alternator consist of two main parts: stator, and set of rotating magnets, known as rotor. The movement of magnets, as blades spin, induces an electrical. Wind turbines first convert the kinetic energy of the wind into mechanical energy – rotation. The mechanical energy is then converted into electrical energy in the alternator.(Chiras, 2010, pg. 83-85) The size of a generator‘s swept area is the factor that determines how many KWh we get. The KWh is the measurement used to determine how large wind generator is needed. The larger generator’s swept area means more energy produced and the less rotation per minute.(Woofenden, 2009, pg. 200)

5.4 Speed of wind and heigh of towers

There is one very common question, why the towers have to be so tall. The reason is simple, the wind blowing is more constant. The factor that moves with wind is Sun that causes blowing around the atmospere. In low levels closer to the ground there are borders – trees, buildings or mountains. Owing to these barriers the speed of the wind decrease and turbulences increases. For wind power plant is profitable strong and constant wind.(Gipe, 2004, pg. 39-40)

The increasement speed of wind and subsequent energy produced is nothing to be omitted. Modern wind power plants have turbines in heigh 100 meters above ground. If in this heigh is e.g. 6 m/s speed of the wind, then modern wind turbine with blades in average 90 meters wide with performance of 2MW will create around 4 500 MWh of electricity per year. To reach this performance in case of 40 meters wind towers there has to be installed up to 6-7 same wind towers in addition to this, they would create only 2/3 of electricity mentioned above. Relatively low wind speed near the ground is the reason why there is not much enthusiasm about small scale wind tower designed for garden or top of the roof.(ČSVE et al., pg. 14)



Picture 2 - Wind turbulences

6 ADVANTAGES, DISADVANTAGES AND EXTERNALITIES

6.1 Advantages of wind power plants

6.1.1 Cleaner environment, saving up water

The obvious benefit is the environmental impact of not relying so much on fossil fuels. The reduction in emissions of gases linked to global warming would also have an impact on water. Generating electricity using fosil fuels as well as nuclear power takes a huge amount of water, while making electricity with wind power does not, this will have a possitive impact on dry countries where supply of water is low. In fact, it is an ideal source of power for countries of third world. Cleaning up the environment is not the only benefit to choose alternative energy source such as wind power.(Nelson, 2009, pg. 13)

6.1.2 Wind is free resource

The cost of wind is not subject to price increases. A future with wind power plants might be the option to lower inflation. It is not meant to say that wind energy will be for everybody for free. While the fuel (wind) is free, the price of wind generators is likely to increase. That is because it takes energy to actually build wind power plant. It also takes energy to make turbines and tower and ship and install them. Wind energetics is dependable, in fact, on local availability of wind a this is not subject that could be restricted by political nor international agreements. (Chiras, 2010, pg. 6-13)

6.1.3 Independent and secure nation

Another benefit of wind energy is that, unlike oil, coal etc., the wind is not owned by major energy companies or foreign nations. Reducing our reliance on resource holding countries may reduce costly operations aimed at holding the resource as well as it reduce international political tensions. In last decades, it has been shown how much oil crisis may influence society. Starting with increasing prices, troubles with dependability on suppliers and finaly leads to interference in domestic politics. Another factor leads to creation of corruption regimes and civil and international wars. Nowadays, it is comsumed anually as much fosil fuels as it was in the past saved for few millions of years. Majority of experts assume that the exploiting of fosil fuels is driving at the limits. The first change will be the increasing price. (Chiras, 2010, pg. 6-13)

If renewable resouces are of domestic origin it increase energetic safety of the country. Biomass can be cultivated on our field, wind, water or sun belongs to everybody. Diversification of resources increases the stability of system preventing from power outage. Creating energy from resources dependable on weather is fluctuanting, though we are able to predict and effectively use in case of energy mix.

6.1.4 Does not prevent cultivation of soil

Wind turbines take up less space than the average power station. Although wind turbines can be very tall each takes up only a small plot of land. This means that the land below can still be used. This is especially the case in agricultural areas as farming can still continue. This is not example of solar panels that prevent any further cultivation of crop. (Chiras, 2010, pg. 6-13)

6.1.5 New job places

Wind energy has brought many jobs for people living nearby. From installation of wind turbines to maintenance of the area where turbines are located, it has created wide range of opportunities for the people. Since most of the wind turbines are based in coastal and hilly areas, in fact places with lower employment, people living there are usually in charge of maintenance of wind turbines.(Fitzgeralt, 2010, pg. 29)

6.2 Disadvantages of wind power plants

Despite all the positive factors of wind energy, some people are not in a favor of it. Arguments against wind powe include both sides: economic and most suprisingly environmental complaints. The problems include aesthetics, bird mortality, property values, unwanted sound, interference with radio and other signals.

6.2.1 Transmission and plug in to energy grid

Many of the best sites for wind farms are located far from more densely populated areas that consume the energy. Obviously there is a strong need for wind tower a pug in to energy grid, transporting energy over long distances which is costly.(Fitzgeralt, 2010, pg. 32)

6.2.2 Aesthetics

The areas with sufficient wind potential are, in case of the Czech Republic, usually in competition with areas restricted according to czech legislative system. Places that are not suitable for installing wind power plant are:

inhabited areas at least 500m away

National parks and other protected areas

Military areas and airports, possible clash with other technologies

agreement of the village as well as the owner of the land

Intalling any wind power plant would always bring intervention in the landscape. (Cetkovský et. al., 2010, pg. 54-55) It is obvious that this influence would be evaluated differently in case of inhabited area and mountain landscape. While decision making process is made about whether accept the project or not it is landscape that is crucial. Not only from point of view of an ecologist, but also from point of view of sociologist. This confirms the fact that quality of landscape is measured by biofyzical elements as well as rather subjective perception of a particular observer which can not be exactly measured. (Cetkovský et. al., 2010, pg. 139-140)

The possitive point for wind power plant is that the measuring landscape intervention is probably the most serious. Visual functioning in the landscape is further reinforced by the fact that due to maximum utilization of wind potential for localized high places in other words for places easily to notice. On the other hand, it is necessary to take into acount the economic, social and cultural needs of the local population. This is a conflict of interests of landscape on the one hand and the production of electricity from renewable sources. It is therefore clear that the scale landscape of the Czech Republic would be for most projects very conflicting issue.

6.2.3 Birds and bats

With increasing number of installed wind power plantsour knowledge abou impact on different species especialy birds and later on bats. In case of the Czech Republic is very important to have an agreement of Česká společnost ornitologie (ČSO) and Česká společnost pro ochranu netopýrů (ČESON), the research should be done before installing any project. While in the USA where huge power plant farms are build, the findings may be allarming. (Cetkovský et. al., 2010, pg. 118-120)

Anticipated impacts

1. Disturbance (noise, presence)

2. Clash

Barrier effect and lost of natural habitat is low, only in cases of installing project with at least tens of wind power plants. An impact on species is noticable especialy in case of disturbance which is typical only for some specific species of birds and bats.

1. Disturbance

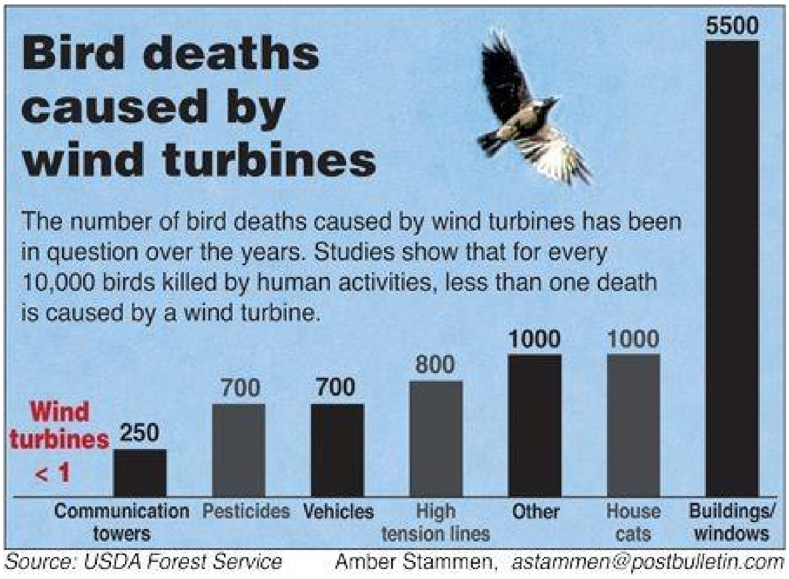
In general, it can be divided into visual and acustical which has scary effect that leads to avoiding the place or the worst leaving their nests. There were found either neutral and negative impacts on different bird species. In fact up to 300 meters is was proven to be harmful and for migratory birds it is needed more than 800 meters. Generally for most of the species is critical up to 200 meters or it does not mind to them. Complications may occur with individual sensity of each species. The second important factor is density and heigh of placement of installed towers. (Cetkovský et. al., 2010, pg. 118-120)

2. Clash

The collision with wind power plant can theoretically occur in any species of bird or bat, some species are known to clash, they are relatively common, but many species were not observed. The possibility of a collision is influenced by many factors, especially wind speed, direction, temperature, humidity, altitude, and the way a bird, time of day, etc. Increased risk of collision occurs primarily in high winds, rain, and fog during the night. Summary, in situations where visibility is reduced and they are more difficult conditions of orientation during movement and migration. generally, the most sensitive groups of birds to collide with wind power are larger birds and predators. Even a few representatives of species in danger may have a huge impact on whole population of the species, though. In terms of risk of collision are dangerous lights that are placed on wind turbine towers, which flying birds attract, especially in poor visibility, which leads to increased mortality.

Another reason is the fact that many species will fly at an altitude of 100 meters above the ground. (Cetkovský et. al., 2010, pg. 118-120)

Surely it is possible to consider the wind power plant control activities, but logically would be done only if it is established that a significant mortality of birds and bats occurs. Should prevent at least one year study focusing on the search of birds and bats.



Picture 3 – Bird deaths

Commercial wind turbines kill an estimated 50, 000 birds per year, maybe even higher. While this sounds like a lot, this nuber pales in comparisonto other lethal forces, windows in skyscrapers an domestic cats. All in all, cats are probably the most lethal, and even scientists estimate that the number is very likely much more higher.

6.2.4 Value of the property decreases

Critics raise concerns when it comes to the placement of wind tower near their property. Impact of previously announced construction and its subsequent implementation on the prices of the surrounding real estate is a hot topic. This effect arises from the interference of wind power plants in the landscape and noise produced during her operation. Combination of these factors may discourage some potential candidates from the purchase of the property and thus reduces its market demand. Consequently decreases the price of real estate.(Chiras. 2010, pg. 6-13)

6.2.5 Noise

During the process of energy production is to produce noise emissions. These emissions are based on their resources fall into two categories. First, the mechanical noise generated mainly due to the gearbox together with the other parts of the machinery as well as the alternator. Thanks to the technological development, mechanical noise is not the main source of noise wind turbines. Noise is formed on the aerodynamic basis. Aerodynamic noise arise flow of wind around each part of the propeller. When increasing wind speed noise emissions increase. The noise is also amplified by the larger size turbines.(ČSVE et al., 2011, pg. 23-24)

Loudness is measured in decibels (dB). The average background noise in a house is about 50 dB. Nearby trees on a breezy day measure about 55 to 60 dB. In some documents, the WHO recommended target value of 30 dB in a protected outdoor space structures. Target value of preventing the adverse health effects of noise at night even in sensitive population groups. At 30-40 db noise level will be observed affecting the quality of sleep, but the effect is slight. The large increase in the impact on health occurs when the noise level more than 40 dB. Target value should protectc the sleep at slightly open windows for ventilation. (Chiras. 2010, 6-13)

The system of limits in the Czech Republic is more stringent than in the EU countries and is in line with WHO recommendations. Therefore wind tower are build few hundred meters far from inhabited areas. The distance is not given by chance. At each single project in the Czech Republic it is made special noise study which contains the terrain and the data are processed by independent laboratory before the project starts. Even when the new wind tower starts working it is followed by further measuring and these measurements have also final impact on permiting continuous operation. The system of limits in the U.S. is insufficient wind turbines are commonly built in close proximity to protected areas, case studies from the United States can not therefore be a generalization of the noise of wind power plants in other countries.(Cetkovský et al., 2010, pg. 139-140) As a result, wind turbine sounds may be distinguishable from ambient noises, even though they are not louder. The only thing is a swooshing sound and the sound of a wind turbine can be picked out from surrounding noise if there is a conscious effort to hear it.

6.2.6 Stroboscopic effect

Is flicker of a shadow cast by the moving rotor, based on experience with completed projects this effect is more evident to the maximal distance 0.7 km. Wind power plants are therefore build with at least 0.6 km far from inhabited areas. There must be met three basic assumptions for effect to occur:

- wind power plant is working,
- sun shine is not shielded by clouds,
- rotor is set perpendicular to the observer.

The frequencies that can cause disturbance are between 2.5-20 Hz. In case of stroboscopic effect the main concern is variations in light at grequencies of 2.5-3 Hz which have been found to cause anomalous reactions in some sufferers from epilepsy. Higher frequencies like 15-20 Hz may even lead to epileptic convulsions. In general, approximatelly 10 % of all adults and 15-30% of children are disturbed to some extent by light variations at these frequencies. Large modern three-bladed wind turbines rotate at frequency less than 1.75 Hz, which is below the critical frequency of 2.5 Hz.(Burton, 2001, p. 527)

Already in the establishment of design layout of machines on the site is taken into account the possibility of stroboscopic effect. Using simulation software can accurately determine which days and hours it may take place. If it is serious, is the power station is in these days out of service. (ČSVE et al., 2011, pg. 25)

6.3 Externalities

The driving force of contemporary economies in the world are natural resources that are largely non-renewable or are in use simultaneously pace in a short period of time exhaustible. Moreover, their use is associated with the production of negative externalities. Externalities are social or external costs and benefits, which are attributable to an activity that is not borne by the parties involved in that activity. Externalities are not paid by the producers or consumers and are not included in the market price, alhough someone at sometime will pay for or be affected by them. An example of a positive externality, social benefit, is the benefit everyone gets from cleaner air from installation of wind farms. While an example of negative externality is that market prices of nearby properties will decrease, noise, aesthetics, etc... (Nelson, 2009, pg. 239).

7 WEATHER CONDITIONS AND MEASURING WIND

7.1 Meteorology in wind power engeneering

As the new trends in power engeneering comes it was estabilished new scientific discipline – meteorology in wind power engeneering. It is a scientific direction as well as e.g.: aviation meteorogoly. This science works with physics of the atmosphere and its continuity to atmosphere adjoining to the surface. Another science that is important to know in case of wind power plants is climatology. It is science about climate with focus on meteorological processes in various geografic areas.(Štekl, 1997, pg. 48)

Main aims of meteorology in wind power ingeneering:

1. Determination of wind potential in specific areas of a nation

2. Resources of wind energy in specific height with usage of scientific knowledge

3. Search for an ideal place with usage of optimal methods with respect to terrain barries and wind speed in specific area

4. Consideration of temperature and density of air, turbolences, electrical discharges etc.

5. Optimizing the production of electrical energy with gained knowledge about the location (Cetkovský, 2010, pg. 25)

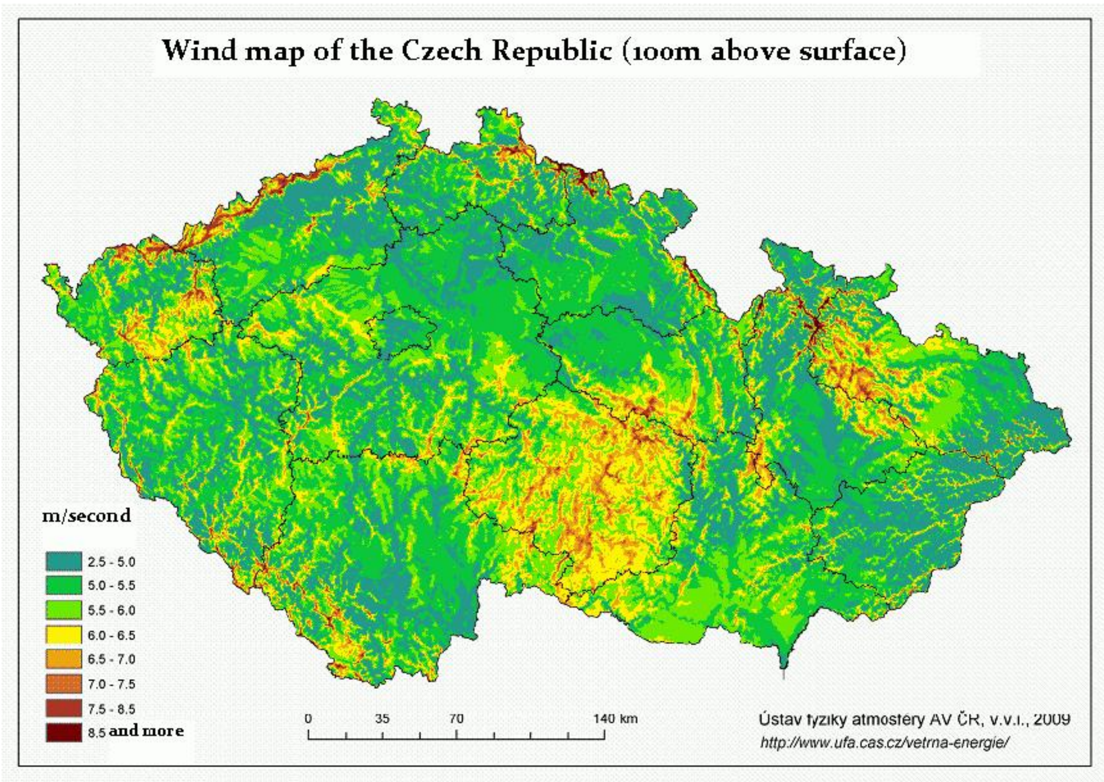
7.2 Wind maps

As it was written above, climate of specific area is a characteric mode of the weather, in case of wind climate we talk about wind speed and direction. The speed of wind is displayed in a wind map of the area below. The wind map displays an average speed of wind in specific height above surface. It depends on height above surface very much because in lower height levels wind blows far less because of turbolenses above ground and local barriers.

Wind maps may give us a knowledge about wind potential of specific area, but it is not possible to start off a project that is dependable only on a wind map. In the past was written many wind maps for the Czech Republic, but these observation were made only for weather forecasting in 10 meters above surface. Nowadays, we need a wind map that could be also used in case of installing wind farms and this requires reliable wind map at least

100 meters above surface. It is unfortunate that none of maps measured height above surface can be perfectly reliable. It is caused by unexpected barriers on the ground that are hard to calculate with in mathematical models, as well as mathematical models itself. Finaly, this reliability may change to better in the future owing to improving technologies in the IT and accuracy in computations through wind simulations. (Cetkovský, 2010, pg. 52)

The wind map below was calculated in 2009 in Ústav Fyziky atmosféry AV ČR. It was used a procedure of combining advantages of three mathematical models: statistical method VAS, model for wind power engeneering WAsP and dynamic model PIAP.(ČSVE et al., 2011, pg. 14)



Picture 4 - Wind map of the Czech Republic

These parameters plays important role in decision-making of installing wind power plant. Third significat parameter are costs linked with installing: Higher expenditure of installing, higher expectation of wind potential of the area. Another request is plug into energy grid and infrastructure which is in the Czech Republic an advantage in comparison with remote areas and coastal wind farms. Available infrastructure helps greatly in pushing down expenditures on the power plant.(Hanslian et al., 2008, pg. 6)

7.3 Potential of wind energy

Wind potential is amount and produced energy of wind power plants that could be instaled at one place. When this place is evaluated it is important to distinguish also the type of potential. There are three different kinds of potential. (Hanslian et al., 2008, pg. 9-14)

7.3.1 Potential of climate

Entirely based on theoretical level, this potential measures only energy that is gained from wind power plant in specified weather conditions. This does not measure technical advantages of modern wind energetics, but it is impartial. (Hanslian et al., 2008, pg. 9-14)

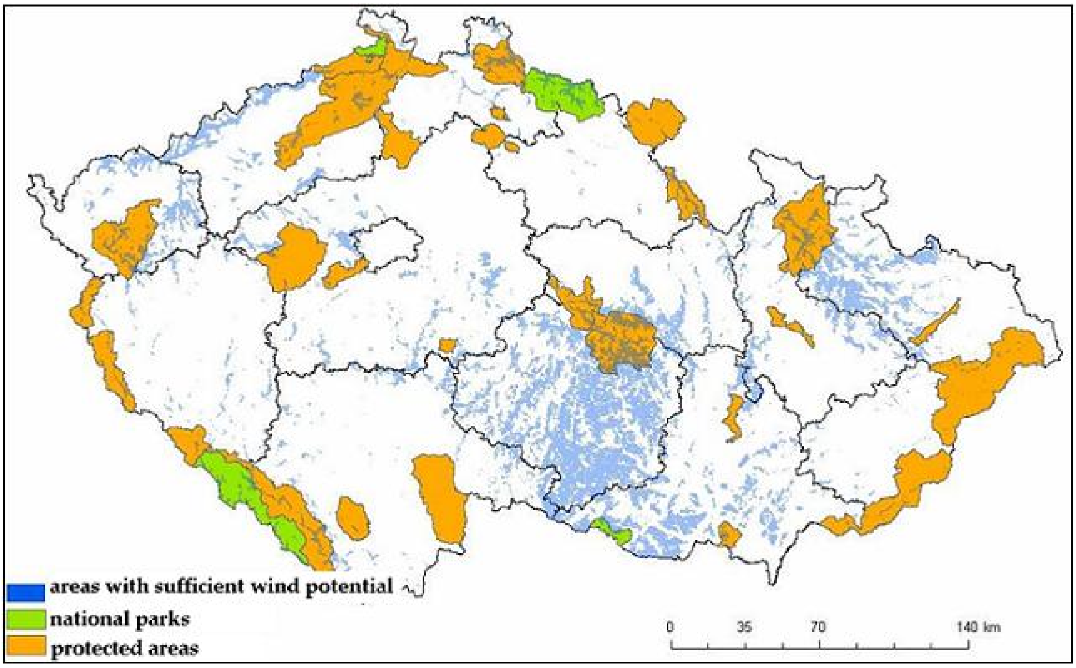
7.3.2 Technical potential

It is a summary of all possible possitions of wind power plant that fulfills conditions. Includes not only wind conditions but also maximal development of wind power plant with usage of all current technical possiblities as well as legislative borders. The measurement is also theoretical, utilization of entire technical potential is in reality almost impossible to reach. The calculation of technical potential depends on chosen conditions and methods. In praxis this calculation is used as a groundwork for possible potential. (Hanslian et al., 2008, pg. 9-14)

7.3.3 Possible potential

Is the measurement of potential that is under current conditions of the area possible. However, the estimation is entirely influenced by the specific approach of an expert, his/hers experiences and expectations. (Hanslian et al., 2008, pg. 9-14)

Computation of possible potential of wind energy needs to be builded from technical potential that is extended with political and social impacts. It is obvious that quantitative solution of all factors is uneasy, for this these computations are only estimations. In praxis, the uncertainity is usually minimalized by estimation of possible potential with two methods that have opposing approaches.



Piture 5 - Areas with wind potential vs. protected areas

8. METHODS OF INVESTMENT EVALUATION

8.1 Brief description of the project

Location of the wind power plant be in the Krušné mountains (1028 m). Considering the project plan with one wind power plant with an output of 2000 kW with a rotor axis at a height of 75 m. This location was chosen because of the superior wind conditions in this area can be found and are the best in the Czech Republic. The investor is a company with limited liability. The company considers it important to yield high reliability. The financing for the bank loan and subsidies from EU funds. The following examples will be compared two common variants of wind turbines. Investor is a VAT payer, therefore the prices of investment and electricity are considering without VAT.

1. Vestas V90, 2 MW performance, 90 rotor diameter

2. Vestas V80, 2 MW performance, 80 rotor diameter

Table 1.: Operating costs		
	Vestas V 90	Vestas V80
wages and insurance	230 000 Kč	230 000 Kč
repairs	200 000 Kč	200 000 Kč
maintenance	500 000 Kč	500 000 Kč
overhead costs	50 000 Kč	50 000 Kč
insurance - power plant	405 889 Kč	337 207 Kč
energy	90 000 Kč	36 000 Kč
Total operating costs	1 457 889	1 353 207

Table 2.: Investment costs		
	Vestas V 90	Vestas V80
technology - power plant	68 682 600 Kč	54 946 080 Kč
energy grid connection	2 200 000 Kč	2 200 000 Kč
construction costs	10 295 250 Kč	10 295 250 Kč
overhead costs	180 000 Kč	180 000 Kč
energy audit	35 000 Kč	35 000 Kč
total without VAT	**81 392 850 Kč**	**67 656 330 Kč**
total	968 557 492 Kč	80 511 033 Kč

All prices are normal value on the market in 2006. The calculation took account of the rate of 28.44 CZK / Euro with a reserve of 5% to change course. Wind power belongs to the depreciation 4 as "energetic work" and the depreciation period is 20 years. Payment of income tax in this case is valid after 5 years from the start of the operation. This review is considering financing the project in full from its own funds investor, without loans and subsidies.

Table 3.: Economic input parameters	
Price of energy	2460Kč/MWh
Vestas V90 output	5186 MWh
Vestas V80 output	3965 MWh

SOURCE: OWN IMPUT

8.2 Investment

Means of investment is a separate business activity, characterized as spending resources in order to obtain benefits that are expected in the long future period.

The decisive criteria for assessing investment:

profitability - the relationship between income and expenses of the investment

risk - the degree of risk of failure to achieve expected revenue

repayment period - the time of conversion investment back into the money form

Investment evaluation methods are used in practice to evaluate the economic efficiency of individual projects. Investments with high returns are usually high-risk, low-risk investment is too little profitable. The final result of the evaluation of the investment is the decision whether to implement the project, or in the evaluation of multiple projects (variant), to decide which project can best be realized.

An important basis for the decision of an investor is to calculate the economic impact on the project while respecting the specific economic decision rules and conditions in which the investor IS, when the project was designed. The results of the economic evaluation must also be reported to institutions that provide necessary resources such as loans, grants or other support.(Synek et al, 2006, pg. 249)

Economic efficiency is measured by money, so this calculation can not include variables that are not precisely measurable by money. Among the immeasurable value because in most cases the positive and negative externalities such as benefit the environment, the negative impact of noise on the local population, etc. Methods of investment evaluation only gives us answers to the questions: How much does it cost? When returning my investment? The investment is effective enough?

Economic viability and effectiveness of the RES (renewable energetic sources) affects the following economic variables:

Investment costs, which include all non-recurring expenses for the preparation of construction, project, supply of technological equipment and its installation, construction work, electrical connection or. the cost of the purchase of the necessary land.

The lifetime of the device, ie the period during which it will be possible to use renewable energy production (to save energy) without having to re-incur capital expenditure for the reconstruction. Reliable technology with long lifetime significantly increases its economic benefits.

Operating costs of servicing the equipment, its regular maintenance, anticipated repairs, overhead, property insurance, property taxes and other fees, the purchase of fuel and energy, including transport.

Size of energy savings, the annual production of electricity and heat. Economic efficiency positively affects the possibility of producing electricity during peak hours when the price is highest.

RES on the economy affect the parameters of the project funding, ie size, repayment period and the interest rate of the loan and also the cost of his own money investor. Economic effect for the investor affects income tax, any tax credits and state or other support. In the future, the economy RES significantly impress even the eventual introduction of taxes, the amount should be dependent on the amount of energy consumed or the production of greenhouse gases resulting from the combustion of solid fuels (not case of renewable sources of energy). [online databasis, Vašíček, 2005]

8.3 Pay-back period method

Pay-back period is commonly used to evaluate proposed investments. It is the amount of time required for the firm to recover its initial investment in a project, as calculated from cash inflows. This method can be found by dividing the initial investment by the annual cash inflow. Use to create a basic comparison, if we do not want to deal with discounting. Although popular, the pay-back period is generally viewed as an unsophisticated capital budgeting technique, because it does not explicitly consider the time value of money (valuation of cash flow due to the discount rate).

Decision Criteria

The method is used to make simple accept-reject decisions:

- If the pay-back period is less than the maximum acceptable payback period, accept the project.
- If the pay-back period is greater than the maximum acceptable payback period, reject the project.

The length of the maximum acceptable pay-back period is determined by the management. This time is set subjectively on number of factors, including type of project (expansion, replacement, renewal) and the risk of the project. On average, it is a value that investment will result in value-creating decisions.

Pros and cons of pay-back period

This method is widely used by large firms to evaluate small prjects and by small firms to evaluate most projects. Its popularity is owing to its computational simplicity and intuitive appeal. It comsiders cash flows rather than accounting profits. By measuring how quicky the firm recovers its initial investment, the pay-back period also gives measure of risk exposure. The longer the firm must wait to recover its invested funds, the greater the possibility of a calamity. Therefore, shorter the pay-back period, the lower exposure to such risk for company.

The major weakness of the computation is that is merely a subjectively determined by actual number. It cannot be specified in light of the wealth maximization goal because it is not based on discounting cash flows to determine whether they add to the value of the firm. Instead it is simply the maximum acceptable period of time over which management decides to be the break even. Another weakness is that this approach fails in accounting the time factor in the value of money. And the last minus of pay-back is failure in recognizing cash flows that may occur after the pay-back period. This criterion (shortest return on investment) neglects a number of important factors such as future increases in energy prices, but also the fact that money can be put to other investment opportunities. (Gitman, 2009, pg: 397-399)

Simplified calculation of economic efficiency can be done by comparing the achieved annual benefits from energy savings with investment costs incurred. The simple return on investment this is calculated as follows:

$$T_s = \frac{IN}{CF}$$

IN investment, one-off implementation costs savings

B benefits of realization of such annual value of energy savings

AOP annual operating costs

CF annual savings in money

CF = B – AOP

8.3.1 Calculation of pay-back period

1. Vestas V90

CF= Benefits from the sale of electricity	5186 x 2460	= 12757560
annual operating costs	-1475889	
=	**11281671**	

Ts =	81 392 850/ 11 281 671
Ts =	7,20
Ts =	**approx. 7 years**

Source: own imput

2. Vestas V80

CF= Benefits from the sale of electricity	3965 x 2460	= 9753900
annual operating costs	-1475889	
=	**8278011**	

Ts =	81 392 850/ 8 278 011
Ts =	9,83
Ts =	**almost 10 years**

Source: own imput

Pay back period of returning our investments is in case of Vestas V90, 7,2 years and Vestas V80 almost 10 years.

8.4 Net present value method (NPV)

Gives explicit consideration to the time value of money, it is considered as a sophisticated capital budgeting technique. All such techniques is way how to discount the cash flows of the firm at a specified rate. The rate, called discount rate, cost of capital, or opprotunity cost, is the minimum return that must be earned on a project to leave market value unchanged. Net present value of the investment is the difference between the present value of expected revenues (cash flow) and the cost of investment.

$$\text{NPV} = \text{Present value of cash inflows} - \text{Initial investment}$$

$$\text{NPV} = \sum_{t=1}^{n} \frac{CF_t}{(1+k)^t} - CF_0$$

$$= \sum_{t=1}^{n} (CF_t \times PVIF_{k,t}) - CF_0$$

When NPV is used, both inflows and outflows are measured in terms of present currency rate. The initial investment is automatically stated in terms of today's crowns. If it were not, the NPV of a project would be found bz substracting the present value of outflows from the present value of inflows.

Decision criteria

- If the NPV is greater that X CZK, accept the project.
- If the NPV is less than X CZK, reject the project.

If the NPV is greater than X CZK, the firm will earn a return greater than its cost of capital. Such action should enhance the market value of the firm and therefore the wealth of its owners. (Gitman, 2009, pg: 400-402)

8.5 Internal rate of return method (IRR)

Is the interest rate at which the net present value of all the cash flows (both positive and negative) from a project or investment equal zero.

It is also based on the principle of the present value. In contrast to the rests in the fact that the discount rate is not given, but looking at the value which is present, the expected revenue from the investment equal to the current costs of the investment. If the investment is financed by a loan, it should be an internal rate of return higher than the interest rate.

The IRR is the discount rate that will equate the present value of the outflows with the present value of the inflows.

$$\sum_{t=1}^{n} \frac{CF_t}{(1 + IRR)^t} = CF_0$$

Decision criteria

Internal rate of return is used to evaluate the attractiveness of a project or investment.

- If the IRR of a new project exceeds a company's required rate of return, accept the project.
- If IRR falls below the required rate of return, reject the project.

There is no guarantee that NPV and IRR will rank projects in the same order. But both methods should reach the same conclusion about the acceptability of the projects. (Gitman, 2009, pg: 404-406)

Comparing IRR and NPV

When comparing investment opportunities the rule is that the best investment is the one at which the NPV is the highest (the tacit assumption correctly estimated future cash flows and selected the same discount). For IRR, the same applies - the higher the IRR*, the* investment opportunity is regarded to us as lucrative. In this mathematical concept from which fades original economic significance, it is possible to happen that in a situation where we compare projects A and B:

NPV(A) > NPV(B)   while   IRR(A) < IRR(B)

In this case it is necessary to move away from mathematics and return to common sense (economic importance). This situation does not tell us anything other than that the project and will bring us more money (cash flow) and that project B, while better value for our money, but we will have them in total as much as it gave us the project A. Therefore, it is the discretion of each which of the two projects they choose. Some companies lead the investment strategy choice about the most profitable projects in terms of the percentage of return (IRR then decides), others go especially after improving cashflow (then decides NPV). The general rule about what is better and what is worse access can not be set. In practice these approaches of companies works either very well or very bad. (Scholleová, 2008, pg. 256)

8.5.1 Vestas V90 - calculation of NPV and IRR

Parameters for the calculation:

Investment costs	**-81 177 850**	
Discont	**7%**	p.a.
Price of energy	**2,46**	CZK/kWh
VAT	**19%**	2%
Free from VAT for	**5**	years
Increase in energy for own needs	**0%**	2%
Average growth in other costs	**0%**	2%
Growth in price of energy	**0%**	
Output	**5 186**	MWh
Profit from 1st year	**12 757 560**	
Costs for each year of operation	**1 475 889**	

Technology	68 682 600	81 177 850
Energy grid connection	2 200 000	
Construction cost	10 295 250	
Overhead cost	180 000	only 1st year
Energy audit	35 000	only 1st year

SOURCE: OWN IMPUT

The data were processed in MS Excel. The computations are based on the fact that depreciation of wind power plant is for 20 years.

Step-by-step calculations:

Years	1	2	3	4	5	6	7	8
Profit	12 757 560	12 757 560	12 757 560	12 757 560	12 757 560	12 757 560	12 757 560	12 757 560
Other costs including its growth	-1 475 889	-1 475 889	-1 475 889	-1 475 889	-1 475 889	-1 475 889	-1 475 889	-1 475 889
one off Expenditures	-215 000							
Increase in energy for own needs		0	0	0	0	0	0	0
VAT	0	0	0	0	0	-2 143 517	-2 143 517	-2 143 517
Net profit from 1 year	**11 066 671**	**11 281 671**	**11 281 671**	**11 281 671**	**11 281 671**	**9 138 154**	**9 138 154**	**9 138 154**
Value of energy for own needs	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000
Years	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Profit	12 757 560	12 757 560	12 757 560	12 757 560	12 757 560	12 757 560	12 757 560	12 757 560
Other costs including its growth	-1 475 889	-1 475 889	-1 475 889	-1 475 889	-1 475 889	-1 475 889	-1 475 889	-1 475 889
one off Expenditures								
Increase in energy for own needs	0	0	0	0	0	0	0	0
VAT	-2 143 517	-2 143 517	-2 143 517	-2 143 517	-2 143 517	-2 143 517	-2 143 517	-2 143 517
Net profit from 1 year	**9 138 154**	**9 138 154**	**9 138 154**	**9 138 154**	**9 138 154**	**9 138 154**	**9 138 154**	**9 138 154**
Value of energy for own needs	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000
Years	**17**	**18**	**19**	**20**				
Profit	12 757 560	12 757 560	12 757 560	12 757 560				
Other costs including its growth	-1 475 889	-1 475 889	-1 475 889	-1 475 889				
one off Expenditures								
Increase in energy for own needs	0	0	0	0				
VAT	-2 143 517	-2 143 517	-2 143 517	-2 143 517				
Net profit from 1 year	**9 138 154**	**9 138 154**	**9 138 154**	**9 138 154**				
Value of energy for own needs	-90 000	-90 000	-90 000	-90 000				

Results Vestas V90:

Profit from 8 years	**83 607 816**
Ts	**cca 7-8 years**
NPV	**24 219 789**
IRR	**10,86%**

Year		**Ts**	**-81 177 850**	**profit/month**	**month**
1.		-70 111 179	11 066 671	922 223	
2.		-58 829 508	11 281 671	940 139	
3.		-47 547 837	11 281 671	940 139	
4.		-36 266 166	11 281 671	940 139	
5.		-24 984 495	11 281 671	940 139	
6.		-15 846 341	9 138 154	761 513	
7.		-6 708 188	9 138 154	761 513	
8.		2 429 966	9 138 154	761 513	8,81
9.	**Returned after**	11 568 119	9 138 154	761 513	
10.		20 706 273	9 138 154	761 513	
11.		29 844 426	9 138 154	761 513	
12.		38 982 580	9 138 154	761 513	
13.		48 120 733	9 138 154	761 513	
14.		57 258 887	9 138 154	761 513	
15.		66 397 040	9 138 154	761 513	
16.		75 535 194	9 138 154	761 513	
17.		84 673 347	9 138 154	761 513	
18.		93 811 501	9 138 154	761 513	
19.		102 949 654	9 138 154	761 513	
20.		**112 087 808**	9 138 154	761 513	

SOURCE: OWN IMPUT

8.5.2 Vestas V80 – calculation of NPV and IRR

Parameters for the calculation

Investment costs	**-67 459 330**	
Discont	7%	p.a.
Price of energy	2,46	CZK/kWh
VAT	19%	2%
Free from VAT for	5	let
Increase in energy for own needs	0%	2%
Average growth in other costs	0%	2%
Growth in price of energy	0%	
Output	3 965	MWh
Benefits from 1st year	9 753 900	
Costs for each year of operation	1 353 207	

Technology	54 964 080	67 459 330
Energy grid connection	2 200 000	
Construction cost	10 295 250	
Overhead cost	180 000	only 1st year
Energy audit	35 000	only 1st year

SOURCE: OWN IMPUT

Step-by-step calculations:

Years	1	2	3	4	5	6	7	8
Profit	9 753 900	9 753 900	9 753 900	9 753 900	9 753 900	9 753 900	9 753 900	9 753 900
Other costs including its growth	-1 353 207	-1 353 207	-1 353 207	-1 353 207	-1 353 207	-1 353 207	-1 353 207	-1 353 207
one off Expenditures	-215 000							
Increase in energy for own needs		0	0	0	0	0	0	0
VAT	0	0	0	0	0	-1 596 132	-1 596 132	-1 596 132
Net profit from 1 year	**8 185 693**	**8 400 693**	**8 400 693**	**8 400 693**	**8 400 693**	**6 804 561**	**6 804 561**	**6 804 561**
Value of energy for own needs	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000
Years	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Profit	9 753 900	9 753 900	9 753 900	9 753 900	9 753 900	9 753 900	9 753 900	9 753 900
Other costs including its growth	-1 353 207	-1 353 207	-1 353 207	-1 353 207	-1 353 207	-1 353 207	-1 353 207	-1 353 207
one off Expenditures								
Increase in energy for own needs	0	0	0	0	0	0	0	0
VAT	-1 596 132	-1 596 132	-1 596 132	-1 596 132	-1 596 132	-1 596 132	-1 596 132	-1 596 132
Net profit from 1 year	**6 804 561**	**6 804 561**	**6 804 561**	**6 804 561**	**6 804 561**	**6 804 561**	**6 804 561**	**6 804 561**
Value of energy for own needs	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000	-90 000
Years	**17**	**18**	**19**	**20**				
Profit	9 753 900	9 753 900	9 753 900	9 753 900				
Other costs including its growth	-1 353 207	-1 353 207	-1 353 207	-1 353 207				
one off Expenditures								
Increase in energy for own needs	0	0	0	0				
VAT	-1 596 132	-1 596 132	-1 596 132	-1 596 132				
Net profit from 1 year	**6 804 561**	**6 804 561**	**6 804 561**	**6 804 561**				
Value of energy for own needs	-90 000	-90 000	-90 000	-90 000				

SOURCE: OWN IMPUT

Results Vestas V80:

Profit from 8 years	**62 202 149**
Ts	**cca 9,9 years**
NPV	**10 971 810**
IRR	**9,15%**

Year		Ts	-67 459 330	profit/month	month
1.	**Returned after**	-59 273 637	8 185 693	682 141	
2.		-50 872 944	8 400 693	700 058	
3.		-42 472 251	8 400 693	700 058	
4.		-34 071 558	8 400 693	700 058	
5.		-25 670 865	8 400 693	700 058	
6.		-18 866 304	6 804 561	567 047	
7.		-12 061 742	6 804 561	567 047	
8.		-5 257 181	6 804 561	567 047	21,27
9.		1 547 380	6 804 561	567 047	9,27
10.		8 351 942	6 804 561	567 047	-2,73
11.		15 156 503	6 804 561	567 047	-14,73
12.		21 961 064	6 804 561	567 047	
13.		28 765 626	6 804 561	567 047	
14.		35 570 187	6 804 561	567 047	
15.		42 374 748	6 804 561	567 047	
16.		49 179 310	6 804 561	567 047	
17.		55 983 871	6 804 561	567 047	
18.		62 788 432	6 804 561	567 047	
19.		69 592 994	6 804 561	567 047	
20.		**76 397 555**	6 804 561	567 047	

SOURCE: OWN IMPUT

From the above calculation tables it is obvious that the preferable option is Vestas V90 with 10.86% IRR than Vestas V80 with 9.15% IRR. Vestas V90 has a larger diameter rotor owing to significantly higher electricity production. The disadvantage of this option is higher investment cost of 13.718.520 CZK. This difference may be for the investor still crucial factor, on the other hand as calculated above the pay-back period is for Vestas V90 about 3 years shorter and profits are also higher, which is more important, therefore I recommend the first model.

8.6. Cost-Benefit analysis (CBA)

For further processing data it was selected taking over only results from preferable project on the basis of financial analysis. Other impacts -externalities- are for both types of power plants comparable because it is the same type of electricity generation.

Cost-Benefit Analysis is a quick and simple technique that you can use for measuring non-critical financial decisions. Where decisions are mission-critical, or large sums of money are involved, other approaches – such as use of Net Present Values and Internal Rate of Return – are often more appropriate.

Although a cost benefit analysis can be used for almost anything, it is most commonly done on financial questions which is based on one ***common denominator***. Since the cost benefit analysis relies on the addition of positive factors and the subtraction of negative ones to determine a net result. The outcome of the analysis will determine whether the project is financially feasible, or if another project should be pursued.

Approach:

Make a list of all of the costs associated with the project

Do the same for all of the benefits of the project

If the discounted present value of the benefits exceeds the discounted present value of the costs then the project is worthwhile

When we come up with the costs and benefits, think about the lifetime of the project. What are the costs and benefits likely to be over time? (Gitman, 2009)

8.6.1 Money evaluated costs and benefits

According to previously shown calculation on pay-back period and IRR, the benefits and cost after substraction of Vestas V90, with discount 7%

Costs		Benefits	
		NPV	24 219 789CZK

8.6.2 Non-monetary expressed costs and benefits

In another words possitive or negative externalities are hard to evaluate in money because of its non existing prices. In case of evaluating bad impact on nature it could be done a comparable study how much it would cost to return the spot to its original state. Of course there has been done many studies showing harmful effects, but unfortunatelly studies are differenciated by many factors. Has the wind power plant been installed far enough from nests of rare birds?

To assess benefits connected to environmental policy, policymakers must determine how health, ecological and property damanges change as a result of that policy. A primari environmental benefit arises as a direct consequence of implemented policy, while a second benefit is an indirect gain arising either from the primary benefit or from some demand-induced effect. It is not generaly known that society derives utility from environmental quality based on its user value and its existence value.

User value refers to the benefit recieved from physical utilization in another words access to an environmental resource. While existence value is a benefit received from the continuance of the resource based on indirect consumption and stewardship. There are various methods to analyze benefits:

- Averting expenditure method (AEM) – expenditures are used on goods that are substitues for environnmental quality to indirectly determine willingness to pay
- Travel cost method (TCM) – identifying a demand for a resource which is a complementary good to environmental quality. As environmental quality improves, demand increases and associated benefits can be estimated as change in consumer surplus
- Hedonic price method (HPM) – implicit price exist for individual product, including those related to environmental quality
- Contingent valuation method (CVM) – survey approach that determines willingness to pay for some environmental improvement (Callan and Thomas, 2009, pg.: 167-168)

9 CONCLUSION

This work was aimed to clarify the issue of wind farms and on the basis of the data obtained, apply selected methods of investment evaluation. To meet this objective the information was taken from the literature review, an internet search and from data provided by Mr. Michael Glöckner, managing director of the company. Selected evaluation methods were applied to two examples from practice where results determine which investment is profitable.

In comparison models Vestas V90 and V80 is probably the best first option. Vestas V90 was evaluated based on the method of calculation - payback period, internal rate of return - more appropriate for the location Krušné mountains. This is thanks to the higher energy output that directly affects the amount of profit. The first type of wind power plant was considered to be more profitable even though the investment costs were 13.718.520 CZK higher. Cost benefit analysis of wind turbines include externalities that are very difficult for the non-expert to evaluate as it deals with point of views of residents, environmentalists defending nearby ladscape and investors, therefore in case of this thesis outcome is not significant measurement wheter install power plant or not..

With respect to the development of technologies it can be assumed that most of today's negative impacts associated with the use of wind energy could be minimized in the future. However, since the height of the wind turbines can not be diminished for physical reasons, it will continue to disrupt surrounding landscape and threats to larger species of birds. While estabilishment of wind farms it is also advisable to intall higher wind power plants in order to gain more energy from fewer towers and therefore reduce already mentioned negative externalities.

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LIST OF USED PICTURES AND TABLES