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Renewable Sources of Energy

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Statement

I state that I had make bachelor thesis on the topic Economic analysis of renewable resort of energy myself, lead by Ing.Mansor Maitah PhD ET PhD.

In Prague day 1.4.2011

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I thank Ing. Mansoru Maitahovi PhD et PhD for professional leadership and experienced advices in writing my bachelor thesis.

Obnovitelné zdroje energie

Renewable Sources of Energy

Summary

In this paper the author deals with the reasons engaged in greater use of renewable resources of energy. Next parts of thesis apply to literary research when an author describes all most common renewable resources in Czech Republic, their characterization and advantages and disadvantages compared to non-renewable resources of energy. The literary exploration discusses today's problem of renewable resorts and its possible utilization in the Czech Republic in future. The literary exploration also includes an economical point from investor view and all aspects which seriously influence return of all investments into renewable resort of energy. The crucial part of the thesis is calculation of operation expenses and recoverability of invested money to photovoltaic power plant and calculates its recoverability with and without solar tax.

Key words

Renewable resort of energy, solar power plant, Biogas station, Biogas, water power plant, wind power plant, geothermal energy, cost, electricity, investor.

Souhrn

V této práci se autor snaží nastínit důvdy, které vedou ke zvýšené podpoře obnovitelných zdrojů elektrické energie. Další část práce patří literární rešerši, kde autor popisuje nejpoužívanější obnovitelné zdroje na území České republiky, jejich výhody a nevýhody v porovnání s běžně používanými zdroji energie. Tato část literární rešerše se také lehce dotýká dnešních problému obnovitelných zdrojů a jejich potencionálního využití do budoucna. Literární rešerše také obsahuje ekonomický pohled na obnovitelné zdroje z pohledu investora a tím také všechny aspekty, které ovlivnují návratnost investice do obnovitelných zdrojů energie. Stěžejní část celé práce je kalkulace investičních nákladů, provozu a rentability fotovoltaické elektrárny bez a s uvalenou solární daní.

Klíčová slova

Obnovitelný zdroj energie, sluneční elektrárna, bioplynová stanice, bioplyn, vodní elektrárna, větraná elekrárna, geotermální elektrárna, náklady, elektrika, investor

Content

1. Introduction

In today's hectic world mankind cannot even imagine its survival without modern technology. Technologies make every day easier for working and often are not appreciated and are taken for granted.

But manufacturing of these technologies often costs a large amount of energy. Energy derived from fossil fuels is gradually more expensive, often due to rough treatment which destroys the natural ecosystem making fossil fuels inexorably falling. Therefore, the mankind must look for new energy sources. We call them renewable energy sources.

This bachelor thesis deals with the most promising renewable sources of energy used with great potential in our country. Although their applicability may depend on the natural conditions of the country or region with the rapid evolution of technology and past experience in the operation can and surely will be an important source of energy for future generations.

2. Aim of work and methodology

The aim of the author is to exhaustively and carefully characterize and evaluate the problem of renewable resort of energy. The author is also going to justify the use of renewable resources in the future. Outline the advantages, disadvantages, and prospects for their use with a large emphasis on economic aspects of the issue.

The economic aspect is meant to compare prices for energy from renewable sources and conventional sources.

In this work, the author will concentrate mainly on solar energy, wind energy, hydropower, biomass and geothermal energy. The above mentioned renewable energy sources are the most important in terms of future use and its expansion for the world and the Czech Republic. Therefore, the author will concentrate more on these sources and in particular on solar energy and energy from biogas, which have great potential in the Czech Republic. Because of the restrictive steps from government side such as restrictive solar tax, the author decided to create a complex economic analysis of these renewable sources from the perspective of an investor, show possible weaknesses and strong points in the permitting process, construction and subsequent long-term operation of these resources. The results will prove if photovoltaic power plant is after still profitable imposed solar tax or not. The photovoltaic power plant is discussed mainly from the perspective of return on investment and stressing the potential investment risk.

Methodology consists of the necessary preparation work of literature relating to renewable energy, which is created in the first part of a literature review and in the second part of a literature dealing with the authorization procedure for staging of construction knowledge. The literature is dealing with issues such as the construction of renewable energy sources and building what all entails, and these findings will form the basis for calculating the cost of investment processing and subsequent analysis of the economic recovery.

3. The reasons of using new sources

Before the characterization of each source individually it is very necessary to answer the question. Why humanity invests plenty of money to new and so far very expensive and non efficient sources of energy? The main reasons are answered below.

3.1 Greenhouse effect

The greenhouse effect is simply explained, a phenomenon which is generated by solar radiation passing through the atmosphere. The principle is that the incoming solar radiation heats the objects on the ground. They then emit thermal radiation back into space. Part of this radiation does not pass through the atmosphere and heats the entire sub Earth's atmosphere. [1]

The amount of bandwidth affects the atmosphere is called greenhouse gases. In general, the sources of greenhouse gases are divided into two groups. The first groups of resources are completely of a natural origin, unrelated to energy production and consumption. A second source for this work much more specifically deals with the production and consumption. [1]

Greenhouse effect itself is divided into the natural greenhouse effect, without which life on earth could be possible and additional greenhouse gases (anthropogenic), whose origin is the human activity on Earth. Thus, in increasing concentrations of greenhouse gases in the atmosphere due to increased industrialization, transport, etc. [1]

3.2. Thermo emission

This phenomenon is so popularized such as the greenhouse effect, but substantially influences Earth's climate. Thermal emission is generally thought to be generated by human activities. Thermal emission could be also described as the transformation of waste created by the usage of energy. An example could be a car. Cars show how the thermal energy is changing chemical energy into mechanical energy. This thermal energy spreads into its surroundings and warms it. It may therefore be hypothetically possible that all the power and industry will be a source of chemical and mechanical impurities, and that will continue to warm the atmosphere. This means that in addition to restrictions on greenhouse gases into the atmosphere, it is necessary to reduce the energy intensity of industrial production around the world. [1]

3.3. Limited reserves of fossil fuels and nuclear fuels

The future of fossil fuels is given by its reserves and its inventory of non-renewability. In this context we use the term peak oil. This is the point at which oil production enters a phase of decline and leads to exhaustion of reserves. Theory, which deals with the exhaustion of fossil fuels, is called Hubert’s peak oil theory, which as well as other theories, has its proponents and also opponents. The group of fossil fuels include coal, oil and natural gas. Depletion of coal reserves is estimated to occur in next 200 years, oil reserves depletion in 50 years, and natural gas reserves depletion in about 80 years. [2], [17] The nuclear fuel group consists of uranium or plutonium produced artificially. According to the Organization for Economic Cooperation and Development (OECD) the is 4.7 million tons of uranium reserves hidden beneath the surface of the Earth identified so

far and could last for another 85 years. This calculation does not reflect technological advances, which is especially in the field of nuclear energy very dynamic. The calculation does not include possible increase in energy demand of particular economies such as China or India. But taking in account those factors will increase the number of years up to 200 [3], [16] China could change the whole market with fuels to nuclear power plants. China plans to build new 400 blocks of nuclear power plants and will be the biggest producer of nuclear energy 2050 the latest.[19] Thus, it is necessary to look for alternative sources of energy to fossil and nuclear fuels in the future to replace them, thereby reducing the energy of our country's dependence on Russian gas.

4. Characteristic of renewable sources of energy

On our planet do exist two kinds of sources of energy – renewable and nonrenewable. Both of them have their own specification. The reserves of nonrenewable sources are located in the Earth. Into the group of non renewable sources belong: fossil materials, fissile stuff and hydrogen bounded in water. It is very important to point out that no other reserves of energy exist on Earth. [1]

The renewable resources of energy in comparison to normal energy sources don’t have any reserves. The renewable sources are understood as natural resources of free disposal and inexhaustible or recoverable very fast. [1]

However the renewable sources have one big defect and that is time instability. It means that sun changes its position and doesn’t shine at one place all day long or at one place all year long. The wind is also very changeable and unpredictable. Therefore the renewable sources are able to create just unstable source of energy so they are not very suitable for industry or for market with high consumption. [1]

Temporal variability creates a requirement for differentiation in the use of renewable resources. In other words, there would have to be not just one renewable source used, but s

variety of resources would be used instead so that for example the no wind area could still produce electricity from the sun, and vice versa when it is dark you may use the wind. [1]

Renewable energy sources also represent an important opportunity for economic development. For example, the wind is usually located in poorer areas of highlands or mountains, where wind turbines could bring jobs and a significant source of money. It is a modern industry, which has a strong export prospects and prospects of creating new jobs. [1] It is five to six times more than coal-fired power plants, even adjusting for coal mining. There is even bigger market difference for nuclear power plants. On the other hand, greater demand for workers increases the price of energy so produced, cresting a significant disadvantage. [1]

Table n.1: divide of renewable sources of energy

Renewable sources	Non renewable sources
1. Solar energy	1. Fossil Fuels
2. Biomass energy	2. Nuclear energy
3. Water energy	3. Hydrogen
5. Wind Energy	
6. Geothermal energy	

Source: own contribution

We are going to focus more on the renewable sources that have significant potential in our country such as wind, water, biomass and especially sun energy.

4.1. Solar energy

This is one of the most important kinds of renewable sources of energy that is very nature friendly. That is the reason why we are going to focus more on this source in this work.

In general, sun is the most basic source of energy on Earth. The sun is used directly or indirectly like emanated source of energy stored somewhere else like different kind of energy. Only source of energy that does not have origin on the sun is nuclear power. It is important to notice that sun shining falling down to the ground gives 20 000x more energy than humanity needs [2]. This data is more of orientation information just for understanding of sun energy potential. [1]

The sum of sun energy is depended on natural conditions of each country or of each parts of earth´ s surface. It is possible to take advantage of the sun shining in areas with long and strong shining during the year and in high located areas like mountains. [1]

The ways of gaining solar energy can be divided to active (by active systems) and passive (by passive systems). The passive systems are especially useful in construction in order to minimize energy loses connected with consumption of energy. These systems have similar principals like greenhouse. Those are principals like Thrombe's wall and its modification, thermal mirror, reflex foil, etc. Description of Thrombe's wall is insignificant for this work. [1]

Photometric collectors are used for instrumental heating and water heating photovoltaic collectors are used for production. [1]

4.1.1. Photometric collector

Gained sunshine is transformed to heat energy and with help of exchanger of heat is warms water or heats a room. There are several kinds of collectors that transform sunshine (liquid, vacuum,) that run on the different principles but still hold the same function. [1]

Important parts of active solar systems are accumulative tanks that cumulate heat energy that is possible for later usage.

Liquid tanks or tanks there are working on principles of state change are most common. Accumulative tanks plays significant role in photovoltaic cells as well.

4.1.2. Photovoltaic collector

As it was already mentioned before photovoltaic collectors transform sunshine to electricity. The electricity made from photovoltaic cells has to change electricity for further usage by conversion to following electricity. For this process every photovoltaic power system on roofs or on land have apparatus calls convector. Also manner of converting electricity is different that in photometric collectors. Significant phenomenon in semiconductor is that there is photovoltaic inside. The phenomenon is based on handover of electricity from electron to photon, which creates sunshine. Thanks to the electron and energy gained from photon a different potential in semiconductor is created. [1]

The photovoltaic collector should be

- Orientated to south (best is 5° diversion on west maximally utilizing sun rise) but photovoltaic cells are also located to north where effectiveness of solar cells is around 35%
- Security photovoltaic components against theft
- All-day sunshine without any barrier

- Possibility to situate collectors to suitable slope to sun. Because collectors are very predisposed on sun slope. Recommended slope of cells is 35°
- Very low if possible no input of appliance power from photovoltaic system [4]

Photovoltaic collectors everyone knows as power lines or collectors but photovoltaic collectors are used today in calculators, automats, satellites or very new kind of solar cells line roofing material. [1]

4.1.3. Aspects of solar energy

Effectiveness in solar cells is highly depended on its quality. These cells are made from semiconductors materials. The most used material for production of solar cells is silicon and its different chemical component (around 90%). As a material for solar cells silicon is the most important. It is important that it has the best natural condition for its operation and longest experience with its process. [1]

The first attempt with silicon are dated in year 1954 when first solar cells were established was established first solar cells with effectiveness around 6 %. During time of implementation of new technologies, the effectiveness had increased (thanks to chemical modification of silicon) to today´ s laboratory effectiveness (in laboratory condition) around 32, 5%. The commercial maximum is around 20 % but in recent years thanks to massive investment, the photovoltaic sector effectiveness had made rapid progress. The effectiveness of ordinary photovoltaic cells is between 7-18% depending on used technology and kind of silicon.

Very significant problem on field of photovoltaic is processing of silicon that is very energy demanding and expensive. This fact influences the price of photovoltaic cells which is high. The defects are the most important negatives of photovoltaic. [1]

Next material used for PV cells is white arsenic, telluride and sulfide. [1]

The effectiveness of solar cells is given by quanta of falling sun on each cell. If the ideal condition for producing electricity from sun that is falling into the earth land comes, sun shines with intensity 1000 $W.m^{-2}$ with effectiveness (depending on other conditions) around 17% and there is solar cell size $1m^2$, then photovoltaic cells is going to produce approximately 170 Wp (Watt peak – maximum production with ideal condition)[1]

Next possibility to enlarge effectiveness of solar cells and production of electricity is to installation of rotary stands called trackers. These trackers keep cells vertical location to sun all day and increase production of electricity. But extra money from trackers doesn't cover the cost for its installation and especially maintenance. The trackers are suitable for wealthy investors that invest just their own money. [1]

As was already mentioned before, the sun energy is one of the most perspective sources of energy in future. Very fast progress of new technologies that is enlarging effectiveness of cells very fast is getting very hopeful result for its use in future. Its potential could be demonstrate on one simple example.

On earth there is around 22 millions km^2 (this number is still spreading) of desert with high intensity of sun (Sahara, Kalahari, and Gobi). These gigantic areas don't have any meaningful use. If we take into account today effectiveness of solar power lines (around 110 kWh per year a m^2) by simple calculation is obvious that 1/10 of Sahara would produce 50 terawatts of energy that is 5 times more electricity all humidity on planet needs. [5]

It looks just like a prediction in long distant future but German companies and banks cooperation with German government had made first project to make gigantic power plant in Sahara that will power Europe. Problem of its project is mainly unstable political representation and poverty in Africa. This fact just show on very big potential of sun electricity and its use in future.

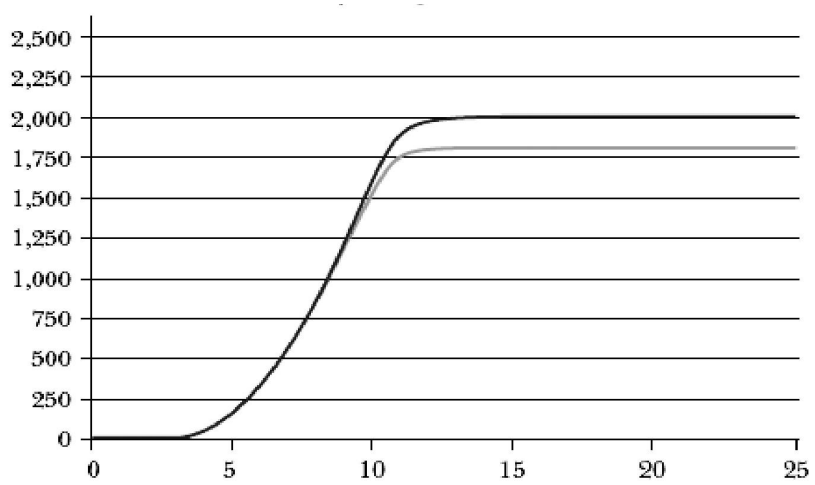
4.2. Wind energy

Wind energy is a very popular source of electrical energy. It is inexpensive and, unlike solar power plant can operate 24 hours a day. Today, however, very often, wind power faces an opposition from residents of the villages and thus they are often not built at the end. A great future in this field presents the power of water levels above the seas, where there is a lot of space for construction, does not meet with opposition of the population and have a great wind potential.

In the case of options for wind energy there is the conversion of translational kinetic energy of flowing air mass in the rotational energy of the wind turbine. They are divided into small (up to 5 kW power, mainly used in buildings without power connections) and high (1-3 MW of power, producing power to the grid, now the normal state 5MW power plant in the near future there are plans to build power plants the output up to 20MW especially at sea). An important figure of this problem is that wind power under ideal conditions can be obtained from the kinetic energy of air up to 60%, which determines the possibilities for producing electric power and hence the economic aspect. The use of wind power is influenced by two major natural factors - wind speed and wind stability. To obtain the two variables in a given locality, long-term measurements are needed to demonstrate the suitability or unsuitability of the site for construction, but still do not guarantee the regularity of the wind flow constantly throughout the year. Another problem is that the wind is blowing more clearly than in night day is also less consumption. [1], [5], [4]

An important figure is the average wind speed, therefore, to ensure the viability of wind power. This limit, according to experiences from around the world, the value is 4.8 ms 1ale rapidly changing depending on the production of new technologies. However, this is an average indicator. The lower limit of wind energy is usable 5m.s-1. In addition, these low velocities flow as characterized by high volatility and thus the unavailability of energy. On the contrary, the upper usable limit of wind is around 25 ms-1, calculated as 90 km / h-1. The wind speed is already dangerous and can cause damage to property and even the wind engines, so the wind speed during large wind is being slowed by modern brake

motors, hampering wind turbine at high speeds and to avoid possible explosion of the rotor. Correlation between wind speed and power output shows a schematic part 2 [1], [5], [4]



Pozn.: Osa Y –power (kW) and X –speed of wind (m/s)

Source: Vestas, 2011

Scheme n.2: Dependency of wind speed on production

From the scheme is obvious that big wind power lines star to produce electricity if intensity of wind is stronger than 4, 5 $m.s^{-1}$. Also is obvious that maximal production of electricity starts on intensity 11 $m.s^{-1}$ after the break point of production power line still produce the maximum installation power of energy no more.

The most significant problem of wind power lines is selection of suitable place where is constant intensity of wind is very high. These areas are mainly on mountains or highland and in nowadays especially on see planes around see cost. Today install power of see wind power plant is 2000MGW .The plan of German government is to install more than 150 GW in North sea to maximally take use of potential strong wind on see. [15] .Similar plans have also Spain and Denmark. The biggest investors in the field of wind energy in EU are mainly Germany, Spain, Denmark, Nederland and Great Britain.

4.2.1. Advantages and disadvantages of wind energy

The main advantage is obviously a minimal negative impact on the environment, which in this manner wind energy is the friendliest type of energy. It does not effect environment because there are no emissions during operation. It is definitely an important factor in safety. It means that possible accidents, which the wind threatened sporadically is not as serious as nuclear accident. A major economic advantage is the cheapness to operate. An important factor is a small occupation of land for construction of a plant, but if the wind should have the same productivity as nuclear power it would take a much larger area than the area of nuclear power plants. Downside is definitely the high cost of acquisition (with power output of 1.5 MW is about 50 million crowns) [4].

As with other renewable energy sources there is a problem of instability of wind blowing, if the blowing is too strong it may damage decommissioned electrical system in the country and cause a blackout.

Another disadvantage is the huge traffic noise propeller identifying successful wind power, thus causing noise. They undermine the influence of natural landscapes in the area, but due to the aesthetic sensibilities of each individual is this individual. A major problem is the killing of bird by propellers. For this reason, an ornithologist´ s approval must be attached to a building permit of the construction of power plants, limiting the risk of building power plants in the field of migration of migratory birds. The last two problems, however, pertain to conventional power plants. [1], [5], [4]

4.3. Biomass

Biomass can be defined as a substance of organic origin, which includes the plant biomass grown on land or in water, hydroponically, as well as animal biomass, which includes organic by-products and organic waste. Biomass energy is used for the assigned objectives and in the use of agriculture waste, food processing, forest production, etc. [1]

The biomass is now hoping that it will replace the current non-renewable energy sources. Evidence may be that today the world produces biomass, which carries 10 times more energy than extracted oil and natural gas for the same period. This calculation shows, the current possibilities of biomass. The countries with the most intensive use of biomass, include Sweden (Biomass is involved in 19% of the total production of energy from renewable sources), Finland (14.5%) and Austria (14%). [1]

Biomass is divided into two types, and it intentionally produces biomass for energy purposes. This category is one of energy wood (willow, poplar, alder and other acacias), cereals (using both whole plants, and only the grain), grasslands (Table grass, permanent grassland) and others (egg sorghum, hemp wheat, oilseed rape, potatoes, flax, etc.) There is second type of biomass waste. These include remnants of primary agricultural production and landscape maintenance (cereal straw, maize, rape, remnants of grassland and pasture areas, management of orchards and vineyards, etc.), waste from animal production (animal excrement, feed residues, waste processing capacity of affiliates) , municipal organic waste from rural areas (sludge from underground water, an organic part of municipal waste, waste from greenery and grassy areas), waste from forestry (wood fuel from forest thinning, bark, branches.[1]

Method of extracting energy from biomass can be divided into two - dry processes, including combustion, gasification and paralysis, followed by wet processes, including alcohol, anaerobic and aerobic fermentation. [1] More information about various types of biomass will be discussed below.

Table n. 2: properties of various types of biomass

Kind of fuel	Content of water %	Calorific property [GJ.t]	Density of fuel [kg/m³]
Softwood	10	16,4	375
	20	14,3	400
	30	12,2	425
	40	10,1	450
	50	8,1	530
wood chips	10	16,4	170
	20	14,3	190
	30	12,2	210
	40	10,1	225
Wood Briquettes	6 - 12	15,5 - 18,5	650 - 850
Wood Pellets	6 -12	16,5 -18	650 - 750
Straw cereals	10	15,5	120
Maize straw	10	14,4	100
Rape straw	10	16,0	100

Source: Oborová příručka OZE, 2006

The professional literature indicates that 1 kg of wood will issue approximately 4.3 kWh. 3 kg of straw can replace 1 kg light fuel oil and 1 tone of household waste can make its calorific replace 1 ton of brown coal. From these figures it is clear that biomass will play a significant role in future energy production. It is estimated that the CR will be able to cover 15-20% of energy consumption of motor fuels and biomass being. [1]

4.3.1. Biogas

Biogas is a product of metabolism that occurs when bacteria break down organic matter. This decomposition process has four phases. [6]

- The first phase of anaerobic bacteria convert the organic macromolecular compounds (proteins, carbohydrates, fat, cellulose) by using enzymes to low molecular weight compounds such as sugars.
- Acidophilic bacteria can then perform further decomposition of the organic acids, carbon dioxide and hydrogen.
- Finally, methane bacteria in an alkaline environment create methane, carbon dioxide and water. [6]

Biogas can be very stable source of energy that produces energy according demand in given region. Unlike the above-mentioned sources, the production of electrical energy through combustion of biogas, more or less influence depending on the situation. Operation of biogas plants will be talked more in the next chapter. For running of biogas station without problem should be meet certain conditions.

Methane bacteria can multiply and work only when the substrate is sufficiently diluted with water (at least 50%) In contrast to aerobic bacteria, yeasts and fungi can not live in a solid substrate. [6]

Methane bacteria are strictly anaerobic. When oxygen is present in the substrate, such as fresh manure, it must first aerobic bacteria consume. This occurs in the first phase of the biogas process. [6]

Also very important for processing of biogas station is to prevent access of light. Light destroys the bacteria, but it slows down the process and thus the entire production. Methane bacteria are very susceptible to temperature in a reactor. They work in temperature. between 0 ° C and 70 ° C. Apart from a few strains that can live up to 90 ° C. To optimize the production is the best temperature is around 40 ° C. [6]

Biogas technology is used as fuel in the premises, related with its production (e.g. in sewage treatment plants for heating digesters), the heat in the gas boilers and as fuel for stationary engine cogeneration units producing heat and electricity. In some cases it is necessary to pre-treatment (FGD) biogas before combustion to reduce emissions of sulfur oxides into the air. [4]

4.4. Heat pump

Heat pumps operate on the principle of withdrawing heat from its surroundings, which translates to a higher level and then heats the building and is used to heat hot water. The principle of heat pump is a closed cooling circuit (similar to that of the cabinet), which is heat on one side of the intake and the other passes. Refrigerator removes heat from inside the capacitor and passes them on his back into the room. The heat pump instead of for example food makes cooler air, soil or groundwater. Heat collected from these sources passes into the heating system. There are several options from which the heat pump heat gain. The most common option is to obtain from the surrounding air from exhaust air (from the outlet air ventilation systems), surface water from the soil, and water from underground or from the waste heat of the technological processes (this has the greatest potential for use in manufacturing companies and industrial premises). [1]

Today, the greatest potential use of heat pumps instead of direct or when compared with heating the liquid gas or fuel oil. They can be unequivocally recommended where there may be a suitable alternative to electric heating, or when switching from solid fuels refined method of heating in the locations where the surrounding gas is not available (there is possibly overloaded power grid, so it would not have been possible the whole power heaters). [4]

Previously used for cooling various chemical derivatives of CFCs, this caused the expansion of the ozone hole. Now pass to propane, which does not damage the ozone hole and improves the natural conditions. [4]

For the construction of the heat pump you must have proper building permits. Building authorities in this matter do not have a uniformed methodology, and depend mainly on the conditions and the discretion of individual planning authorities on how to deal with the matter. Sometimes official clerk can insist on statements from all concerned authorities. An example is provided; in order to cool the surface water we will need to contact the management of river basins and arrange everything. [1]

5. Renewable sources in Czech Republic

The European Union has long declared the promotion of renewable energy sources. They understand that energy dependence on foreign countries is strategically the best. Despite the high investment costs, high prices and volatility of electricity from renewable sources attempt to continue their efforts. I think renewable resources have passed the worst phase due to a massive investment in its research to a very promising future.

European Parliament and Council is adopting on the 27 September 2001 is adopting a directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market [EurLex1]. The aim was to promote the fulfillment of obligations arising from the Kyoto Protocol. Representatives of national indicative targets agreed on the share of RES in 2010, particularly with respect to the initial development of renewable energy sources and climate and their technical capabilities. [10]

Gross production of electricity from renewable sources in 2005 contributed to the gross domestic electricity consumption of 4.5%. National target of interest for the Czech Republic was set at 8% in 2010. The EU has a target for 2020 that 20% of the total electricity produced by renewable energy sources accounted for. The total domestic gross electricity production, gross production of electricity from renewable sources in 2005 contributed 3.8%. [8]

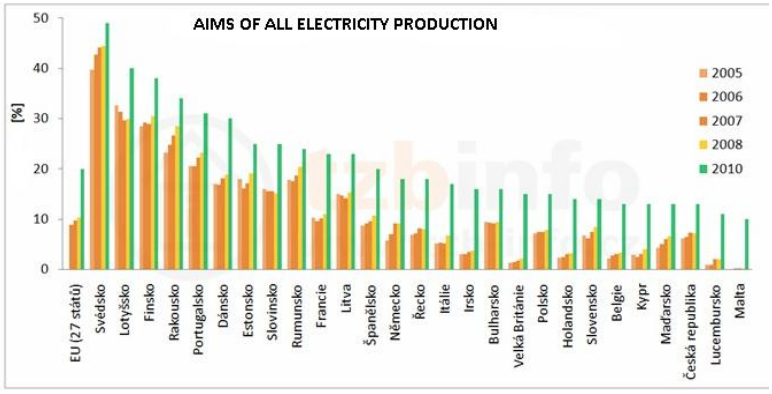
According to the Energy Regulatory Office in 2010, production of power stations using renewable energy sources had a total of 5854.5 MWh [ERU]. The majority is still on the electricity from hydroelectric power plants, but their share has fallen for the first time in history to less than half the production from renewable sources, although in absolute hydropower production figures compared to 2009 significantly increased. [10]

	Production in 2010	Renewable source share	Aggregate share
Source	MWh	%	%
Water energy	2792,7	47,7%	3,9%
Wind energy	335,5	5,7%	0,5%
Biomass	1513,5	25,9%	2,1%
Biogass	597,1	10,2%	0,8%
Photovoltaic	615,7	10,5%	0,9%
All	5854,5	100,0%	8,3%

Source: Energetický regulační úřad, 2011

An indicative target of 8% of electricity production from RES in 2010 was met. Compliance with a binding target of all types of energy from renewable sources by 2020 will depend more on renewable sources of media images than on the technical and economic constraints. Czech Republic in the media heavily promoting renewable lags behind other EU countries. [10]

The main problem of Czech renewable is the lack of concept solutions. The Czech Republic lacks a clear vision and strategy on what renewable, we are able to implement even with our limited natural conditions. For a comparison table of the use of renewable sources of other EU states.

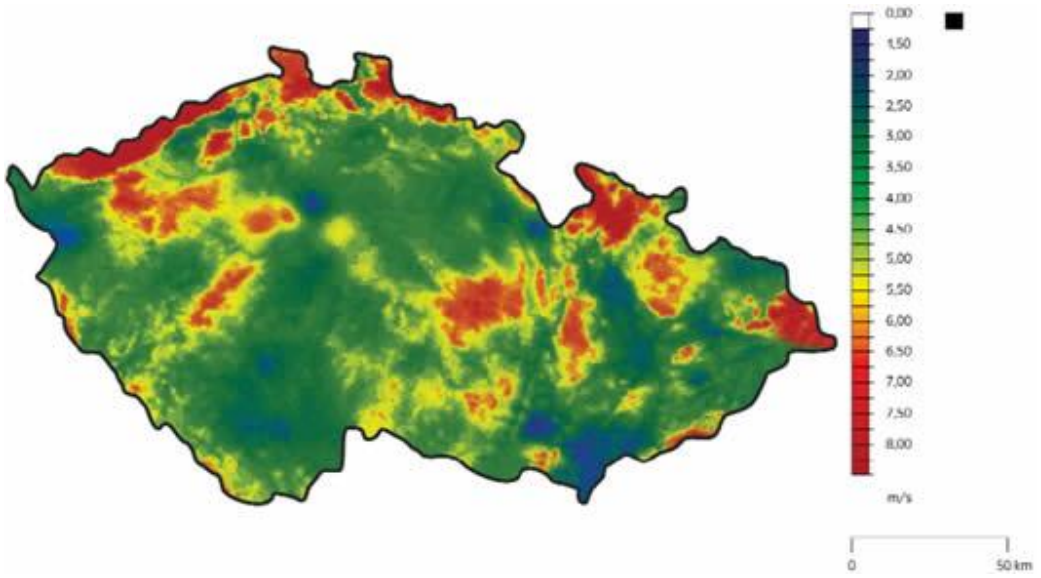


Source: Eurostat, 2011

5.1. Wind energy in Czech Republic

Currently there are about 49 turbines installed in our area that produce power close to 215 MW. [11] For this year 50-80 new power lines are planned to be built. The main barrier for the further expansion of the wind power lines are poor natural conditions. Most of the habitat suitable for the construction is located in mountainous areas or in protected areas. According to the results of many studies, the potential capacity of wind power is between 500 - 2000 MW. Inset map shows the average wind speed in our area. [4]

Scheme n.2: Wind map of Czech republic ČR (m/s)



Source: CSVE, 2011

5.2. Biomass in Czech Republic

The main potential, as mentioned above is the use of biomass to produce thermal energy. In 2004, the biomass made for about 2.2% of total primary energy supply. In 2010, the proportion of energy from biomass, 36% and contributed with 2.9% of total energy consumed in the United Republic. In the Czech Republic there is a relatively high potential of biomass and mainly biogas. With the rapid development of technology biogas stations electricity are produced and waste heat is then converted back into electrical energy. A great potential lies in the possibility of cleaning methane into natural gas. With this purified methane, gas can then get to peoples home. The biggest weakness of the project is its bad reputation and people reject it because of smell. If you take into account the data association CZ BIOM, biomass can contribute up to 7.2% of the total consumption of primary energy sources. [4]

The biogas stations represent a great potential for agriculture use and especially for rape straw pellets. For these purposes, a straw pellet does not unnecessarily destroy the land by any genetically modified trees. Comparison with heating value is comparable and the price is much lower. For these purposes, it is appropriate to enjoy the digestation from biogas stations and use it as a binder.

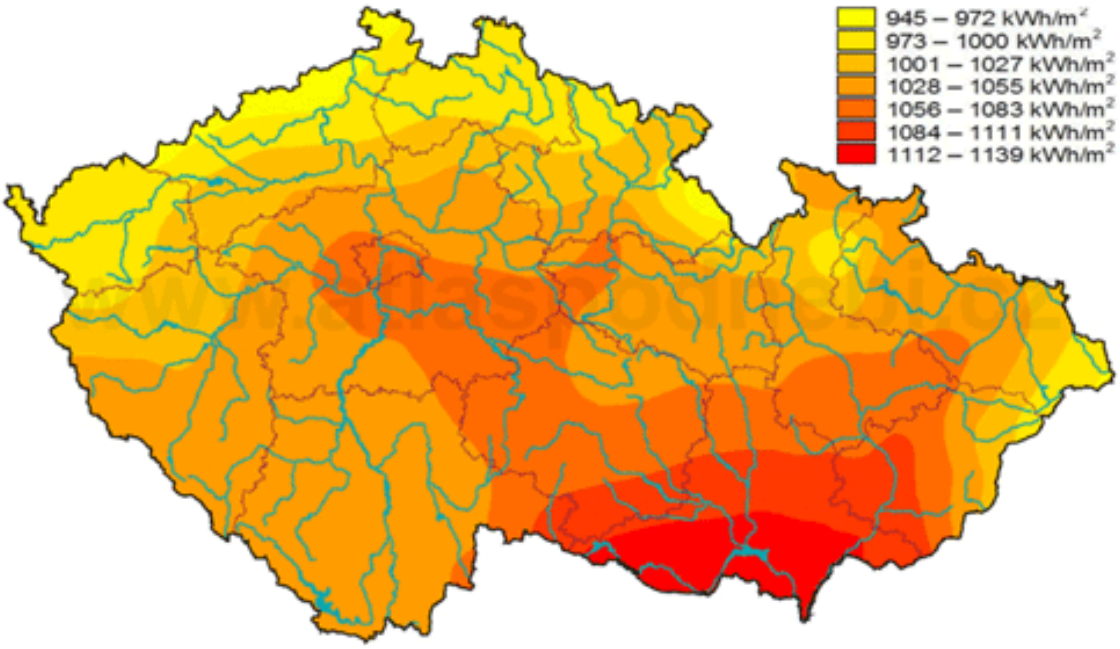
5.3. Energy of water

Technically exploitable potential energy flows in the CR is around 3300 GWh. It accounted for nearly half of MVE and 1570 GWh. [4]. Currently, hydroelectric power produced in 2790 MG / ha less than 3.9% of share of the gross production of electricity. Due to the natural conditions of Czech Republic is another use of limited water resources. The potentially promising source of the energy is pumping station. [4]

5.4. Sun energy

Energy from the sun is now a much debated topic in the Czech Republic. Details of this matter will be addressed the next chapter. ERU registers connected to the power source in February 2011 1900MG / h. [3] The annual input of solar energy on a horizontal surface in terms of CR. ranges from 1 000 to 1 250 kWh.m-2 per year, of which the period from April to October and about 75% from October to April about 25% of energy. The map shows the global solar radiation incident on a horizontal surface of 1 m2 per year and gives an idea of the amount of usable solar energy. [4]

Scheme n.1: The impact of solar radiation in the Czech Republic (MJ/m^2 a year)



Source: Česká fotovoltaiká asociace, 2011

The picture above shows potential of Czech sun conditions. The highest potential of sun is on south of Moravia and lowest is on south of Bohemia.

6. Economic evaluation of a solar power plant in Czech Republic

Construction of solar plant and other renewable sources are supported by the European Union. The European Union has set a certain required amount of electricity produced from renewable sources. Individual member states set the requirements for individual resources.

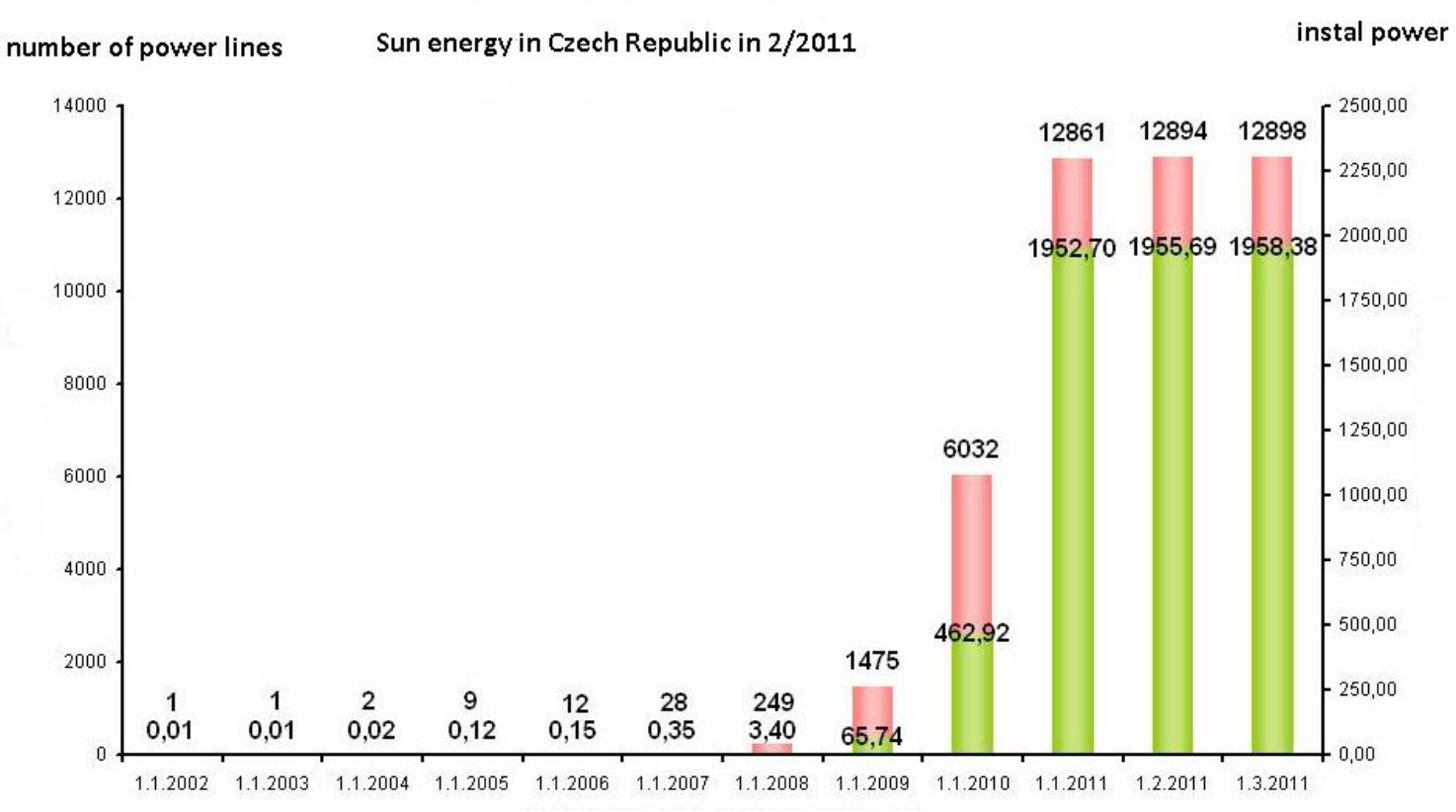
Procedure was to calculate costs and returns of money within 15 years. There was also support for:

- guaranteed buyout for 20 years
- maximum purchase price reduction of 5% per year
- indexing purchase price by 2-4% (inflation)
- Income tax relief

The problem occurred at a time when prices of individual components dramatically cheaper. ERU as the supervisor state can reach an immediate reduction in prices of more than 5%.

Each kilowatt-hour produced from renewable sources is being subsidized by a state contribution. The contribution of each buyer must pay electrical energy. Thanks to the boom in the photovoltaic energy price jump risk for households and companies could threaten the competitiveness of Czech economy.

Czech Government has therefore decided to step up in a very controversial way. To impose restriction tax on already built solar power plant. This tax is 26% at three years of operation.



Source: ERU, 2011

Picture above shows the situation of sun energy in Czech Republic for three years. With this measure, the government got into a dispute with the owners of solar power believing that solar power is still profitable under current conditions. Our task is to evaluate and calculate the profitability of solar power in 2010 and the possibility of building in 2011 and to draw attention to sensitive positions in the construction of the investor.

For our example we are using information from installations at Krmelín 2 MGw/p and Pržno 3 MGw/p located in north Moravia region. In example we calculate with quantity of 1MG/p.

6.1. Permitting construction management

The construction of photovoltaic power plants with all the legal issues takes from a year to two years. During this period, the investor must be very careful because of failing to carry out construction may lose a lot of money from his investment.

Therefore, instead of carefully selected so as to minimize the need for field work, a minimum legal requirements of the building office and the intensity of solar radiation as possible.

The problem building control for photovoltaic power is inconsistent methodology. Each planning authority can do as they wish and only the assistant decide what is and is not important in this case. Because big photovoltaic plants are still a new segment of building there is not a unified methodology of construction. An investor can therefore meet with the authority, which seeks to extend the construction as long as possible. Construction office can issue:

- Building permits
- Zoning permits
- Public contracts

A building permit is probably the most widespread. Investor needs a building permit, the project documentation and the comments of the authorities. Acquisition of land in this agreement is quite problematic because it requires the expression of all concerned bodies. For this reason it is not issued by most of construction offices. Public contract is the ability to completely skip the lengthy civil proceedings. This greatly simplifies the whole construction management. However, the planning authority does not use this contract.

Each plot of land where the construction of solar power plant is considered must be in the urban community as other areas or industrial zone. If it is not in the industrial zone, you have to apply for a permit.

6.2. Expenses

The costs of construction of photovoltaic power plants are very individual. Location of power plant is important if investor needs to modify land. Because of the fact that most components are bought abroad a very significant indicator for future rentability is the exchange rate of Euro.

Many suppliers with PV cells have appeared on the solar market. Some of them offer untested and uncertified components imported from China. However not every Chinese PV module is of poor quality but it is usually much cheaper than European one or one made in the US.

6.2.1. Building expenses

Total cost 1kw/p	**60 000 – 80 000 CZK (2010)**
Total install power	**1000 000 w/p**

INDIVIDUAL UNIT	*PRICE*
Fence	350 000 CZK
Road + Substation	300 000 CZK
Terrain editing	Individual
Geodetic work	50 000 CZK
Security system	500 000 CZK
Excavation work for NN+VN	450 000 CZK
Grounding	150 000 CZK
Cabling NN	3000 000 CZK
Cabling VN	1000 CZK/ m
Network fee	150 000 CZK/ 1MG
Constructions	4000-6000 CZK/1KW
Substation DO-X	3000 000 CZK
Container kiosk	1000 000 CZK
PV cells polycrystalline	1, 3 Euro/ Wp
PV cells monocrystalline	1, 4 Euro/ Wp
PV cells amorphous	0, 99 Euro/ Wp

6.2.2. Length of construction

PROCESS	*TIME*
Project documentation	individual
Fence	3-4 weeks
Drilling structures	1 week
Road	2 weeks
Excavations for cables NN	1 week
Cabling	2 week
Blasting cables	3 weeks
Construction + panels	3 weeks
Substation	3 weeks
Security system	1 week
TOTAL CONSTRUCTION PERIOD	**2-3 MONTHS**

6.2.3. Operating expenses

INDIVIDUAL SERVICE	*PRICE*
Security agency	5000 CZK/month
Electricity for operation	4000 CZK/month
Service	30 000 CZK/ year
Land resources	40 000 CZK/ year
Insurance	150 000 CZK/ year
OPERATING COST	**28 000 CZK/month** [14]

6.3. Financing

Financial negotiation is also very individual. Many institution on the market provide financial service. Financial institutions usually evaluate creditability of every client depended on amount of money. The creditability is crucial for setting the interest rate. If the client is rich, he usually gets a discount on credit interests. Big advantage of leasing is that client does not have to issue a draft for his own property but usually an interest rate is higher.

We can usually use:

- Credit- min 20% own resources, interest 4-6%, maturity 10-15 years
- Leasing- min 10% own resources, interest 6-10%, maturity x-20 years
- Refinancing(leasing)

These sources of financing are the most common kinds on Czech market. [14]

6.4. Production of electricity

Production is depended on location and density of sun radiation. Very important as was mentioned is efficiency of all systems. PV GIS model made by European Union is used for measuring density of the sun.

Location: 49°53'40" North, 17°50'30" East, Elevation: 298 m a.s.l.,
Nominal power of the PV system: 1000.0 kW (crystalline silicon)
Other losses (cables, inverter etc.): 7.0%
Combined PV system losses: 16.3%

TOTAL PRODUCTION 1MGW/p is 961 000 KW/p a year
Purchase price of electricity 2010 12, 15kč/Kw

	Fixed system: inclination=35 deg., orientation=0 deg.			
Month	Ed	Em	Hd	Hm
Jan	1150.00	35800	1.25	38.7
Feb	1880.00	52700	2.09	58.5
Mar	2610.00	80900	2.97	92.0
Apr	3340.00	100000	3.98	119
May	3920.00	122000	4.82	149
Jun	3760.00	113000	4.68	140
Jul	4010.00	124000	5.03	156
Aug	3630.00	113000	4.53	140
Sep	2800.00	84000	3.37	101
Oct	2400.00	74300	2.79	86.4
Nov	1200.00	35900	1.34	40.1
Dec	831.00	25700	0.91	28.1
Year	2630.00	80100	3.15	95.9
Total for year		961000		1150

Source: PVGIS, 2011

Ed: Average daily electricity production from the given system (kWh)
Em: Average monthly electricity production from the given system (kWh)
Hd: Average daily sum of global irradiation per square meter received by the modules of the given system (kWh/m2)
Hm: Average sum of global irradiation per square meter received by the modules of the given system (kWh/m2) [12]

6.5. Economic evaluation

In this economic evaluation the author is going to describe potential Rentability of solar power plants with and without solar tax. Cost of components and interest for its financing are taken for analysis. The deal is to calculate how solar tax effects the rentability of solar plants.

Financing

Power plant (including price of land)	**80 000 000 CZK**
Interest	**5, 5%**
Duration	**14 Years**
Partnership	**20%**
Repayment	**683 869 CZK/month**

[16]

CALCULATION WITHOUT TAX

	Negative	Positive
REPAYMENT	**8 206 428 CZK/year**	
OP. COSTS	**336 000 CZK/year**	
EL.PRODUCTION		**11 676 150 CZK/year**
SURPLUS		**3 133 722 CZK/year**

[16]

CALCULATION WITH 26% SOLAR TAX

	Negative	Positive
REPAYMENT	**8 206 428 CZK/year**	
OP. COSTS	**336 000 CZK/year**	
EL.PRODUCTION		11 676 150 CZK/year
EL.PRODUCTION with tax		**8 640 351 CZK/year**
SURPLUS		**97 923 CZK/year**

[16]

7. Conclusion

Producing energy from renewable sources is a relatively new type of technology and especially a new kind of business. This new type of technology has done a major progress in the past few years but even now this technology has some obvious disadvantages. Such as very quick time changeability due to natural condition, low density of electricity flax or very high acquisition costs. The ambition of renewable resources is not 100% coverage of electricity consumption but definitely playing a significant role in future electricity production.

There are many reasons for this statement. First and very important reason is that renewable sources do not have any tangible base but are inexhaustible. Second and probably the most important is that they do not pollute atmosphere, soil and water. And especially operation of renewable power plant is not a threat to nature and human such as nuclear power. This topic of nuclear energy is very discussed now across all developed world. The world has after years realized the fear from nuclear power due to uncontrolled nuclear reactor in Japan.

Renewable sources have one big disadvantage and that is a very high investment cost and high price of electricity production. This clean electricity compared pricewise with price of electricity made from classical resources is much higher. In a classic market would this be this clean energy absolutely uncompetitive without government subsidies. The government has to motivate investors by subsidies, tax discount and other benefits to support renewable sources of energy.

This support of renewable energy led to enormous building of new resources, and especially photovoltaic power plants. The number is so high that it might get the price of electricity for normal customers higher. Therefore government decided to impose a special solar tax on solar electricity producer' s.

The author´ s calculations have proved that solar that solar power plant after solar tax does not make almost any profits and easily can be unprofitable. This was discussed in chapter seven where all possible steps to get a building permission were evaluated, as well as price of components, financing conditions and production of solar power plant.

8. Bibliography

1. Kol. autorů. Obnovitelné zdroje energie. 2. uprav. a dopl. vyd. Praha : FCC PUBLIC, 2001. ISBN 80-901985-8-9, s.10-116, s. 139-171
2. Wikimedia
   http://cs.wikipedia.org/wiki/Uhl%C3%AD, 2011-03-28
   http://cs.wikipedia.org/wiki/Ropa, 2011-03-28
3. TOMEŠ, Milan; HARTINGER, Karel; BERAVSKÝ, Jiří. *Fotoovltaika : elektřina ze slunce*. 2004. Praha : Hell, 2004. 200 s.
4. Hospodářská komora ČR. Oborová příručka OZE, 2006, s.3-12
5. Actum, s.r.o.
   http://www.alternativni-zdroje.cz/slunecni-solarni-elektrarny.htm, 2011-03-28
6. http://www.alternativni-zdroje.cz/vetrne-elektrarny.htm, 2011-03-21
7. SCHLUTR, Heinz ; EDER, Barbara . *Bioplyn v praxi*. Praha : Hell, 2004. 197 s. ISBN 80-86167-21-6.
8. http://www.biodiesel.cz/pumpy, 2011-02-23
9. http://energie.tzb-info.cz/solarni-kolektory, 2011-2-12
10. http://www.csve.cz/cz/kategorie/vzdelavani/13, 2011-03-21
11. http://www.eru.cz/, 2011-03-28
12. http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php#, 2011-03-20
13. ČEZ, a.s.
    www.zelenaenergie.cz
14. http://www.enviweb.cz/clanek/fotovolt/77601/fotovoltaicka-elektrarna-vyplati-se-a-jak-ji-nejlepe-financovat, 2011-02-11
15. http://www.nazeleno.cz/energie/jaderna-energie/jaderne-elektrarny-celosvetove-vyrobi-16-elektriny.aspx, 2011-02-16
16. Lukáš Mališka, direktor of company MEVRA energy, Mega Sun invest, Interval copany data