Czech University of Life Sciences Prague
Faculty of Economics and Management

Department of Economics

Bachelor Thesis

Economic impact of the use of photovoltaic power plants in the Czech Republic.

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Evaluate the impact of photovoltaic power plants on final price of electricity in the Czech Republic and the Czech economy.

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Analysis - regression framework, qualitative and quantitative data analysis

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Recommended information sources

Perlin John, From space to earth, First Harvard University Press edition, 2002, ISBN 0-674-01013-2,

Goetzberger A., Hoffmann V.U., Photovoltaic Solar Energy Generation, Springer-Verlag Berlin Heidelberg, 2005, ISBN 3-540-23676-7,

New society publishers, Photovoltaics, Fourth printing, 2006, ISBN 0-86571-520-3,

Castellano Robert, Alternative energy technologies, Old City Publishing, Inc., 2012, ISBN 9782813000767

Hantula Richard, Solar power, Infobase Publishing, 2010, ISBN 978-1-60413-779-8

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Declaration

I declare that I have worked on this bachelor thesis titled “Economic impact of the use of photovoltaic power plants in the Czech Republic.” on my own with the use of only those literature resources which are listed at the end of this work

In Prague on _____

Acknowledgement

I would like to express my gratitude to my supervisor Ing. Petr Procházka, MSc, Ph.D. for his useful suggestions and guiding through the process of composing the thesis.

Hospodářský dopad využití fotovoltaických elektráren v České republice.

Economic impact of the use of photovoltaic power plants in the Czech Republic.

Souhrn

Bakalářská práce se věnuje problematice využívání fotovoltaiky na území České republiky, a ekonomickým důsledkům, které plynou z dotační politiky státu na tento druh obnovitelných zdrojů energie. Je zaměřena na vliv fotovoltaiky na konečnou cenu elektřiny pro domácnosti. Práce je rozdělena do dvou hlavních celků. V teoretické části jsou vypracovány základní poznatky a údaje o využívání fotovoltaiky, i obnovitelných zdrojů obecně. Tato část také podrobně popisuje průběh legislativního procesu, který tuto situaci výrazně ovlivnil. Jsou zde zmíněny zákony přijaté Evropskou Unii i Českou republikou. Druhá část je analytická. Podrobně popisuje vybrané období 2005-2013. V práci je provedena regresní analýza, jejímž cílem bylo ukázat závislost konečné ceny elektřiny pro domácnosti na vybraných determinantech. Tyto determinanty jsou: instalovaný výkon fotovoltaických elektráren, cena zemního plynu, spotřeba elektřiny a hrubý domácí produkt.

Summary

The Bachelor Thesis deals with the issue of the use of photovoltaics in the Czech Republic and the economic consequences that arise from the state subsidy policy for this type of renewable energy sources. It focuses on the effect of the use of photovoltaic on the final price of electricity for households. The Thesis is divided into two main parts. Fundamental knowledge and information about the use of photovoltaics and renewable resources of energy in general is processed in the theoretical part. This part also describes in detail the legislative process, which greatly influenced this situation. Laws accepted by the European Union and the Czech Republic are mentioned in this part as well. The second part consists of analytical research. The selected period of 2005-2013 is described in detail. A regression analysis is also made in the thesis, which aims to show the dependence of the final price of electricity for households on the selected determinants. These determinants are: installed output of photovoltaic power plants, the price of natural gas, electricity consumption and Gross Domestic Product.

Klíčová slova: fotovoltaika, energie, solární, podpora, obnovitelné zdroje, cena elektřiny, instalovaný výkon

Keywords: photovoltaics, energy, solar, subsidy, renewable resources, electricity price, installed output

Table of contents

List of Abbreviations

CHP – Combined heat and power

CTU – Czech Technical University in Prague

CZK - Czech crowns

EEX - Leipzig Energy Exchange

ERO – Energy Regulatory Office

EU – European Union

GDP – Gross domestic product

GWh – Gigawatt hour

KW - Kilowatt

KWh - Kilowatt-hour

kWp – Peak watt

MW - Megawatt

MWh - Megawatt-hour

PV – Photovoltaic

RER – Renewable Energy Resource

SC - Secondary sources

TWh – Terawatt hour

VAT – Value added tax

List of tables

List of illustrations

List of annexes

1 Introduction

Electricity is the most important type of energy that our civilization uses. The most common method for its production is fossil fuel combustion. It is a process by which a society not only loses a precious raw material, but it also leads to air pollution and to release of dangerous amounts of greenhouse gases into the atmosphere. Moreover, these are finite resources. Given that today's civilization is built on electricity, the society is forced to seek other forms of sources of its production. The alternatives are renewable energy resources (RER), which are virtually inexhaustible, and to a much lesser extent pollute the environment. Their only effect in this sense is intervention in the landscape.

Opinions about this method of electricity generation passed through certain historical developments. A significant decline in the preference of alternative energy sources occurred in the mid-twentieth century, when the world focused to the development and use of fossil fuels as a primary energy source. However, due to all the negative impacts and the need for their elimination, the demand for renewable energy sources raised again. The oil crisis in the seventies of the last century had a major contribution, because it showed how much the world depends on Arab oil producers. Therefore, this crisis is called the oil crisis. During this time, a lot of studies have been published which confirm that conventional sources of energy, including coal, gas or oil are exhaustible and the world must seriously reckon with renewable energy resources as a possible alternative.

This bachelor thesis is divided into four main chapters. The resources of electrical energy are described in the first chapter, where they are sorted by their renewability. The first part of the chapter includes non-renewable resources, their definition and use. The second part is devoted to renewable energy sources. Different types and use of such sources are described in that section as well. The end of the chapter focuses on solar energy, to which the rest of the work is devoted. The main source of information in this part was the publication MASTNÝ, Petr., DRÁPELA, Jiří. and coll. *Renewable energy resources.*

The second chapter is closely focused on solar energy and its issues. Also, the history of photovoltaics is described. Some important personalities who have contributed to the development of this sector are mentioned as well. The photovoltaic cells and the method of converting sunlight into electrical energy in photovoltaic power plants are also described in

this section. The chapter is ended with a listing of advantages and disadvantages of solar energy.

Given that the subject matter is closely related to the legislation, the third chapter is focused on legislative actions relating to renewable resources. After the Czech Republic joined the European Union (EU), the country had to adapt to the Union directives and regulations and therefore relevant legislations not only of the Czech Republic but also of the European Union are described in this chapter.

The analytical part of the thesis begins with the fourth chapter. The beginning is centered on the price of electricity, its formation and composition. Great attention is paid to the issue of how much is the final price of electricity affected by the support of renewable resources. The thesis analyzes the period since 2005, when the state began to pay more attention to this sector, to 2013. The situation in the field of photovoltaics and the impact of all the changes is also described. Concrete numbers used in this chapter are used mainly from the publication of Energy Regulatory Office (ERO): BDO Audit s.r.o. *Audit Process of setting purchase prices of photovoltaic energy*.

The chapter ends with a regression analysis. Four specific elements and their influence on the final electricity price are analyzed. The installed output of photovoltaic power plants, price of natural gas, electricity consumption and Gross Domestic Product belong among the various determinants.

2 Goals and methodology

Hypothesis: The growing number of photovoltaic power plants and their output in the Czech Republic is negatively reflected in the final price of electricity and the overall economy of the Czech Republic.

2.1 Goals

After the entrance of renewable resources on the market, their support began to show in the final price of electricity in the Czech Republic. Primarily photovoltaics was receiving significant subsidy and that was the main reason why the number of photovoltaic power plants began to grow uncontrollably and their output as well. The aim of this thesis is to show the effect of this increase in the final price of electricity for households. For this purpose, a regression analysis is made and the results should either confirm or refute the given hypothesis.

2.2 Methodology

The methods of synthesis, abstraction, deduction, induction and extraction were used for literature review in the theoretical part of this thesis.

The analytical part of the thesis includes selected qualitative and quantitative data which was used to approach the situation of each year. A regression analysis was performed at the end of the analytical part and the results show the effect of the increasing installed output of photovoltaic power plants on the final price of electricity.

Because photovoltaic power plants are not the only determinants affecting the price of electricity, three other economic parameters, of which it was assumed that they influence the pricing of electricity in some way, were used in the regression analysis. Gretl, analytical software, was used for making this analysis.

3 Literature review

3.1 Sources of electrical energy

Electricity is produced by decay of primary energy to electricity. Its sources can be classified according to several criteria, but the most common is split by the renewability of these resources to renewable and non-renewable.[1]

3.1.1 Non-renewable energy sources

Non-renewable energy sources have an expected lifetime of tens and hundreds of years. These energy sources include fossil and nuclear fuels. The most widespread source of energy is fossil fuels from which 70% of the electricity is globally received.[2] They are converted to electricity in thermal power plants. The most common materials that are burned in thermal power plants include coal, coke, gas and petroleum products.

One of the main sources of energy from fossil fuels is certainly coal. It originated from organic material, which was located in the deeper layers of the earth's crust. It decayed there for a long time in absence of air. It is generally distributed into black and brown coal. Black coal has a better quality of coalification and originated in the period before 280-350 million years ago. Brown coal is of lower quality, mainly due to higher water content and sulphur. This type of coal has half of calorific value. Surface coal mining often leads to land degradation.[3]

Another non-renewable resource is definitely oil, currently one of the most important fuels. From an economic point of view, it belongs to the most important raw materials. Oil production takes place both on land and under the ocean and about three and a half billion tons is produced annually. It is primarily used in the chemical industry and energy as fuel, where it is practically irreplaceable. Nearby, or rather over the oilfield, a gas field is usually found. Natural gas needs little modification before it can be used and is used primarily as fuel in factories and households. It also has great importance as an industrial fuel through the release of heat energy during its combustion. After cleaning and freeing it

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[1] *Elektroenergetika – Výroba energie* [online]. Prague: 2009-2014 © Copyright Done, s.r.o. [Accessed on 20.11.2013] Available from WWW: http://www.mojeenergie.cz/cz/elektroenergetika-vyroba-energie

[2] *Elektroenergetika – Zdroje* [online]. Prague: 2009-2014 © Copyright Done, s.r.o. [Accessed on 28.11.2013] Available from WWW: http://www.mojeenergie.cz/cz/elektroenergetika-zdroje#Fosiln%C3%AD

[3] MASTNÝ, Petr, DRÁPELA, Jiří. and coll., *Obnovitelné zdroje elektrické energie,* p. 16

of moisture, long-distance pipelines lead it to the points of consumption. The disadvantage of fossil fuels is their limited and finite quantities.

An important part of non-renewable energy sources are nuclear fuels, which release energy through nuclear reactions. The most common nuclear fuel that nuclear power plants use is enriched uranium. One of the serious problems associated with the use of nuclear fuels is the storage of spent fuel. It is still highly radioactive and dangerous; therefore it must be stored under special conditions.

3.1.2 Renewable energy sources

World demand and energy consumption continues to grow and society was forced to find an alternative to fossil fuels. Basic laws of nature directly encourage the use of renewable sources as the ability to switch from fossil fuels to alternative energy resources. If it does not occur, it could result in a reduced quality of life and environmental degradation. The transition process is consistent strategy that can be successful in the long term.[4]

There are a large number of alternative energy resources, and the decision about which type of resource should be used should be based on economic, environmental and safety aspects. Energy policy of the European Union emphasised the issue of environmental issues. This eventually resulted in the greatest possible effort to use renewable energy sources.[5] Renewable energy sources present an environmentally clean way of generating energy, by which it would be possible to cover the global energy consumption.

The most important renewable energy sources include solar, wind and hydro power and also biomass power plants. Other renewable energy sources are geothermal heat pumps and tidal power plants.

Water power plants

In the Czech Republic, despite the unfavourable natural conditions, water power plants belong among the important renewable energy resources. The principle is very simple; the flow of water spins a turbine coupled to an electric generator. The advantage of this method is the high energy conversion efficiency and a long lifetime of power plants. Water

[4] MASTNÝ, Petr, DRÁPELA, Jiří. and coll. *Obnovitelné zdroje elektrické energie,* p. 20
[5] MASTNÝ, Petr, DRÁPELA, Jiří. and coll. *Obnovitelné zdroje elektrické energie,* p. 14.

power plants, however, can only be used at specific locations; also their sometimes significant impact on the landscape is not negligible.

Flows in the Czech Republic do not have the required gradient and suffer from lack of sufficient amount of water. Their share of the total electricity production is low and they are primarily used as an additional source of energy production, where they can use their ability to quickly operate at a high output and thus flexibly settle immediate energy balance in the power system.[6]

The power system of the state has an obligation to make at every moment as much electricity as it is currently required. Consumption of energy is constantly fluctuating, which is a problem that pumped storage hydroelectric power plants[7] help solve. These power plants are irreplaceable for stabilization of electricity network.

Biomass

Biomass is a material of organic origin, usually wood, energy crops or agricultural residues. This material is either burned and made into gas or converted to methane or fermented to alcohol.

During its processing, there is no danger of toxic substances that pollute the air. In order to put it into good use, there are certain technological processes that must be met during its processing. The water content significantly affects its calorific value; therefore it is necessary to dry the biomass before its combustion.[8] The disadvantage of processing biomass is the formation of nitrogen oxides.

Wind power plants

This method of obtaining energy has been used by humans for several centuries. Wind power plants do not have very good natural nor social conditions in the Czech Republic. In geographic terms of the country there is a problem with the intensity of the wind and with

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[6] MASTNÝ, Petr, DRÁPELA, Jiří. and coll. *Obnovitelné zdroje elektrické energie,* p. 24

[7] "Pumped storage hydroelectric power plant is in principle a system of two differently lying reservoirs associated rail, on which at its bottom positioned turbine with an electric generator. It produces electricity for the power system in times of energy peaks; during the downturn, the water from the lower reservoir is pumped by "cheap electricity" to the top of the tank, where its potential energy is waiting for its optimal use in "real time"." Available from WWW: http://www.alternativni-zdroje.cz/vodni-geotermalni-energie.htm

[8] MASTNÝ, Petr, DRÁPELA, Jiří. and coll. *Obnovitelné zdroje elektrické energie,* p. 87

the selection of the correct locations where to place such power plants. Favourable wind conditions are mainly in the highlands and mountainous areas. However, the use of wind energy has significant potential in our country.[9]

The principle of their operation is to convert the aerodynamic forces acting on the rotor blades into mechanical energy and its subsequent conversion to electrical energy. The lifetime of wind power plants is around 20 years and their use does not pollute the environment.[10]

A slowdown in the development of wind energy occurred after 2008; in the following years there was a reduction in the purchase price of electricity from wind power, which moved some projects below break-even point.[11]

Solar power plants

Solar power plants experienced a huge expansion in recent years. Obtaining energy from the sun has great potential, but the problem is the low efficiency (16%). According to the method of using solar energy, solar systems can be divided to active and passive. The passive way means that heat is trapped in building structures, the use of active solar system can be divided into heat and electricity production. How the solar system will be used is primarily a question of costs of the solar system.

Unlike fossil fuels, solar energy faces no risk of fuel price volatility or delivery risk. With the general availability of solar radiation, it is not a big problem to find locations for solar energy. "*As a result, solar power limits the expense of, and energy losses associated with, transmission and distribution from large-scale electric plants to the end users*."[12]

Solar power plants can be placed on the roofs of houses (whether conventional pitched or horizontal), or on loose surfaces. This surface should be flat and sloping to the south. The area on which to build a power plant should not be used in agriculture, that is, it should not

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[9] *Využití větrné energie v ČR: Dlouhá tradice, nejistá budoucnost.* [online]. 30.10.2011 © E.ON Česká republika, s.r.o. [Accessed on 2.1.2014] Available from WWW: http://www.ekobonus.cz/vyuziti-vetrne-energie-v-cr-dlouha-tradice-nejista-budoucnost

[10] *Větrné elektrárny*. [online]. [Accessed on 2.1.2014] Available from WWW: http://www.alternativni-zdroje.cz/vetrne-elektrarny.htm

[11] *Využití větrné energie v ČR: Dlouhá tradice, nejistá budoucnost.* [online]. 30.10.2011 © E.ON Česká republika, s.r.o. [Accessed on 2.1.2014] Available from WWW: http://www.ekobonus.cz/vyuziti-vetrne-energie-v-cr-dlouha-tradice-nejista-budoucnost

[12] CASTELLANO, Robert. *Alternative energy technologies*. [online]. p. 2

be on arable land or grassland. The land should be kept as another area, building area or an industrial zone in the zoning plan. The municipality must approve the construction of the power plant.[13]

3.2 Solar energy and its conversion

3.2.1 The Sun as an energy source

Energy puts things in motion around us. The sun is the largest source of energy, supplying us a huge amount of heat and light. Due to the large distance from the Sun, the Earth receives only a small portion of the total solar energy.[14]

The sun is the centre of our solar system and represents 99.8% of its total weight. The total weight of the Sun is about 330 000 times greater than the weight of the Earth and its age is estimated to be 4.6 billion years old. Solar radiation is one of the most affordable sources of energy on Earth.

Without solar energy, the life as we know it would not be possible. The source of this energy is the conversion of hydrogen into helium by reactions occurring inside the solar core. The core of the Sun consists mainly of hydrogen, up 70%, less than 30% are helium and only 2% belongs to other elements.[15]

Energy from the sun can be used to produce heat or to generate electricity. This method of power generation is called photovoltaics and it occurs in photovoltaic power plants.

3.2.2 The history of photovoltaics

The production of electricity by a direct conversion of sunlight into energy dates back to the 19th century. At that time, the only type of transportation was allowed by locomotives and ships. All of these machines were burning an alarming amount of coal. Augustine Mouchot, a mathematician and physicist who dealt with this issue, said that over time the industry in Europe would not be able to find the resources to satisfy its enormous expansion. Coal would be undoubtedly consumed. Mouchot was convinced that the best

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[13] *Umístění FVE* [online]. Prague: Last Updated: 18.02.2011 [Accessed on 28.11.2013] Available from WWW: http://www.zlutaenergie.cz/umisteni-fve

[14] HANTULA, Richard. *Solar power*. [online]. p. 4

[15] *Solar System Exploration. Sun: Overview* [online]. USA gov., ExpectMore.gov, NASA Advisory Council, Open Government in NASA. Last Updated: 19 Dec. 2013. Available from WWW: http://solarsystem.nasa.gov/planets/profile.cfm?Object=Sun

for the future functioning of the industry would be to find an alternative to burning coal. In 1869 he published his book *La chaleur solaire et ses applications industrielles*, which dealt with finding a suitable way to use the direct rays of the sun, not only for industry purposes but also for agriculture.[16]

An important place in the history of photovoltaics belongs to the French physicist Alexandre Edmond Becqueler, who is credited with the discovery of the photovoltaic effect during experiments in 1839. Although, due to his low age (19 years) it is assumed that his father, Antoine César Becqueler, should be credited with the foundation of photovoltaics.

The first working solar cell was constructed by an American investor Charles Fritts in 1884. This cell was made of selenium semiconductors and its efficiency was approximately 1%. Since then, the efficiency value doubled approximately every 30 years. Because of the low efficiency, cells had no chance of electricity production.

Solar cells in their present form were invented by an American engineer Russell Ohl in the last century. They began to be produced from silicon, since silicon semiconductors substantially reflect on light with some additions. Silicon solar cells were improved at Bell Laboratories in the fifties.[17]

Also Albert Einstein made history in this field by describing the photoelectric effect based on quantum physics in 1905. He received the Nobel Prize in 1921 for describing this effect.[18]

Until the end of the last century, the use of photovoltaic sources in the Czech Republic was limited to the construction of small island systems, whose task was to provide a source of electricity at places where electricity from the network was too expensive or not possible at all.[19]

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[16] PERLIN, John. *From space to earth*, p. 2

[17] *Historie fotovoltaiky.* [online]. © 2014 SOLARENVI a.s. [Accessed on 6.1.2014] Available from WWW: http://www.solarenvi.cz/slunecni-elektrarny/technicke-informace/historie-fotovoltaiky/

[18] MLA style: *The Nobel Prize in Physics 1921*. *Nobelprize.org.* [online]. Nobel Media AB 2013. [Accessed on 8.2.2014] Available from <http://www.nobelprize.org/nobel_prizes/physics/laureates/1921/>

[19] HRUBÝ, Zdeněk., KRŠKA, Štěpán. *Ekonomické dopady podpory výroby energie z fotovoltaických článků v České republice.* Charles University in Prague, CZ: IES Working Paper 31/2012, 2012. p. 2

Photovoltaics is one of the fastest growing sectors with an annual growth of installed capacity of over 30%. The photovoltaic market is growing every year and this technology also produces a range of jobs opportunities, mainly in the production of glass and steel. With consideration of photovoltaics and its impact on the environment and the speed of its development, this source is considered to be the future of energy production.[20]

3.2.3 Photovoltaic cells

In terms of application, the photovoltaic system can be divided into three basic types:

- Autonomous systems which are used in places where there is no access to the public electricity network.
- Hybrid systems with accumulation
- Systems directly connected to the network without accumulation

The cornerstone of the photovoltaic system consists of photovoltaic semiconductor devices called photovoltaic or solar cells, which are grouped into so-called PV modules. The energy produced by this cell depends not only on its effectiveness, but also on the location, slope, latitude, orientation to the south and the time of the year.

PV cells are actually large diodes with at least one PN junction, which is based on a crystalline P-type wafer and a thick layer of N-type semiconductors. To understand the function of semiconductor devices and thus of solar cells, a precise understanding of the processes within a p-n junction is important.[21] There is a lack of negative electrons in layer P, while there is a surplus in layer N. There is a transition between those the two layers which acts as a socket because the electric current passes in one direction only.

The front size is adapted so it can absorb solar radiation. When light hits the cell, an internal photoelectric effect occurs within the semiconductors, due to which negative electrons are released from the crystal lattice, which creates a voltage at the PN junction. It is led by cables to converters and inverters, which produce the final product – an alternating current. This is how the energy of solar radiation is converted into electrical energy. If a greater current or voltage is needed, then individual cells are connected in series or in parallel sequences in order to make photovoltaic panels. By aggregating more

[20] NEW society publishers. *Photovoltaics*: *Design and Installation material.* p.2
[21] GOETZBERGER, Adolf, HOFFMANN, V. U., *Photovoltaic Solar Energy Generation*. p.18

such panels, a large photovoltaic array is created, which can be installed, for example, on the roof of a building. The lifetime of these modules is estimated to be 30 years.

Photovoltaics thus use direct conversion of light energy into electrical energy in the photovoltaic cell.[22]

3.2.4 Advantages and disadvantages of photovoltaics

The operations of photovoltaic power plants are influenced by several factors. Unlike other sources of electrical energy, photovoltaic device operations have many environmental and operational benefits. The biggest advantage of photovoltaics is its universal use. PV systems can be used in a wide range of capacities, from fractions of a watt to megawatt power plants, and in a number of domestic, industrial and municipal applications. The unquestionable advantage is the infinity of resources photovoltaic electricity - sunlight, plant safety and a cleaner and healthier environment. But even in the field of photovoltaics there are several issues associated with manufacturing and the use of photovoltaic devices. The manufacturing process of these devices is in fact very energy intensive. But photovoltaic modules produce more electricity than is needed for their production during their lifetime. And the energy break-even point is usually achieved after three years, up to a maximum of six.[23]

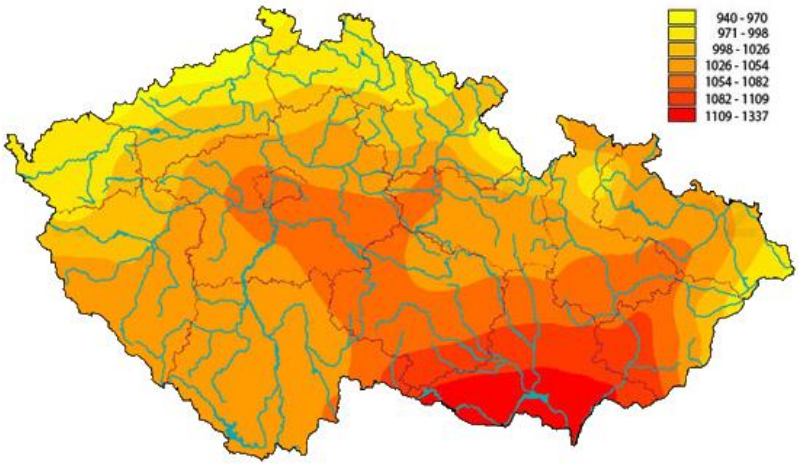
Photovoltaic power plants themselves are not very difficult to maintain. Due to the climatic conditions of our country, we must reckon with the disadvantages limiting the effective use of this device. For example, in the winter their performance may be limited due to snow, so it is therefore necessary to take care of the panels at this time of the year. Conversely, rain or hail does not do any harm and does not obstruct the plant's operations.

Their performance is highly dependent on the intensity of sunlight. Solar radiation is characterized by considerable variations, both in time as well as the region. The average annual sunshine hours are short in the Czech Republic. 75% of annual sunshine falls on April-September, the remaining 25% from October to March. On the basis of published information, we can say that approximately 950 to 1 250 kWh of energy falls to 1 m squared of horizontal surfaces in the Czech Republic. Due to the high price of solar modules, the installation of photovoltaic systems nowadays is very expensive. Photovoltaic

[22] Kolektiv autorů. *Obnovitelné zdroje energie a možnosti jejich uplatnění v České republice*. p.131
[23] NEW society publishers. *Photovoltaics*: *Design and Installation material.* p.3

power plants have their protagonists, as well as their opponents. *"Photovoltaic power plants are less efficient in terms of utilization of the installed capacity in the conditions of the Czech Republic. The average time of annual utilization of the maximum installed capacity of photovoltaic power plants is 11%. In comparison with the 22% of wind power plants, 42-65% of small hydro power plants, 57% of the sources of clean burning biomass, 86% of biogas plants and 65% of geothermal energy, photovoltaic power plants are desperately inefficient."* [24]

Picture 1: Annual total global solar radiation in the Czech Republic (W/m2).



Source: Solar news (2010)[25]

3.3 Legislative measures

The Czech Republic did not give the issue of renewable energy greater attention. The situation changed after the country's accession to the EU in 2004. The Union has produced a number of documents, which stressed the need to promote the use of renewable energy resources as an instrument of the energy policy and the climate policy. The documents

[24] KOCOUREK, Martin. a col. *Fotovoltaika a růst cen elektřiny: sborník textů.* CZ: PB tisk Příbram. 2010.
[25] *Vliv slunečního záření na výkon solárních elektráren v podmínkách České republiky.* [online]. [Accessed on 10.11.2013] 21.1.2010 Available from WWW: http://www.solarninovinky.cz/ 2010/ index.php?rs=4&rl=2010012104&rm=15:91

were binding for EU member states and so the countries had to respond by taking appropriate legislative measures.

3.3.1 Legislation of the European Union

The legally binding document, which the member states had to adapt, was the Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.[26] The Directive set specific targets for individual Member States specifying their share of electricity which had to be produced from renewable energy resources to gross electricity consumption by the year 2010, so that in a given year they would achieve a 12% share of electricity produced from RER in gross electricity consumption within the EU. States which joined the EU on 1 January 2004 were added to this undertaking on the basis of the Accession Treaty and accession-related acts. The Czech Republic was set an indicative target of 8% of gross electricity consumption to be provided from renewable energy sources in 2010. This goal was embedded in Act No. 180/2005 on the promotion of electricity from renewable energy sources (Law on the promotion of renewable energy sources).

In 2009, the EU accepted a new directive on the promotion of renewable energy resources in the climate and energy package. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC[27] contains a summary of the measures to contribute to the achievement of the goal to have at least 20% of energy from renewable sources in gross final energy consumption in the EU by 2020. The goals set to individual Member States on the basis of this directive are binding. The Czech Republic applies a binding national target of 13%

[26] *Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market* [online] [Accessed on 10.12.2013] Available from WWW: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32001L0077:en:NOT

[27] *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC* [online] [Accessed on 10.12.2013] Available from WWW: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0028:cs:NOT

share of energy from renewable resources in gross final energy consumption in the Czech Republic in 2020.

The national action plans for renewable energy are supposed to contribute meeting the stated objectives. These set the energy shares from renewable resources for individual areas and also include long-term strategies which should help achieve those shares.

3.3.2 Legislation of the Czech Republic

The long-term strategy for energy management is handled in a binding document - the State Energy Policy. Its main objective for the future is to ensure reliable, safe and environmentally friendly energy supply for the needs of the population and the economy. Uninterrupted power supply in emergency situations to the extent necessary for the functioning of the most important components of the country's infrastructure and population survival also has to be ensured.

The still valid State Energy Policy was accepted by the Czech government in 2004. Its aim was to achieve an eight percentage share of electricity generated from renewable energy resources in gross consumption in 2010, and gradually increasing this percentage after 2010. The Czech Republic achieved this objective when gross electricity consumption from renewable energy resources reached 8.3% in 2010. By the undertaking of the directive given by the European Union, the Czech Republic is supposed to cover more than 13% of its energy from renewable resources by 2020. Since 2011, the Czech government has beenworking on a new version of the National Energy Policy, which sets out strategic objectives of the Czech energy and defines the strategic priorities of the Czech Republic with a view to 2040.[28]

One of the basic functions that a modern state must ensure is a stable supply and energy management. After joining the European Union the Czech Republic had to adopt its legislation and promote renewable energy resources, which include solar power plants as well. The use of solar energy in the Czech Republic has been sporadic until the end of the 20th century. The production of electricity from photovoltaic cells was considered

[28] *AKTUALIZACE STÁTNÍ ENERGETICKÉ KONCEPCE ČESKÉ REPUBLIKY.* [online] [Accessed on 10.1.2014] Available from WWW: http://www.cne.cz/e_download.php?file=data/editor/180cs_1.pdf&original=St%C3%A1tn%C3%AD+energetick%C3%A1+koncepce+%C4%8CR_aktualizace+srpen+2012.pdf

economically disadvantageous. The situation dramatically changed with the RER Act, which codified the promotion of photovoltaics and enabled its development.

The Act No. 180/2005 addresses the promotion of electricity from renewable energy sources (Act on Promotion of renewable energy sources). The purpose of the Act was to promote the use of renewable energy resources in accordance with climate and environmental protection and to ensure continuous increase in the share of renewable resources in primary energy resources consumption contributing to the efficient use of natural resources and a sustainable development of the society. The purpose was also to create the conditions for the fulfillment of the indicative target share of electricity from renewable sources in gross electricity consumption in the Czech Republic in the amount of 8% by 2010 and to create the conditions for further increase of the share after 2010. The Act also regulates the manner in which the purchase prices for electricity from renewable energy resources and green bonuses are determined.[29]

The law was subsequently amended four times. In 2009, Act No. 281/2009 Coll. edited the rules on penalties.[30] Another three amendments were made in 2010. Act No. 137/2010 Coll. allowed the ERO to reduce the purchase prices by more than 5% for the following calendar year if the return fell below 11 years, with validity for pricing resources put into operation since 2011. The second amendment was the Act No. 330/2010 Coll., which determined contribution requirements only for photovoltaic power plants with an output of 30 kWp placed on roofs or outside walls of buildings. The last governing norm, which came into effect in 2010, was the Act No. 402/2010 Coll., which was supposed to limit the increase in electricity prices due to the development of renewable energy resources and photovoltaics, in particular.[31]

Another important legal document in the field of photovoltaics was the Decree No. 475/2005 Coll., which defined the technical and economic parameters ensuring a fifteen-

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[29] Act No. 180/2005 Coll. [online]. Available from WWW: http://aplikace.mvcr.cz/sbirka-zakonu/SearchResult.aspx?q=180/2005&typeLaw=zakon&what=Cislo_zakona_smlouvy

[30] Act No. 281/2009 Coll. [online]. Available from WWW: http://www.mzcr.cz/Odbornik/Soubor.ashx?souborID=18450&typ=application/pdf&nazev=20%20-%20Z%C3%A1kon%20%C4%8D%20281-2009.pdf

[31] Act No. 137/2010 Coll., Act n. 330/2010 Coll., Act 402/2010 Coll. [online]. Available from WWW: http://www.mvcr.cz/clanek/ sbirka-zakonu.aspx

year rate of return. Life expectancy of 15 years was established for photovoltaics, minimum efficiency, capital costs and annual utilization of the installed peak power.[32]

The amendment to Decree No. 364/2007 Coll. extended the expected life of the photovoltaic power plant to 20 years. The efficiency of the panels declined at 0.8% per year and the value of annual utilization of installed capacity was slightly adjusted.[33]

Decree No. 409/2009 Coll. addressed the distribution of solar power plants according to installed output by up to and over 30 kWp and set different investment costs and power usage for each. Unit costs were reduced due to the decline in market prices.[34]

Decree No. 300/2010 Coll. adjusted the economic and technical measures to photovoltaics. Two categories of power plants were added, ranging from 30 kWh to 100 kWh and over 100 kWp and specific investment costs were significantly reduced again.[35]

Other legal standards are also important in the field of photovoltaics. For example, Decree No. 150/2007 Coll., which states that the purchase prices and green bonuses are applied throughout the service life and during that time, the purchase prices increased annually with regard to the industrial producer price index by at least 2% and a maximum of 4%, with the exception of biomass and biogas.[36]

4 Analytical part

4.1 Electricity price

The European Union suffers from increasing of electricity prices because of the subsidy of renewable energy resources, environmental excise duty and also emissions trading. Altogether, this raises the overall price of electricity by more than a third, which is why Europe is becoming less competitive.

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[32] Decree No. 475/2005 Coll. [online]. Available from WWW: http://www.psp.cz/sqw/sbirka.sqw?cz=475&r=2005

[33] Decree No. 364/2007 Coll. [online]. Available from WWW: http://www.psp.cz/sqw/sbirka.sqw?cz=364&r=2007

[34] Decree No. 409/2009 Coll. [online]. Available from WWW: http://aplikace.mvcr.cz/sbirka-zakonu/ViewFile.aspx?type=c&id=5599

[35] Decree No. 300/2010 Coll. [online]. Available from WWW: http://aplikace.mvcr.cz/sbirka-zakonu/ViewFile.aspx?type=c&id=5599

[36] Decree No. 150/2007 Coll. [online]. Available from WWW: http://www.psp.cz/sqw/sbirka.sqw?cz=150&r=2007

Prices of electricity are high above the average of the European Union since 2010 in the Czech Republic. The huge increase in the number of installed photovoltaic power plants also contributed to this. This occurred for several reasons. The investment costs for solar power plants fell by more than 40% in the years 2008 to 2010, making the return on investment given the level of 5-6 years, but the investors had guaranteed support for twenty years.[37]

For investors, this was an opportunity for easy earnings. Most of the cost was covered by the industry and citizens in the form of compulsory contributions in the price of electricity. The price of the solar panel for the end customer has also reduced since 2008. Its price was 150 CZK in 2008. "*The price fell by almost 20% per year in 2009 and 2010, then almost by 30% in 2011. In early 2012, it was possible to buy the same panel for 2 Euros (50 CZK)*"[38]

4.1.1 Pricing of electricity

The final price of electricity consists of several items. Electricity customers receive an invoice with the amount that must be paid that is influenced by several factors. Buyers are, of course, primarily interested in the item, which may itself be affected. This is the unregulated part of the price of electricity. The price is to be determined based on a direct agreement between the seller and the customer. The concept of power electricity began to be used from January 2006, when there was a change in billing payments for electricity. Since then, electricity bills are distributed to the total power and regulated.[39]

Unregulated

Unregulated pricing of electricity makes up 40% of the total price of electricity. It is not determined by law or defined by any other regulations. It is the price at which the customer agrees with the merchant from which he buys electricity. Since the market consists of more of such vendors, subscribers can decide from whom they want to purchase electricity.

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[37] GUTH, Jiří. *Český fotovoltaický tunel.* [online]. 1.12.2010 [Accessed on 8.1.2014] Available from WWW: http://kbe.prf.jcu.cz/files/prednasky/verejna_sprava_a_regionalni_rozvoj/fve.doc.

[38] ARCHALOUS, Martin. *Má ještě investice do solární elektrárny reálnou návratnost?* [online]. 03.12.2012 ©2008 xBizon, s.r.o. ISSN 1803-4160 [Accessed on 6.1.2014] Available from WWW: http://www.nazeleno.cz/energie/fotovoltaika/ma-jeste-investice-do-solarni-elektrarny-realnou-navratnost.aspx

[39] *Silová elektřina*. [online] ©2010-2013 Superia.cz [Accessed on 28.11.2013] Available from WWW: http://cojeto.superia.cz/ekonomie/silova_elektrina.php

When choosing an electricity supplier, there are several parameters which must be considered. Of course, apart from the price of the electricity supplied, it is necessary to take into account both the supplier communication with the customer, as well as whether their customers are provided certain guarantees and benefits.[40]

Regulated

Regulated pricing of electricity is determined by the Energy Regulatory Office every year. It cannot be affected in any way, nor avoided. This price includes transmission and supply of electricity. The main transmission system operator in the Czech Republic is the group Čeps.[41] Its task is to ensure reliable transmission of electricity and also a balance between the production and the consumption of electricity. In the regulated price of electricity subsidy of renewable energy sources is also included.

Renewable Energy Resources subsidy

Photovoltaics, solar boom and, in particular, price increases are what comes to our mind after the term subsidy of renewable resources. The field of photovoltaics is not the only one to blame for the increase of electricity prices. Even though, there is no doubt it is hidden in the back of the mind of most people.

The subsidy of the use of renewable energy resources is in accordance with international obligations of the Czech Republic and the National Energy Policy. This subsidy includes using renewable energy resources themselves, combined heat and power (CHP) and secondary sources (SC).

Although the main law providing the subsidy of renewable resources was adopted in 2005, renewable resources were partially supported before that. The Energy Regulatory Office has been setting the purchase prices for each category of RER since 2002.[42]

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[40] *Z čeho se skládá cena elektřiny?* [online]. © 2012 Energium.cz [Accessed on 28.11.2013] Available from WWW: http://www.energium.cz/cena-elektriny/

[41] *Cena elektřiny: Z čeho je složena?* [online]. © 2010-13 xBizon, s.r.o. [Accessed on 28.11.2013] Available from WWW: http://www.cenyenergie.cz/cena-elektriny-z-ceho-je-slozena/

[42] *Obnovitelné zdroje- stručná historie podpory ČR.* [online]. 25.3.2011 2003-2009© Czech RE Agency [Accessed on 10.12.2013] Available of WWW: http://www.czrea.org/cs/druhy-oze/strucna-historie-podpora-oze

Moreover, in 2001 the Ministry of Environment approved the start of the campaign to promote the use of renewable energy sources. Large contribution to this campaign belongs to the Czech Environmental Institute, together with the Technology centre AS CR. The main aims of the campaign are *"Coordination of activities in spreading the awareness of the use of renewable energy sources, increasing the awareness of the possibilities of using renewable energy sources and providing assistance in the preparation of projects in this area."* [43]

The Energy Act was accepted in 2001, which, in particular for photovoltaic meant a radical change. This Act set the purchase price at level 6 CZK / kWh without VAT. Another radical change was the acceptance of the already mentioned Act No. 180/2005 and based on which the purchase price for the year 2006 was set, which was compared to the previous year almost double the value for the obligatory purchase of electricity from photovoltaic sources.

The increase in the subsidy of renewable resources did not only bother state coffers, but also all consumers of electricity because it reflected on the price. Above all, the huge support of photovoltaics in recent years had a significant impact on the trade balance. Czech manufacturers were unable to respond quickly enough in order to satisfy the growing demand for solar panels. A substantial part of these panels was therefore imported from abroad. It is expected that the development of this industry will continue to be low.

The following table illustrates that the subsidy of RER has increased by more than twenty times in the last 7 years.

[43] *INFORMAČNÍ A OSVĚTOVÁ KAMPAŇ na podporu využívání obnovitelných zdrojů energie.* [online]. [Accessed on 10.12.2013] Available from: http://www.oze.cz/www/zpravy4283.html?typ=5

Table 1: Development of the subsidy of RER

Amount of subsidy (CZK/MWh)	Year
28	2006
34	2007
41	2008
52	2009
166	2010
370	2011
419	2012
583	2013

Source: ERO (2013)[44]

A re-raise in the subsidy of renewable resources was assumed for 2014 and therefore an increase in the price of electricity as well. In July 2013, however, a law which reduced the subsidy of renewable energy was accepted and thus the contribution for 2014 amounts to 495 CZK / MWh.

Cost of RER

The adoption of the aforementioned Law 180/2005 on the promotion of renewable resources meant the introduction of a robust framework for the promotion of RER. It was mainly an attempt to introduce a system that would provide a solid and stable environment for investors. Unfortunately, in 2008, when there was an alarming increase in the installation of photovoltaic power plants and the state realized what damage it causes, it was too late for the discussion of these issues.

[44] www.eru.cz

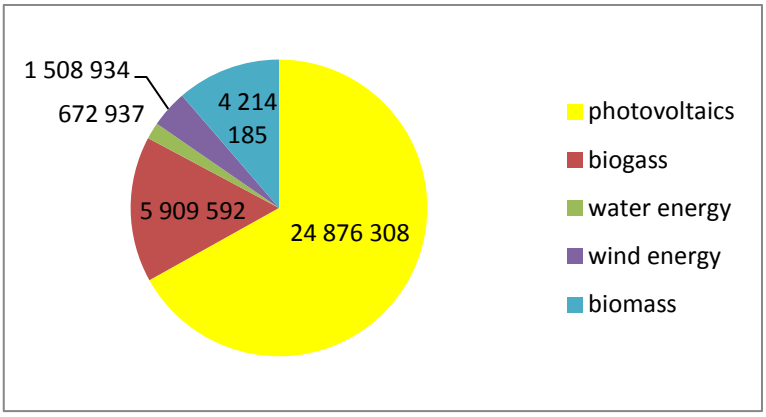
Table 2: Subsidy costs (CZK/billion)

Contribution costs (CZK /billion)	Year
1.759	2005
2.319	2006
2.754	2007
3.261	2008
4.545	2009
13.101	2010
34.322	2011
35.713	2012
44.444	2013

Source: Czech Info Energy (2013)[45]

Necessary steps of lawmakers were too slow to limit the subsidy system in time, thereby allowing a massive increase in the installation of solar power plants leading to subsequent huge costs.

Graph 1: The cost of renewable energy in 2013



Source: Chamber of RER (2013)[46]

[45] SVĚTLÍK, Jan. *Náklady na podporu OZE v letech.* [online]. [Accessed on 20.11.2013] 15.5.2013 Czech Info Energy. Avilable from WWW: czechinfoenergy.cz/files/svetlik_jan.ppt

The total cost of RER reached the level of 44.4 billion in 2013. It constitutes 30% of small customers (households 19%), wholesale 48% and 22% of taxpayers.[47]

4.2 Development of electricity prices in the years 2005-2013

The photovoltaic power plants, which means power plants built on the basis of photovoltaic panels, became the phenomenon of Czech energy since 2009. Except of producing energy from sunlight through these panels, there are also several other ways how to produce energy from the Sun, but they are built on a completely different principle. Photovoltaic panels use sunlight to energy production, the others so called alternative technologies use heat coming along with the sunlight. These technologies, however, are not present in our country.

The operation of photovoltaic power plants is a specific type of business, whose operator must follow the Act No. 458/2000 Coll. It is the law on business conditions and public administration in the energy sectors, which states that natural and legal persons in these sectors can operate in our country only under a license, which has to be granted by the Energy Regulatory Office. An applicant does not need any professional qualifications or previous experience in order to obtain a license for the operation of power plants up to 20 kW. According to the ERO, a holder who was not registered for tax on personal income until obtaining any licenses has the obligation to register at the tax office.

The state provided huge benefits to the operators of photovoltaic power plants including taxes from which the income from the operation of photovoltaic power plants was exempt by 2010. It has changed since 1 January 2011, when the income from the operation of a photovoltaic power plant is taxed to both natural and legal persons as well. This fundamental change was brought by the Act No. 346/2010 Coll. A special method of depreciation has been established in 2011 for tangible assets that are used to generate

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[46] Chamber of renewable energy resources. 5.8.2013 [online]. [Accessed on 20.11.2013] Available from WWW: http://www.komoraoze.cz/Komora_OZE/Aktualne_files/Prezentace_6-8-2013.pdf

[47] SVOZIL, Miroslav. *Jak platit náklady na podporu obnovitelných zdrojů energie (OZE)?* [online]. [Accessed on 10.2.2014] Available from WWW: www.schp.cz/en/odborne-akce/ getfile?format=raw&file=115

electricity from sunlight. It is depreciated evenly without interruption for a period of 240 months to 100% of the cost or increased input prices.[48]

The increase in the construction of photovoltaic power plants in this period had a negative impact not only on the final price of electricity, but also on the issue of public access to the use of renewable resources. Photovoltaic power plants built in the high-risk period 2009-2011 represent 75% of all costs in the support of photovoltaics in the Czech Republic and are probably the biggest problem. *"From the perspective of the customers, this is a policy that will increase the price of electricity and the cost of electricity for all customers by a significant amount. Households that use electricity only for lighting and operation of small energy appliances have to pay additional 900 to 1 250 CZK per year for electricity. Households that use electricity to cook and are better equipped with electrical appliances pay an additional 2 500 to 3 000 CZK per year for electricity."* [49]

Year 2005

The production of photovoltaic power plants was not very significant in terms of volume in 2005. The purchase prices for the said year have been calculated according to the price decision of the Energy Regulatory Office in 2004, at a time when there was no Act No. 180/2005 Coll. on the promotion of electricity from renewable resources. The construction of power plants with an installed output higher than several tens of kilowatts was not expected at that time, that is why the purchase price was stated for power plants with an installed output of 3 KW and the lifetime of photovoltaic devices was calculated to be 20 years. The value of the purchase price for a photovoltaic device in 2005 was 6 CZK/kWh.

The value of the purchase price was a lot lower than the real market conditions. At that time, the support of photovoltaics was not a priority for ERO and also due to the absence of an Act that would establish firm criteria for setting purchase prices, the ERO may have

[48] VYCHOPEŇ, Jiří. *Účetní a daňová stránka provozování fotovoltaické elektrárny.* [online]. 1.3.2011 ©2014 Wolters Kluwer, a.s. [Accessed on 6.1.2014] Available from WWW: http://www.ucetnikavarna.cz/archiv/dokument/doc-d32827v41983-ucetni-a-danova-stranka-provozovani-fotovoltaicke-elektra/

[49] *EKONOMICKÉ DOPADY VÝSTAVBY FOTOVOLTAICKÝCH A VĚTRNÝCH ELEKTRÁREN V ČR, odborná studie*, p. 10

determined the purchase price at a low value. According to a study prepared by the CTU, the purchase price was supposed to be set around 16 to 20 CZK / kWh in 2005.[50]

The legislative area faced a lot of changes during 2005, namely the acceptance of the Act No. 180/2005 Coll., whose preparation involved the Ministry of Industry and Trade of the Czech Republic together with the Energy Regulatory Office. According to this Act, the purchase prices are set for every year since 2005. This legislation consists of criteria of setting the purchase prices of photovoltaic energy, which the ERO must follow. The legislation was setting contribution for all photovoltaic devices that were producing energy in our country. For the upcoming year, the purchase prices had to be adjusted to support the effort to comply with the aim that renewable energy should account for 8 % of the gross electricity consumption by 2010. Another goal was a 15-year rate of return period for the fulfilment of the economic and technical parameters. The purchase price for the following year also could not be less than 95% of the purchase prices of the current year.[51]

Table 3: Summary of the year 2005

2005	
Final electricity price (CZK/MWh)	2356.17
Number of photovoltaic power plants	15
Subsidy to RER (MWh/CZK)	39.45
Installed output of Photovoltaic power plants (MW)	0.50

Source: ERO (2012)[52]

[50] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 [Accessed on 28.11.2013] Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf. p. 17/18

[51] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 [Accessed on 28.11.2013] Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf. p. 19

[52] *Development of the elektricity prices.* [online]. [Accessed on 10.1.2014] Available from WWW: http://www.eru.cz/user_data/files/Aplikace%20106/Vyvoj_cen_ee.pdf

Year 2006

During the calculation for purchase prices for 2006, the Act No. 180/2005 Coll. was already in force and the purchase prices had to be set in accordance with its terms. Thus, it prevented possible pricing, which would not be in accordance with the actual conditions of the market for photovoltaics, as was the case in 2005. The calculation was set for projects of the size of 100 KW for 2006. The lifetime of power plants, which was used in the calculations, was again set at 20 years. However, this was in contradiction with the Decree No. 475/2005 Coll., which indicated the expected useful lifetime of 15 years. The value of the purchase price for photovoltaic power plants put into operation after 1 January 2006 was set at the level of 13 194 CZK / MWh. The purchase prices for photovoltaic power plants put into operation before 1 January 2006 were increased by the inflation of 1.5%, so from the original 6 000 CZK / MWh to 6 280 CZK / MWh.[53]

Table 4: Summary of the year 2006

2006	
Final electricity price (CZK/MWh)	2560.26
Number of photovoltaic power plants	32
Subsidy to RER (MWh/CZK)	28.26
Installed output of photovoltaic power plants (MW)	0.76

Source: ERO (2012)[54]

In terms of volume of electricity produced by photovoltaic power plants in 2006, their contribution was still minimal to negligible. The total electricity production accounted for just 0.02 %.

[53] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 [Accessed on 28.11.2013] Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf. p. 21/22

[54] *Development of the elektricity prices.* [online]. [Accessed on 10.1.2014] Available from WWW: http://www.eru.cz/user_data/files/Aplikace%20106/Vyvoj_cen_ee.pdf

Year 2007

No new category of photovoltaics was assigned for the year 2007. The purchase price was set at the level of 13 460 CZK/MWh for resource put into operation after 1 January 2006, so the price increased by 2% against the previous year. The price for the category of power plants put into operation before 1 January 2006 rose at the level of 6 410 CZK/MWh. The economic and technical parameters set in the Decree No. 475/2005 Coll. experienced several changes during 2007 as well. One of the changes was expected lifetime of power plants, which was set at 20 years, instead of the original 15. There was also an increase in the annual utilization of the installed capacity to 935 kWh.

The new Decree was accepted – the notice No. 150/2007, which replaced the Decree from 2001. The new Decree specifies mainly the time of application of green bonuses and the purchase prices of photovoltaic devices with the set lifetime. The purchase prices are increasing semi-annually by 2 % minimum and 4% maximum according to this Decree. The Decree No. 150/2007 came into force in July 2007. The granting of licenses for photovoltaic devices with lower output also started in 2007.

Table 5: Summary of the year 2007

2007	
Final electricity price (CZK/MWh)	2763.52
Number of photovoltaic power plants	248
Subsidy to RER (MWh/CZK)	34.13
Installed output of photovoltaic power plants (MW)	4.69

Source: ERO (2012)[55]

At the end of 2007, the cumulated installed capacity of photovoltaic power plants was 3 MW. These were mainly smaller residential systems. The technologies were still

[55] *Development of the elektricity prices.* [online]. [Accessed on 10.1.2014] Available from WWW: http://www.eru.cz/user_data/files/Aplikace%20106/Vyvoj_cen_ee.pdf

inefficient and the knowledge of the installation was not at the required level, so the costs of the systems which were installed by the end of 2007 were not high.[56]

Year 2008

ERO reduced the subsidy for photovoltaic electricity generating power plants for 2008. It was caused primarily by the Decree 475/2008 Coll., when there was a change in the value of annual utilization of installed output. There was also new category of photovoltaics set for 2008, "Electricity generation using solar radiation as a source put into operation after 1 January 2008." The purchase price set for this category was 13 460 CZK/MWh. The purchase price for power plants put into operation before 1 January 2006 rose to 6 570 CZK/MWh, and the power plants put into operation after 1 January 2006 until 31 December 2007 had their purchase prices set at 13 800 CZK/MWh.[57]

Table 6: Summary of the year 2008

2008	
Final electricity price (CZK/MWh)	3060.23
Number of photovoltaic power plants	1433
Subsidy to RER (MWh/CZK)	40.75
Installed output of photovoltaic power plants (MW)	66.61

Source: ERO (2012)[58]

The share of photovoltaic power plants in the total volume of energy production was still negligible in 2008 but the number of solar power plants began to grow during that year.

Since 2007, there was nearly a tenfold increase in the total installed output of photovoltaic power plants. The increase was a consequence of maintaining a favourable purchase price, but also a decline in prices of photovoltaic panels by more than 40 %.

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[56] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 [Accessed on 28.11.2013] Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf. p. 25/26

[57] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 [Accessed on 28.11.2013] Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf. p. 30

[58] *Development of the elektricity prices.* [online]. [Accessed on 10.1.2014] Available from WWW: http://www.eru.cz/user_data/files/Aplikace%20106/Vyvoj_cen_ee.pdf

Year 2009

Two new categories of photovoltaic power plants were set according to the installed output for that year. "Electricity generation using solar radiation after 1 January 2009 with installed output above 30 KW" and "Electricity generation using solar radiation after 1 January 2009 with installed output under 30 KW". This time, the purchase prices were not set according to the date when the power plant was put into operation, but according to the output of the photovoltaic device. The main reason was that during the calculations of the purchase prices in the previous years, the reference values of the installed output which were greater than 30 kWp were considered, because of which the purchase price for power plants with installed output lower than 30 kWp became undervalued.

The purchase price for power plants with lower output was set to be 12 890 CZK/MWh and 12 790 CZK/MWh for power plants with higher output. The changes in the purchase prices of other photovoltaic power plants for 2009 are illustrated in the following table.[59]

Table 7: Price Decision for the year 2009

Price Decision 8/2008	Value (CZK/MWh)
Electricity generation using sunlight for power plants put into operation before 1 January 2006.	6 710
Electricity generation using solar radiation for resource put into operation from 1 January 2006 to 31 December 2007.	14 080
Electricity generation using solar radiation for resource put into operation from 1 January 2008 to 31 December 2008.	13 730

Source: ERO (2012)[60]

The Ministry of Industry and Trade together with ERO started to be interested in submission of an amendment to Act No. 180/2005 Coll. However, this amendment was not

[59] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 [Accessed on 28.11.2013] Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf. p. 33

[60] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf

accepted in time, so it did not affect the calculation of the purchase prices for 2010, moreover it did not give ERO any chance to reduce the purchase prices of energy from photovoltaic power plants. Not even the exchange rate decline in 2009 prevented a huge amount of installed solar panels, whose price reduction led to an increase in the number of holders of licenses for the operation of photovoltaic power plants with nearly four and a half thousand.

Table 8: Summary of the year 2009

2009	
Final electricity price (CZK/MWh)	3503.24
Number of photovoltaic power plants	5 888
Subsidy to RER (MWh/CZK)	52.18
Installed output of photovoltaic power plants (MW)	491.01

Source: ERO (2012)[61]

The so-called solar boom from which our country suffered that year brought such an alarming amount of electricity supplied to the power system that it was necessary to declare a stop condition for the connection of new photovoltaic power plants at the beginning of the following year. According to experts, the main reason for the solar boom was the decrease in prices of photovoltaic technology since 2008. The state responded to this situation too late and did not reduce the amount of subsidy in time.[62]

Year 2010

The Price Decision No. 4/2009 was issued at the beginning of November 2009, based on which the subsidy of electricity generation from renewable resources is determined, but it was released without the provisions of promoting photovoltaic power plants. The Price Decision No. 5 /2009, which added support of photovoltaic power plants in the previous price decision, was released at the end of November 2009. The proposed amendment to

[61] *Development of the elektricity prices.* [online]. [Accessed on 10.1.2014] Available from WWW: http://www.eru.cz/user_data/files/Aplikace%20106/Vyvoj_cen_ee.pdf

[62] *Využití větrné energie v ČR: Dlouhá tradice, nejistá budoucnost.* [online]. 30.10.2011 © E.ON Česká republika, s.r.o. [Accessed on 5.12.2013] Available from WWW: http://www.ekobonus.cz/vyuziti-vetrne-energie-v-cr-dlouha-tradice-nejista-budoucnost

Act No. 5/2005 Coll. has not been approved and therefore ERO could not reduce the purchase prices of photovoltaic energy by more than 5%.[63] The summary of the purchase prices for 2010 is illustrated in following table.

Table 9: Price Decision for the year 2010

Price Decision 5/2009	Value(CZK/MWh)
Electricity generation using sunlight for power plants put into operation before 1 January 2006.	6 850
Electricity generation using sunlight for power put into operation from 1 January 2006 to 31 December 2007.	14 370
Electricity generation using sunlight for power plants put into operation from 1 January 2008 to 31 December 2008.	14 010
Electricity generation using sunlight for power plants with an installed output over 30 kW and put into operation from 1 January 2009 to 31 December 2009.	13 050
Electricity generation using sunlight for power plants with an installed output up to 30 kW including, and put into operation from 1 January 2009 to 31 December 2009.	13 150
Electricity generation using sunlight for power plants with an installed output over 30 kW and put into operation from 1 January 2010 to 31 December 2010.	12 150
Electricity generation using sunlight for power plants with an installed output up to 30 kW including, and put into operation from 1 January 2010 to 31 December 2010.	12 250

Source: ERO (2012)[64]

[63] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 [Accessed on 28.11.2013] Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf. p. 38

[64] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 Available from WWW: http://www.eru.cz /user_data/files/ Aplikace_106/faq3/auditBDO_FVE.pdf

In 2010, Law No. 5/2005 was amended, and the ERO may adjust the purchase prices of energy from renewable sources, which achieve a return on investment above 5% within 11 years. The next amendment of this Act was focused on photovoltaic power plants. Newly the subsidy applied only to power plants with an installed output of production up to 30 kWp. Including the amendments to regulations, ERO also edited the technical and economic parameters specified in Decree No. 475/2005.

In 2010, the society was informed about the development of the consequences of photovoltaic power plants in electricity prices for final customers. The government set a goal to figure out another way the extra cost for the subsidy of RER could be paid, other than through electricity prices.

The price of unregulated electricity fell by 30% in 2010. Significantly cheaper electricity prices for households were expected, but it did not happen. The price of electricity fell only by 4%. According to official sources, this happened because of *"the rise in prices for electricity distribution, further increasing the value added tax (VAT) from 19 to 20% and an increase in the contribution of renewable energy resources."* [65]

Table 10: Summary of the year 2010

2010	
Final electricity price (CZK/MWh)	3391.08
Number of photovoltaic power plants	12 654
Subsidy to RER (MWh/CZK)	166.34
Installed output of photovoltaic power plants (MW)	1 910.96

Source: ERO (2012)[66]

Subsidies for renewable resources increased threefold compared to the previous year, from 52 to 166 CZK/MWh.

[65] *Jak se vyvíjí průměrná cena elektřiny?* [online]. 11.2.2011 ©2010-13 xBizon, s.r.o. [Accessed on 11.1.2014] http://www.cenyenergie.cz/jak-se-vyviji-prumerna-cena-elektriny/

[66] *Development of the elektricity prices.* [online]. [Accessed on 10.1.2014] Available from WWW: http://www.eru.cz/user_data/files/Aplikace%20106/Vyvoj_cen_ee.pdf

Year 2011

The amendment to Act No. 180/2005 Coll. came into force on 1 January 2011, which allowed the Energy Regulatory Office to reduce purchase prices for power plants with a rate of return less than 11 years.[67]

The government accepted a new Act in November this year, on the promotion of energy from renewable resources, which was criticized by both experts and the general public. The main objective of this Act is to regulate the uncontrolled growth of energy production from renewable resources. It is a reason not only for rising prices of electricity for households, but it could also cause network congestion. This Norm is also associated with the National Action Plan for renewable energy resources, which in accordance with the European Union set a 13% share of renewable energy sources by 2020.

ERO's powers are large enough to set the purchase price, reflecting the real situation in the market for photovoltaics. The summary of purchase prices for 2011 is illustrated in the following table.

[67]BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 [Accessed on 28.11.2013] Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf. p. 41

Table 11: Price Decision for the year 2011

Price Decision 2/2010	Value (CZK/MWh)
All the resources put into operation before 1 January 2006.	6 990
All the resources put into operation from 1 January 2006 to 31 December 2007.	14 660
All the resources put into operation from 1 January 2008 to 31 December 2008.	14 300
Resources with an installed output over 30 kW and put into operation from 1 January 2009 to 31 December 2009.	13 320
Resources with an installed output up to 30 kW including and put into operation from 1 January 2009 to 31 December 2009.	13 420
Resources with an installed output over 30 kW and put into operation from 1 January 2010 to 31 December 2010.	12 400
Resources with an installed output up to 30 kW including and put into operation from 1 January 2010 to 31 December 2010.	12 500
Resources with an installed output over 100 kW, put into operation from 1 January 2011.	5 500
Resources with an installed output from 30 kW to 100 kW including, put into operation from 1 January 2011.	5 900
Resources with an installed output of 30 kW, including and put into operation from 1 January 2011.	7 500

Source: ERO (2012)[68]

In 2011 there was again an increase in electricity prices compared to the previous year. In 2011 there was an increase in electricity prices mainly because of the solar tax. There were also many catastrophic scenarios, the amount by which the price of electricity will

[68] BDO Audit s.r.o. *Audit Procesu nastavení výkupních cen fotovoltaické energie. Energetický regulační úřad.* [online]. Praha: 18.5.2012 Available from WWW: http://www.eru.cz /user_data/files/Aplikace_106/faq3/auditBDO_FVE.pdf

increase. Finally, the price of electricity has increased by about 4.6%, which is part of the price levied to support renewable energy.[69]The total cost for renewable energy increased to 32 billion, out of which 20 billion was only for photovoltaics.

Table 12: Summary of the year 2011

2011	
Final electricity price (CZK/MWh)	3555.61
Number of photovoltaic power plants	12 953
Subsidy to RER (MWh/CZK)	370
Installed output of photovoltaic power plants (MW)	1 955.44

Source: ERO (2012)[70]

Year 2012

Because the setting of purchase prices had been based on newly applicable legislation since 2011; the purchase prices for 2012 were calculated only for the category of photovoltaic power plants with an installed output up to 30 KW put into operation between 1 January 2012 and 31 December 2012. The purchase price was set at the value of 6 160 CZK / MWh. The amount took into account the return on investment for a period of 13 years, and a lifetime of 20 years.

On 31 January 2012, Act no. 165/2012 Coll. on the promotion of renewable energy resources was accepted. The main purpose of this Act in the interests of climate protection and environmental protection is primarily to promote the use of renewable resources, secondary sources, high-efficiency cogeneration of heat and electricity, bio methane and decentralized production of electricity and create conditions for the implementation of a

[69] *Ceny elektřiny 2011: Velké srovnání dodavatelů.* [online]. 17.1.2011 © 2010-13 xBizon, s.r.o. [Accessed on 10.1.2014] Available from WWW: http://www.cenyenergie.cz/ceny-elektriny-2011-velke-srovnani-dodavatelu/

[70] *Development of the elektricity prices.* [online]. [Accessed on 10.1.2014] Available from WWW: http://www.eru.cz/user_data/files/Aplikace%20106/Vyvoj_cen_ee.pdf

binding target for the share of energy from renewable sources in gross final consumption energy in the Czech Republic.[71] This Act came into force on 1 January 2013.

The new Act not only changed the whole system of support for renewable energy, it also introduces support for bio methane and heat production from renewable sources. In addition to changing the whole system of support for renewable energy resources, it also changes the way of funding subsidies. All purchase prices for 2012 are summarized in the following table.

Table 13: Price Decision for the year 2012

Price Decision /2011	Value (CZK/MWh)
All the resources put into operation before 1 January 2006.	7 130
All the resources put into operation from 1 January 2006 to 31 December 2007.	14 960
All the resources put into operation from 1 January 2008 to 31 December 2008.	14 590
Resources with an installed output over 30 kW and put into operation from 1 January 2009 to 31 December 2009.	13 590
Resources with an installed output up to 30 kW including and put into operation from 1 January 2009 to 31 December 2009.	13 690
Resources with an installed output over 30 kW and put into operation from 1 January 2010 to 31 December 2010.	12 650
Resources with an installed output up to 30 kW including and put into operation from 1 January 2010 to 31 December 2010.	12 750
Resources with an installed output over 100 kW, put into operation from 1 January 2011 to 31 December 2011.	5 610
Resources with an installed output from 30 kW to 100	6 020

[71] *Act no. 165/2012 Coll.* [online]. © Ministry of the Interior of the Czech Republic. Available from WWW: http://portal.gov.cz/app/zakony/zakonPar.jsp?page=0&idBiblio=77573&recShow=0&nr=165~2F2012&rpp=15#parCnt

kW including, put into operation from 1 January 2011 to 31 December 2011.	
Resources with an installed output of 30 kW, including and put into operation from 1 January 2011 to 31 December 2011.	7 650
Sources with an installed capacity up to 30 kW, including and put into operation from 1 January 2012 to 31 December 2012.	6 160

Source: ERO (2011)[72]

Table 14: Summary of the year 2012

2012	
Final electricity price (CZK/MWh)	3996.71
Number of photovoltaic power plants	19 526
Subsidy to RER (MWh/CZK)	419
Installed output of photovoltaic power plants (MW)	2085.96

Source: Solar power plants in the Czech Republic (2014)[73]

Year 2013

The Government of the Czech Republic considered updating the State Energy Policy of the Czech Republic and approved its submission to the process of assessing the effects of environmental concepts in November 2012. The Draft of the National Energy Policy envisages especially with the decline of primary energy sources in the years 2010-25, and then their subsequent growth. This increase should be caused by an expansion of nuclear energy expected from the current methodology of the calculated consumption of primary resources. The share of photovoltaic power plants is supposed to grow rapidly in the context of renewable resources. According to the principles of energy policy, the gross energy consumption is supposed to be reduced by 2015, and then grow again in the

[72] *Výkupní ceny pro rok 2012 slibují další rozvoj malých FVE.* [online]. 30.11.2011 [Accessed on 12.1.2014] Available from WWW: http://www.svp-solar.cz/2011/11/vykupni-ceny-pro-rok-2012-slibuji-dalsi-rozvoj-malych-fve/

[73] *Solární elektrárny v ČR.* [online]. [Accessed on 10.2.2014] Available from WWW: http://www.elektrarny.pro/

following years. Similarly, the final consumption of electricity is supposed to increase slightly. Nuclear energy along with renewable resources and natural gas should participate on its production.

A fundamental change occurred at the end of 2013, when an amendment to the Act on energy resources subsidy was approved, which is changing the Act No. 165/2012 Coll. This ended the possibility of receiving operating support for newly built power plants using renewable resources. This amendment fundamentally solves the problem of extremely high costs of supporting renewable energy, which reached 44.4 billion this year. *"This year's support of renewable energy resources reached a total of 44.4 billion crowns, out of which the state contributed 11.7 billion. According to critics, the solar boom in 2009 and 2010 is responsible for such a high contribution to the support of green electricity. The fee will be reduced to a maximum of 495 crowns per megawatt hour in the next year in order to reduce the restricting burden to the customers."* [74]

Renewable energy sources produced a total of 6.3 TWh of electricity in 2013. The production of electricity from photovoltaic sources dropped to 2 070.2 GWh over the previous year. However, electricity consumption has decreased in 2013 compared to 2012, from 58.80 TWh to 58.66 TWh. All Czech households together consumed 14.7 TWh.[75]

[74] *Na podporu obnovitelných zdrojů šlo 30 miliard KČ, většina na solární.* [online]. 03.11.2013, last updated 03.11.2013. ISSN: 1213-4996. [Accessed on 9.1.2014] Available from WWW: http://www.financninoviny.cz/zpravy/na-podporu-obnovitelnych-zdroju-slo-30-miliard-kc-vetsina-na-solarni/1003462

[75] *Spotřeba elektřiny loni nepatrně klesla na 58,66 TWh.* [online]. 4.2.2014 [Accessed on 5.2.2014] Available from WWW: www.ctk.cz

Table 15: Price Decision for the year 2013

Price Decision 11/2012	Value (CZK/MWh)
All the resources put into operation before 1 January 2006.	7 273
All the resources put into operation from 1 January 2006 to 31 December 2007.	15 260
All the resources put into operation from 1 January 2008 to 31 December 2008.	14 882
Resources with an installed output over 30 kW and put into operation from 1 January 2009 to 31 December 2009.	13 862
Resources with an installed output up to 30 kW including and put into operation from 1 January 2009 to 31 December 2009.	13 964
Resources with an installed output over 30 kW and put into operation from 1 January 2010 to 31 December 2010.	12 903
Resources with an installed output up to 30 kW including and put into operation from 1 January 2010 to 31 December 2010.	13 005
Resources with an installed output over 100 kW, put into operation from 1 January 2011 to 31 December 2011.	5 723
Resources with an installed output from 30 kW to 100 kW including, put into operation from 1 January 2011 to 31 December 2011.	6 141
Resources with an installed output of 30 kW, including and put into operation from 1 January 2011 to 31 December 2011.	7 803
Sources with an installed capacity up to 30 kW, including and put into operation from 1 January 2012 to 31 December 2012.	6 284
Resources with an installed output up to 5 kW, including and put into operation from 1 January 2013 to 30 June 2013.	3 410
Resources with an installed output of 5 kW to 30 kW	2 830

including, put into operation from 1 January 2013 to 30 June 2013.	
Resources with an installed output up to 5 kW, including and put into operation from 1 July 2013 to 31 December 2013.	2 990
Resources with an installed output of 5 kW to 30 kW including, put into operation from 1 July 2013 to 31 December 2013.	2 430

Source: Purchase prices for photovoltaics for 2013. (2012)[76]

ERO published their pricing decisions and the subsidies for the year 2014 at the end of November 2013 and it did not bring good news for a number of operators of photovoltaic power plants. The amount of the green bonus[77] also decreased substantially, especially for power plants connected between 2012 and 2013.

Table 16: Summary of the year 2013

2013	
Final electricity price (CZK/MWh)	4 088
Number of photovoltaic power plants	27 956
Subsidy to RER (MWh/CZK)	583
Installed output of photovoltaic power plants (MW)	2132.36

Source: Solar power plants in the Czech Republic (2014)[78]

The new year 2014 is therefore a year with zero subsidies for photovoltaic resources. That does not mean that the construction of these power plants is not profitable this year. Photovoltaics still remains a profitable investment. This return shall be proportionately increased with its use for own consumption: "*The more of produced energy you use, the*

[76] *Výkupní ceny FVE pro rok 2013* [online]. 28.11.2012 [Accessed on 18.2.2014] Available from WWW: http://www.silektro.cz/aktuality/vykupni-ceny-fve-pro-rok-2013-49

[77] Green bonus is the subsidy of photovoltaic power plants that do not supply the generated electricity directly into the power system. Available from WWW: http://www.cefas.cz/informace-cfa/vykupni-ceny-pro-fotovoltaicke-elektrarny-v-roce-2014-a-v-dalsich-letech.html

[78] *Solární elektrárny v ČR.* [online]. [Accessed on 10.2.2014] Available from WWW: http://www.elektrarny.pro/

sooner your investment in photovoltaics returns, the generated power which you do not consume will be bought by electricity traders"[79]

4.3 Regression analysis

This is a representation of the relationship between at least two variables. For a simple regression we work with only two variables. There is one dependent variable, which is signed with the letter y. The second variable is independent, or explained variable, which is signed with the letter x. In this analysis it is counted with more than one independent variable, therefore it is a multiple regression.

Estimated model

$$Yt = \alpha + \beta X_{1t} + \gamma X_{2t} + \delta X_{3t} + \omega X_{4t} + \varepsilon_t \qquad [I]$$

Y= electricity price (CZK/MWh)[80]

X1= installed output of photovoltaic power plants (MWh/quarterly)[81]

X2= gas prices (CZK/quarterly)[82]

X3= electricity consumption (MWh/quarterly)[83]

X4= GDP (bil.CZK/quarterly)[84]

[79] *Fotovoltaické elektrárny 2014 – návratnost investice.* [online]. [Accessed on 20.2.2014] ©2012 rdsolar.cz Available from WWW: http://www.rdsolar.cz/fotovoltaika%202014

[80] Data available from WWW: http://www.eru.cz/user_data/files/Aplikace%20106/Vyvoj_cen_ee.pdf

[81] Data available from WWW: http://www.elektrarny.pro/grafy.php

[82] Data available from WWW: http://www.cena-plynu.eu/ceny-plynu/

[83] Data available from WWW: http://www.eru.cz/user_data/files/statistika_elektro/rocni_zprava/2012/RZ_elektro_2012_v1.pdf

[84] Data available from WWW: http://www.czso.cz

Model 1: OLS, using observations 2005:1-2012:4 (T = 32)

Dependent variable: y

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	330.397	670.991	0.4924	0.62642	
x1	0.186535	0.0505061	3.6933	0.00099	***
x2	1.06526	0.260714	4.0859	0.00035	***
x3	-0.0407602	0.257029	-0.1586	0.87518	
x4	0.00120414	0.00102295	1.1771	0.24942	

Mean dependent var	3148.353	S.D. dependent var	532.7589
Sum squared resid	812226.1	S.E. of regression	173.4429
R-squared	0.907689	Adjusted R-squared	0.894013
F(4, 27)	66.37232	P-value(F)	1.42e-13
Log-likelihood	-207.6748	Akaike criterion	425.3496
Schwarz criterion	432.6783	Hannan-Quinn	427.7789
rho	0.599330	Durbin-Watson	0.775801

Estimated model

$Yt = 330.397 + 0.186535X_{1t} + 1.06526X_{2t} - 0.0407602X_{3t} + 0.00120414X_{4t}$ [II]

Cons.: If all explanatory variables are equal to zero, then final electricity price will be 330.397 CZK/year.

$X1_t$: If installed output of photovoltaic power plants will increase by 1 MWh/quarterly, then final electricity price will increase by 0.186535 CZK/MWh.

$X2_t$: If gas price will increase by 1 CZK/quarterly, then final electricity price will increase by 1.06526 CZK/year.

$X3_t$: If total electricity consumption will increase by 1 MWh/quarterly, then final electricity price will decrease by 0.0407602 CZK/year.

$X4_t$: If gross domestic product will increase by 1 bil.CZK/quarterly, then final electricity price will increase by 0.00120414 CZK/year.

Goodness of Fit

R^2 = 90% of variance of dependent variable is explained by my model.

Hypothesis

H0 ..... $\mu i = 0$ ... the parameter is statistically insignificant

H1 ..... $\mu i \neq 0$ ... the parameter is statistically significant

p-value		**alpha 0.1**
$\mu_0 = 0.62642$	>	α_0

⇒ Do not reject Ho, the parameter is statistically insignificant.

$\mu_1 = 0.00099$	<	α_1

⇒ Reject Ho, the parameter is statistically significant.

$\mu_2 = 0.00035$	<	α_2

⇒ Reject Ho, the parameter is statistically significant.

$\mu_3 = 0.87518$	>	α_3

⇒ Do not reject Ho, the parameter is statistically insignificant.

$\mu_4 = 0.24942$	>	α_4

⇒ Do not reject Ho, the parameter is statistically insignificant.

Result

Four determinants of which it was assumed that they might significantly influence the production of final electricity prices for small consumers were used in the regression analysis. Gretl, analytical software, was used for making this analysis. The regression analysis was primarily created to confirm or deny the hypothesis of this thesis (see Goals and Methodology).

The four determinants which were selected showed that two of them significantly affect the formation of the final price of electricity. This is the price of the selected substitute, natural gas, which affects electricity pricing proportionally. The second statistically very significant determinant is the value of installed output. The regression analysis clearly demonstrates that the price of electricity increases together with increasing installed output. This confirms the hypothesis.

The other two determinants affect the pricing of electricity in a very limited extent. The regression analysis showed that the GDP affects the price of electricity only minimally, and electricity consumption has almost no effect on the final electricity price. Both are statistically insignificant. Weak influence of electricity consumption at the price of electricity may seem like a surprising finding. This work, however, dealt only with retail customers, who are involved in the consumption of electricity minority (25%)[85], and therefore do not have such a negotiating position in the market as wholesalers.

Another important factor affecting the pricing in our country is the price of electricity on the EEX (Leipzig Energy Exchange), which is the main energy exchange in EU. The following graph shows the development of prices on the stock exchange in Leipzig during the past five years.

[85] http://www.eru.cz/user_data/files/statistika_elektro/rocni_zprava/2012/RZ_elektro_2012_v1.pdf

Graph 2: Development of electricity price on the EEX

Source: Current and historical electricity prices (2014)[86]

These values were not used in the regression analysis because our country has a number of suppliers who gradually entered the Leipzig exchange and therefore these data would be misleading.

[86] *Electricity – current and historical elektricity prices.* [online]. 2014 [Accessed on 21.2.2014] Available from WWW: http://www.kurzy.cz/komodity/nr_index.asp?A=5&idk=142&od=29.9.2003&curr=CZK&default_curr=EUR&unit=&lg=1

5 Conclusion

The aim of this thesis was to assess the situation of the use of photovoltaics in the Czech Republic and its economic consequences. Nine years ago, our country began to devote to the field of renewable resources much more and it had both positive and negative responses. Renewable resources were sought by society as an alternative for fossil fuels and the subsequent release of pollution. The European Union has opted for the wider use of renewable resources; to which the Member States had to respond, and since 2004 that meant the Czech Republic as well. A year after the entry into the Union the Czech Republic accepted a law that supported renewable resources and the state approved a generous subsidy policy. In particular, the area of photovoltaics had become a very convenient type of business. Investors were receiving huge subsidies from the state, and there has been a rapid increase in the installation of photovoltaic power plants since 2008.

The state supported this growth and in order to meet the given target for the percentage of RER in gross electricity consumption by 2010, it created very favourable conditions for investors in this field. Because the conditions were extremely favourable, it attracted entrepreneurs also from abroad.

Such state subsidy divided the society into two groups. The first group were the investors, who received generous subsidies, and the second group formed by the rest of the society who had to pay for it in the form of mandatory annual contributions to RER in the final price of electricity. The commitment of the state to meet the objective of an eight percentage share of RER in gross electricity consumption was so strong that it led our country to the so-called solar boom in 2009 and 2010. The Czech Republic had met the goal, but the situation regarding photovoltaics became unbearable in 2010. The state began to deal with this issue and not only reduced the purchase prices, but also imposed a tax on income from photovoltaics, which until then was tax free.

The period of 2009-2011 is in terms of PV estimated to be the worst. In this period, the largest increase in the number of photovoltaic power plants occurred, especially their installed output. The installed output is the main determinant influencing the price of electricity in the regression analysis which was used in this thesis. Along with another determinant, the price of natural gas as a selected substitute, both proved to be statistically significant and both affect the final price of electricity in direct proportion. The other two

determinants, electricity consumption and GDP, proved to be statistically insignificant and neither of them participates on the creation of the final price of electricity significantly. The fact that electricity consumption does not affect its price might seem as a surprise. Because this thesis deals only with retail customers, households, and not wholesalers, such a result could have been expected. Households account for only 25% of the total electricity consumption in the Czech Republic, their bargaining position in the market is therefore too small to be able to influence the price of electricity. The result of the regression analysis proves the set hypothesis, that the growing number of photovoltaic power plants and their output in the Czech Republic is negatively reflected in the final price of electricity and thereby in the overall economy of the Czech Republic.

The Bachelor Thesis analyses individual steps which were made since 2005 and which ultimately resulted in the fact that the society has a negative approach to renewable resources, especially for photovoltaics. Now the development and the course of these years points to the thoughtless legislative policy of the state and the negative effects of this process. The work itself does not serve to condemn photovoltaics or renewable resources in general. It is supposed to approach the fact that a thought to detail legislative system is the cornerstone for greater use of renewable energy and, in particular, to prevent the subsequent economic damage from which the Czech Republic will have to recover from over the next 15 years.

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7 Annex

Annex 1: Underlying data for Gretl

y	x1	x2	x3	x4
2 356.17	0.1	930	1346.375	763415
2 356.17	0.1	1 002	1110.665	771907
2 356.17	0.1	1 074	1046.058	781242
2 356.17	0.1	1 146	1303.05	796896
2 560.26	0.2	1 218	1431.183	810386
2 560.26	0.2	1 282	1140.3	827202
2 560.26	0.2	1 362	1082.125	851518
2 560.26	0.2	1 323	1298	867017
2 763.52	3.4	1 283	1337.89	900459
2 763.52	3.4	1 243	1152.525	901394
2 763.52	3.4	1 204	1112.275	926650
2 763.52	3.4	1 333	1376.633	937371
3 060.23	4.13	1 462	1398.533	951866
3 060.23	4.83	1 591	1194.608	962973
3 060.23	9.5	1 720	1139.415	975399
3 060.23	26.1	1 728	1307.258	954938
3 503.24	59.16	1 735	1349.465	953542
3 503.24	72.26	1 742	1065.15	934028
3 503.24	96.23	1 749	1059.983	931341
3 503.24	250.6	1 762	1284.7	942923
3 391.08	482	1 775	1365.89	937923
3 391.08	537.93	1 788	1142.408	949256
3 391.08	703.86	1 801	1100.125	951499
3 391.08	1456.96	1 806	1329.515	949113
3 555.61	1975.3	1 812	1362.965	947214
3 555.61	1978.23	1 817	1141.383	952415
3 555.61	1971.36	1 823	1091.208	957048
3 555.61	1970.23	1 829	1290.65	964033
3 996.71	1970.56	1 835	1376.008	965407
3 996.71	1973.06	1 841	1137.458	962458
3 996.71	1987.86	1 847	1091.575	958800
3 996.71	2041.76	1 856	1294.84	959698