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CZECH
UNIVERSITY
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Bachelor Thesis

The Economy of Solar Energy in the Czech Republic

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BACHELOR THESIS ASSIGNMENT

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Economics and Management

Thesis title

The Economy of Solar Energy in the Czech Republic

Objectives of thesis

The aim of the thesis is to analyze the relationship between the price of electric energy and the amount of electric energy produced from the possible installation of photovoltaic panels in our Czech University of Life Sciences Prague.

Methodology

In the thesis will be used descriptive and comparative methods of research.

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Prague October 7, 2013

Affirmation

I declare that the Bachelor Thesis based on the topic: “The Economy of Solar Energy in the Czech Republic” was individually written by me using specific literature and other information sources which are included in the references at the end of the Thesis and by the help of consultations with the supervisor Doc. Ing. Mansoor Maitah, Ph.D. et Ph.D.

Prague, 13th March 2014

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Signature

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The Economy of Solar Energy in the Czech Republic

Ekonomika solární energie v České republice

Summary

The aim of this study is to analyze the evolution of the photovoltaic industry in the Czech Republic after the year 2005 until the present days (2014), with special attention to the regulatory policy implemented regarding solar energy.

The theoretical part of this paper shows the importance of the utilization of renewable sources of energy, making especial emphasis in the solar energy in a world where there is an increasing scarcity of fossil fuels and therefore an increasing dependence on nations possessing natural resources, and the uncertainty about the supply and price of fuels and the adverse effects caused by their combustion including greenhouse gas emissions and global warming.

During the research a chronological study of the relevant legislation and other factors influencing the development of photovoltaic power plants was made. Descriptive and comparative methods of research were used to evaluate the purchase price policy taking for computation the payback periods of a sample photovoltaic power plant for different years of launch and the current applicable legislation. The final results suggest the adverse effect of the regulatory policy and the possible strategies that would have successfully prevented the "Solar Boom".

Key words: Solar energy, renewable sources of energy, photovoltaics, economics, Czech Republic

Souhrn

Cíl teto práce je analyzovat vývoj fotovoltaického průmyslu v České Republice od roku 2005 do přítomnosti (2014) se speciálním zameřením na regulační politiku zaměřenou na solární energii.

Teoretická část této bakalářské práce zdůrazňuje využití obnovitelných zdrojů energie s důrazem na solární energii ve světě kde je nedostatek fosilního paliva a proto zvyšující se zavislost na státech vlastnících přírodní zdroje s nejistotou o dodavce a ceně paliv a o nepříznivých efektech způsobených spalováním zahrnující skleníkový efekt a globální oteplování.

Během výzkumu byla vytvořena chronologické studie příslušných právních předpisů a dalších faktů ovlivňujících vývoj fotovoltaických elektráren. Byly použité popisné a komparativní metody výzkumu ke zhodnocení politiky kupní ceny pro výpočet doby návratnosti zkušební fotovoltaické elektrárny pro různé roky spuštění a aktuální použitelné legislativy. Konečné výsledky naznačují nepříznivý vliv regulační politiky a možné strategie, které by mohly uspěšně předejít “Solarnímu Boomu“.

Klíčová slova: Solární energie, obnovitelné zdroje energie, fotovoltaika, ekonomika, Česká republika

Content of the Bachelor Thesis

I. List of Acronyms

CR- Czech Republic

CZK- Czech Koruna, code of the Czech currency

ERO- Energy Regulatory Office

EU- European Union

EUR- EURO, code of the currency of the euro zone

FITs- Feed-in tariffs

GHG- Greenhouse Gases

GWh- Gigawatts per hour

IC- Installed capacity

i.e.- id est, that is

kWh- Kilowatt per hour

NAP- National Action Plan

PP- Purchase price

PV- Photovoltaics

RES- Renewable energy sources

TWh- Terawatt per hour

UV- Ultraviolet

Wp- Watt-peak

II. List of Tables

III. List of Figures

1. Introduction

Sustainable development is a frequent discussed topic nowadays. Future technological development cannot continue to be based on growth of production and consumption of fossil fuel based sources (oil, coal, natural gas) because deposits are gradually being exhausted. They also represent a considerable burden for the environment. At present the consumption of energy from fossil fuels is much faster than its accumulation. Hopefully, there is a general recognition that adoption of renewable energy sources is the only viable alternative for growth of our civilization. The human population of the Earth has now passed 7.2 billion, and all of these inhabitants want the energy necessary to sustain their lives.

The European Union already acts towards a switch to other alternative sources of energy by setting a target of 20% production share from renewable energies. Czech Republic's objective is to produce 13.5% of total energy production by renewable sources.[1]

However, switching only to alternative sources is not the right answer. Renewable sources such as wind or solar energy are unreliable and inappropriate for meeting the demand in the long run. Nuclear energy can be the solution but only if proper and detailed security conditions are guaranteed. The most reasonable solution to the energy sustainability problem is the right mix of all resources in the right ratio. In despite of the positive potential of the solar energy, the energy output of solar photovoltaic power still only covers less than 1% of the worldwide electricity generation because solar power is not efficient enough and needs subsidies by the State to promote the share of renewables in the energy mix.

[1] National Renewable Energy Action Plans - European Commission.

2. Objectives and Methodology

2.1 Objectives

The aim of this Bachelor thesis is to analyze the evolution of the photovoltaic industry in the Czech Republic after the year 2005 until the present days (2014), with special attention to the regulatory policy implemented regarding solar energy. The first part of this paper provides a theoretical background about the importance of renewable sources of energy making emphasis in the solar energy. This study aims also to evaluate the progress of the PV industry in the Czech Republic influenced by the relevant legislation and other factors affecting the PV development.

The subsequent objective is to evaluate the purchase price policy taking for computation the payback periods of a sample photovoltaic power plant for different years of launch and the current applicable legislation. The final results suggest the negative consequences of the regulatory policy and measures that should have been taken in order to mitigate the massive expansion of Photovoltaics.

2.2 Methodology

The first step in the analysis of the regulatory policy was a study of the relevant legislative framework for renewable sources and PV in particular. The different types of support schemes and various factors that affect the purchase price of electricity generated by Photovoltaics were then analyzed. A chronological research of the progress of the regulatory policy was carried out and the results evaluated by computation of the payback periods for an existing PV power plant for different years of launch and the current applicable legislation.

3. Literature Review

3.1 The Energy Problem

Sustainable development is a frequent discussed topic nowadays. Future technological development cannot continue to be based on growth of production and consumption of fossil fuel based sources (oil, coal, natural gas) because deposits are gradually being exhausted. They also represent a considerable burden for the environment. At present the consumption of energy from fossil fuels is much faster than its accumulation. Hopefully, there is general recognition that adoption of renewable energy sources is the only viable alternative for growth of our civilization.

3.1.1 Renewable Energy Around the World

Energy production is among the top problems that humanity will face over the next century because of growing energy demand, particularly in developing countries. A major part of electric power is currently produced by burning fossil fuels (coal, oil or gas). The increasing energy demand currently as well as in future, however, will possibly not be met by fossil fuels for two reasons: their limited reserves and their significant contribution to greenhouse gases which have adverse effects on the climate. Consequently, many organizations from around the world have been searching for alternatives to fossil fuels that are low cost, sustainable and clean.

In recent years, usage of nuclear energy, which has the potential to satisfy a great part of overall electrical energy demand, is being discussed in the context of growing global warming because its contribution to the greenhouse effect is minimal compared to other sources of energy. The amount of nuclear fuel, however, is also limited and not renewable. The recent nuclear disaster involving the Japanese reactors at Fukushima due to a massive earthquake caused an incomparable tragedy and has triggered global discussion and questions the future of nuclear power.

Increasing demand for electrical energy as well as environmental concerns related to fossil fuel usage are the driving forces behind the development of new energy sources, which are renewable and ecologically safe. The energy sources, which include energy from wind, water and biomass, geothermal and solar energy are renewable and environmentally friendly. Among these clean energy sources, solar energy is one of the most promising and fastest growing renewable energy sources worldwide. In 2006, for the first time, more than half of the silicon production went into PV instead of computer chips.[2]

Solar energy comes from an abundant source, and is available in direct form as solar radiation and in indirect form as wind and biomass. The Sun deposits 120 000 TW of radiation on the surface of the Earth. The total energy needed by the humans in 2020 is expected to be 20 TW.[2]

Solar PV is considered to world's fastest growing power technology, and is used to generate electricity in more than 100 countries. Despite this tremendous growth, however, solar power still accounts for a share of less than 0.1% of the global energy generation because of its high cost of production.[3]

Germany is the world leader in terms of renewable energy use and equipment manufacturing capacity. In 2004, wind energy overtook hydro energy as the main source of renewable energy electricity generation. The total installed wind generator capacity in Germany is now 16.6 GW. In 2004 wind energy produced 4.1% of the country's electricity and hydroelectric plants produced 3.4%. 6 300 000 m2 of solar thermal collectors have been installed, 90% of heat energy produced form renewables comes from bio energy in the form of biogas and biomass, generating 53 000 GWh of electricity in 2004.[4]

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[2] REDDY P. Jayarama. Solar power generation technology. New concepts & policy.
[3] Photon Intl. 2009, BPs Report 2010.
[4] ANTONY Falk, DURSCHNER Christian, REMMERS Karl-Heinz. Photovoltaics for professionals. Solar electric systems marketing, design and installation.

The German Renewable Energy Law, which offers guaranteed prices for PV generated electricity, has led to dramatic growth in this market sector, making Germany the world's largest market for PV.

In the USA, about 6% of total energy is produced form renewable sources, mainly hydro-electric and geothermal. There is over 7.2 GW of wind energy installed, 86 MW of PV and 52 000 m^2 of solar thermal collectors (2004). The USA is the world's third largest PV market.[4]

3.1.2 Climate Change and Dwindling Fossil Fuel Reserves

Since the industrial revolution, developed nations have been burning fossil fuels in ever increasing quantities. However, in the past decade two major problems with this have come to light. The first relates both to the scarcity of fossil fuel resources and the notion of energy security. Currently about 80% of the energy used in the industrialized world comes from fossil fuels in the form of coal, natural gas and oil. It is now generally accepted that the oil reserves that the world currently depends on are a limited resource, and it is acknowledged that demand for oil will only increase as countries such as India and China increase their levels of industrialization. This growth will create an enormous demand on finite resources. Moreover, these resources are generally found in areas characterized by political conflicts, such as the Middle East, therefore prices can be highly variable.

Interest in renewable energy technologies like solar power is driven by the need to meet these increasing needs and a desire for independence from ever increasing oil prices. The beauty of solar power is that it has very few running costs. Once the capital investment has been made, the energy is effectively free, while fossil fuels must be purchased continuously and all indications are that prices will continue to rise.

The second problem is that of human induced climate change also known as global warming. At the end of the 21st century, in only 400 years of industrial activity, humanity will have used up much of the fossil fuels which have been deposited in the Earth's crust over the last 400 million years.[5] There is a widely accepted theory that burning fossil fuels (coal, oil and gas) is releasing vast quantities of greenhouse gases (GHGs) such as carbon dioxide and methane into the atmosphere causing the planet's climate to change and alter weather patterns. It is now clear that carbon dioxide in the atmosphere is increasing, and that the change in climate, both regionally and globally, is clearly measurable.

The total energy production on Earth is growing exponentially, in the year 2000 it already exceeded $E = 10^{14}$ kWh/year. If this trend continues it would reach $E=10^{17}$ kWh/year within less than a century.[6] This would be a catastrophic scenario which global ecosystems would probably not survive. The Intergovernmental Panel on Climate Change (IPCC) predicts a temperature increase of between 1.4 – 5.8 ^{0}C over the next 100 years, depending on whether industrialized societies and newly industrializing societies continue in a business as usual scenario or shift to a low carbon economy. The shifting of climate zones and the increasing frequency of extreme weather events such as floods, storms and droughts associated with climate change will severely damage the natural environments on which millions of people are dependent. The burning of fossil fuels also produces a range of other pollutants which impact on human health and the environment: benzene, soot, nitrogen oxides, hydro-carbons, carbon monoxide, sulfur oxides and ammonia. Acid rain destroys forests and lakes, and oil spills regularly cause massive environmental damage. A change in the way we use and produce energy is necessary to preserve the ecosystems on which human life is dependent and the only possible solution is a radical shift from fossil fuels to a low carbon economy.

[5] STAPLETON Geoff, NEILL Susan. Grid-Connected Solar Electric Systems

[6] POULEK Vladislav, LIBRA Martin. Solar Energy. Photovoltaics – Promising trend for today and close future.

Human induced climate change has been acknowledged by all levels of government in developed and developing countries as needing urgent international actions to mitigate its effects. These actions include measures to reduce the use of fossil fuels, so reducing the release of GHGs, a major contribution to the success will be the substitution of fossil fuels with cleaner low emission technologies. Renewable energy technologies that make use of wind and solar power will therefore play an important role in reducing global GHGs emissions and are likely to represent a large portion of the world's energy production in the near future to avoid a possible environmental catastrophe.

In the next 50 years, oil consumption should drop to about one half its present levels and consumption of coal should start decreasing around the year 2040. On the other hand, utilization of solar energy grows rapidly and by 2040 its share of total energy production should be the largest of all energy sources.[7]

3.1.3 Solar Energy. The Possible Solution

The Sun is our nearest star. It originated slowly about five billion years ago from a nebula of rarified gases and dust. Due to gravitational forces, the nebula gradually concentrated and its temperature increased. The Sun is composed of a mixture of gases, with a predominance of hydrogen, as the Sun converts hydrogen to helium in a massive thermonuclear fusion reaction, mass is converted to energy. As a result of this reaction, the surface of the Sun is maintained at a temperature of approximately 5800 K and radiates this energy out into the space in the form of electromagnetic waves. The Sun became a gigantic natural thermonuclear reactor. Although only a very small proportion of the solar radiation reaches the surface of the Earth, just a few hours of sunshine contain more energy than the entire population of the planet consumes in one year. If we could use just 0.04% of the available solar radiation effectively, the sun could meet our total energy needs worldwide.[8]

[7] J. Skorpil, Z. Martinek, Elektroenergetika a obnovitelne zdroje energie

[8] MESSENGER Roger A., VENTRE Jerry. Photovoltaic Systems Engineering

The table 1 shows the Sun's key parameters.

Table 1: Principal Parameters of the Sun

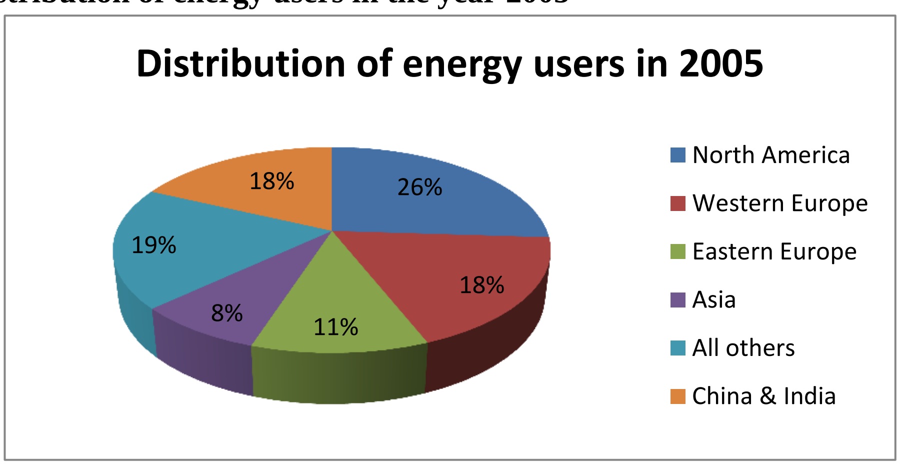
Parameter	Mean Value
Sun radius	R_s=6.96x10^8 m
Sun mass	M_s=1.99x10^{30} Kg
Sun output	P_s=3.91x10^{26} W
Effective temperature	T_s=5800 K
Gravitational acceleration at surface	G_s=274 m/s^2
Distance between the Sun and Earth	R_{sz}=1.49x10^{11} m
Solar constant	I=1367 W/m^2

Source: NASA Goddard Space Flight Center. My own table

The Sun provides the energy needed to sustain life in our solar system, either directly as sunlight or indirectly as wind and waves. Even the coal reserves mined today were once living plants that gained their energy from photosynthesis.

The figure 1 shows that North America, with slightly more than 5% of the world population consumes 26% of the world's energy, while China and India, with nearly one third of the world's population consume 18% of the world's energy.

Fig. 1: Distribution of energy users in the year 2005



Source: MESSENGER Roger A., VENTRE Jerry. Photovoltaic Systems Engineering

Solar radiation is the most important source of renewable and clean energy and the most promising source from a long term perspective. So far solar energy is not able to compete with high capacity power plants burning fossil fuels, with nuclear power stations or with hydroelectric power plants, but it has been already successfully applied as a supplementary local power source.

Although hydro turbines, biomass power stations and wind turbines utilize solar energy indirectly, the term solar energy is usually used to refer to devices which utilize solar energy of the Sun directly to produce both heat and electricity. These technologies are broadly categorized into two categories: active and passive solar.

Passive solar technology does not have any electrical components, and it refers to architectural and constructional features which reduce the overall energy needs of buildings by keeping them warm in winter and cool in summer.

Active solar systems are categorized into solar thermal, which usually produce hot water, but can also be used for cooling and producing steam which drives electricity generating turbines and Photovoltaics (PV) which produces electricity directly from solar radiation and will be the focus of this paper.

3.2 Photovoltaics

Photovoltaics (PV) is the active solar technology which produces electricity from solar radiation using solar cells encapsulated in panels called PV modules. The photovoltaic is the direct conversion of sunlight to electricity. In the 21st century solar cells are an increasingly attractive energy source considering the problems posed by greenhouse gas emissions and dwindling fossil fuel energy reserves.

Even in northern latitudes, in regions not generally thought of as sunny, solar energy can be harnessed effectively. To supply current global electricity need using PV, the land area needed would be only 1.5% of the European landmass, about 145 000 square kilometers at solar radiation levels found in the northern latitudes, it would be even less at the Equator.[9]

[9] GAIDDON Bruno, KAAN Henk, MUNRO Donna. Photovoltaics in the Urban Environment.

3.2.1 PV System Types

Solar energy is harnessed by using solar electric systems, also known as photovoltaic (PV) systems. The word photovoltaic is derived from the Latin words photo (light) and voltaic (energy). PV devices capture the energy in sunlight and convert it into electricity. There are several different types of solar electric systems. This paper focuses on solar electric systems that feed electricity back into the grid (grid-connected solar electric systems).

Off-grid systems

An off-grid or stand-alone solar electric system is designated to replace or supplement conventional mains power supply. One third of the world's population has no access to electricity at all, this is over 1 700 million people.[4] Most of them live in rural or remote areas where mains power is not available due to the high cost of grid extension. Small stand-alone PV systems are in reality the only practical way to supply many of these people with power. There is a large market for small stand-alone PV in urban areas in the developing world such as solar powered bus shelters, parking meters and traffic signs. In fact, PV can be used to provide electricity practically anywhere on the planet, from the Artic to the tropics.

Grid-connected systems

Grid-connected or utility-interactive solar electric systems are the focus of this paper. Grid-connected systems are normally found in urban areas that have readily available mains supply and the power is fed back into the grid. In this way the grid acts as a kind of storage medium and when power is needed in the building it can be imported from the grid. One of the key benefits is that the system does not have to supply enough electricity to cover the property's power demand as in an off-grid system. The property can be powered by the PV system, the electricity grid or a combination of the two, meaning that the system can be as small or large as the owner desires and the excess power generated by the PV system will be exported to the power grid and the system owner is paid for the exported power.

3.2.2 Applications of Solar PV Systems

Solar electric technology is developing very quickly. Its worldwide use is increasing rapidly as prices of other electric energy sources rise. Before the 1990s, solar electricity was a new technology, used mostly for off-grid telecommunications systems, signaling, water pumping and remote clinic power. Since the mid-1990s, world production of solar modules increased rapidly because of the demand for grid-connected systems in Europe, the US and Japan. Meanwhile, the price of solar cell modules fell from about US $100 per peak watt in 1974 to less than US $4 per peak watt in 2008.[10]

Photovoltaic panel arrays can be located on open terrain or directly incorporated into the architecture of buildings. Mobile photovoltaic systems also exist in various sizes and configurations, for use in remote areas not connected to a power distribution network. Scientific expeditions, nomad herders, inhabitants of remote places use these systems. Emergency phone booths located along highways are designed as off-grid photovoltaic systems and urban parking meters as well.

International race competitions with solar powered cars are organized regularly, the largest being the transcontinental race in Australia. In these races the winning solar powered cars reach an average speed of 90 Km/h. A group of enthusiasts participated in designing a solar powered car in the Czech Republic, at the Faculty of Transport of the Czech Technical University. They have taken part in several international races in Austria, achieving the second place in 1998.

Solar pumping systems are widespread. They can be used to pump drinking water from wells or water for irrigation in agriculture. The more the Sun shines, the drier the soil gets and the more irrigation is needed. But with more sunshine the volume of water pumped by the system can be larger.

[10] HANKINS Mark. Stand-alone solar electric systems. The earth scan expert handbook for planning, design and installation.

According to statistics about 6000 people, mainly children, die in Africa from drinking bacteriologically contaminated water every day. The Dutch company Nedap developed a device solar energy powered called NAIADE intended to sterilize water in less developed countries. A solar photovoltaic panel charges an accumulator that powers a low pressure mercury vapor lamp producing hard ultraviolet radiation that kills the bacteria. The volume of the container is 100 liters and the daily capacity of the device is as much as 2000 liters of sterilized water on a sunny day enough to supply as many as 400 people.[11]

The applications of solar electricity generation depend on advantages and disadvantages shown in Table 2.

Table 2: Solar electricity advantages and disadvantages

Advantages of solar electric power	**Disadvantages of solar electric power**
1. PV systems consume no fuel and convert freely available sunlight directly into electricity. 2. PV systems produce electricity without giving off exhaust gases or pollutants. 3. PV systems require comparatively little maintenance. Solar modules can last for more than 20 years after been installed. 4. PV systems are particularly cost effective for small applications where power demand is bellow 3-5kWh/day. 5. PV systems are safe when properly installed. Risks of electric shock are low with 12 and 24 volt systems, and there is much less fire risk than for generator solutions.	1. Solar energy can only be harnessed when it is daytime and sunny. 2. PV systems often have higher initial costs. 3. Most off-grid PV systems require batteries to store electric power. Batteries require maintenance and must be replaced at the end of their lives. The performance of PV systems is dependent on the quality of batteries available. 4. PV systems must be designed and installed by qualified technicians. Poorly designed or installed PV systems perform less effectively. 5. Large stand-alone PV systems often need to be backed up by fossil fuelled generators to supply power during peak-use or cloudy periods.

Source: HANKINS Mark. Stand-alone solar electric systems

[11] Wikiwater. Treatment using solar power and production of UV radiation

Photovoltaic panels already operate on satellites and spaceships on orbits close to the Sun providing their energy. In these applications, solar power is the most efficient energy source. Photovoltaic panels were located on the Moon surface to provide energy for scientific instruments during the Apollo program.

3.2.3 Marketing and Promoting PV

Due to the growing demand for clean sources of energy, the manufacture of solar cells and photovoltaic arrays has expanded dramatically in recent years. PV production has been doubling every two years, increasing by an average of 48% each year since 2002, making it the world's fastest growing energy technology.

The PV industry is growing rapidly and new types of technologies become available each year as shown in table 3.

Table 3: Commercially available solar cell module types

Type of PV technology	Maximum cell efficiency	Module efficiency	Notes
Crystalline Silicon			
Monocrystalline	24%	11–17%	Fully mature technology: 35% of world production (2007)
Polycrystalline	20%	11–15%	Fully mature technology: 45% of world production (2007)
Ribbon	19%	7–13%	Fully mature technology
Thin Film			
Amorphous Silicon	13%	4–8%	Initial degradation in performance
Multi-junction Amorphous Silicon	12%	6-9%	Similar to Amorphous Silicon Flexible
Cadmium Telluride	17%	7-8.5%	
Copper Indium Gallium Selenium	19%	9-11%	
Organic Solar Modules	12%	3-5%	Uncommon
Other Types			
Hybrid HIT	21%	17%	Combined Amorphous and Crystalline Silicon

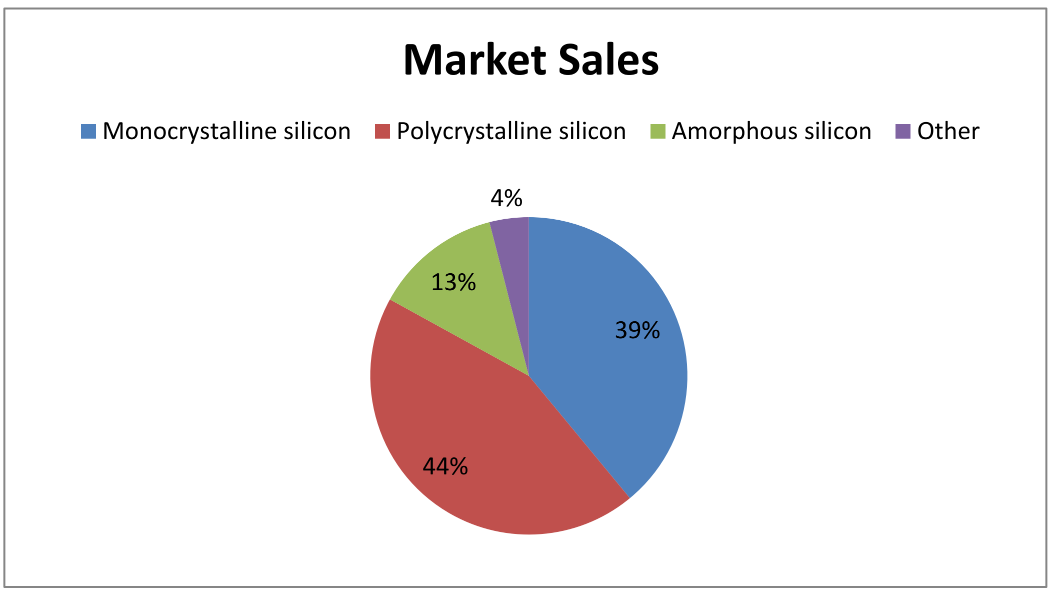
Source: HANKINS Mark. Stand-alone solar electric systems

The Greenpeace Advanced Scenario shows that by the year 2030, PV systems could be generating approximately 2 600 TWh of electricity around the world. This means that assuming a serious commitment is made to energy efficiency, enough solar power would be produced globally in 25 years' time to satisfy the electricity needs of almost 14% of the world's population.[12]

The range of solar cells spans differ in materials and structures in the quest to extract maximum power from the device while keeping the cost to the minimum. Crystalline silicon cells hold the largest part of the market. In order to reduce the costs, these cells are now often made from polycrystalline material, rather than from the more expensive single crystals. Crystalline silicon cell technology is well established and the modules have a long lifetime (20 years or more) and their best production efficiency is approaching 18%.

The figure 2 shows the shares of the different solar cells available on the market.

Fig. 2: Market share of the principal photovoltaic technologies



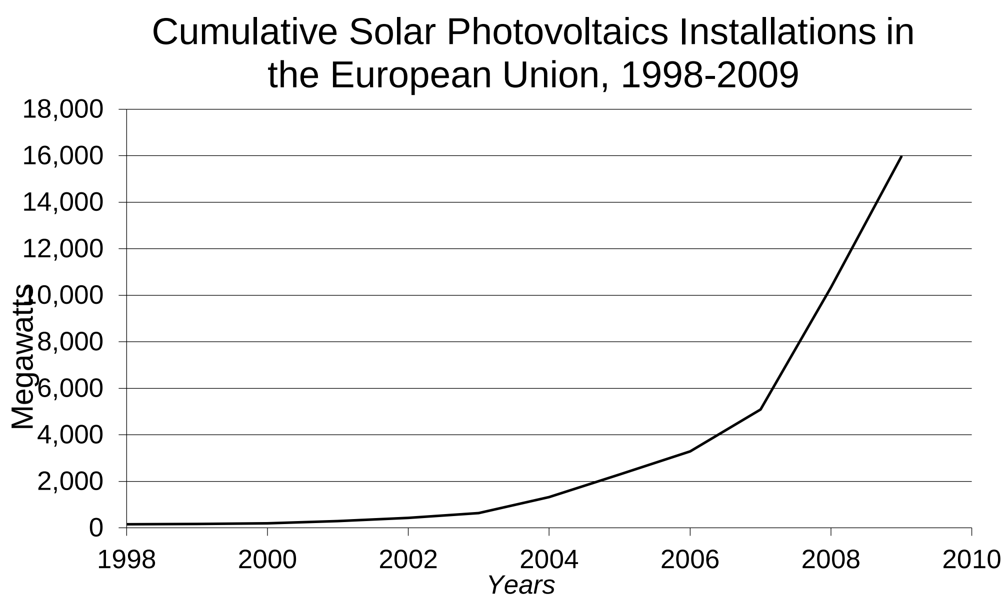
Source: PV Tech

[12] MILLER Frederic, VANDOME Agnes, McBREWSTER John. Solar Energy

The PV sector is expanding rapidly in many countries. About 5.56 GW of PV capacity were installed during 2008 making an increase of about 150% over the previous year and 7.3 GW in 2009 which brought the total installed capacity to 20.7 GW. In 2009, 68% of this was installed in the Czech Republic and Germany.[13]

The figure 3 shows the cumulative installed photovoltaic capacity in Europe.

Fig. 3: Cumulative installed Photovoltaic capacity in Europe for the years 1998 to 2009



Source: Earth Policy Institute

It is estimated that by 2050, PV will provide around 11% of global electricity production and reduce 2.3 gigatonnes of CO_2 emissions per year.[13]

[13] THORPE David. Solar Technology. The earthscan expert guide to using solar energy for heating, cooling and electricity

3.2.4 The Economic Viability of P.V

Solar radiation is free, but it can be expensive to set up a PV system capable of taking advantage of this free energy source. Conversely, energy from fossil fuels is not yet free, but the system using these energy sources are already well established, so at this point in time it is less expensive to continue using fossil fuels than to build new infrastructure to integrate renewable energy generators into the grid.

The costs associated with the individual components of the PV system need to be analyzed in order to estimate the full cost of the system. System costs will vary significantly depending on the area and the local PV market. The main costs associated with a PV system are as follows:

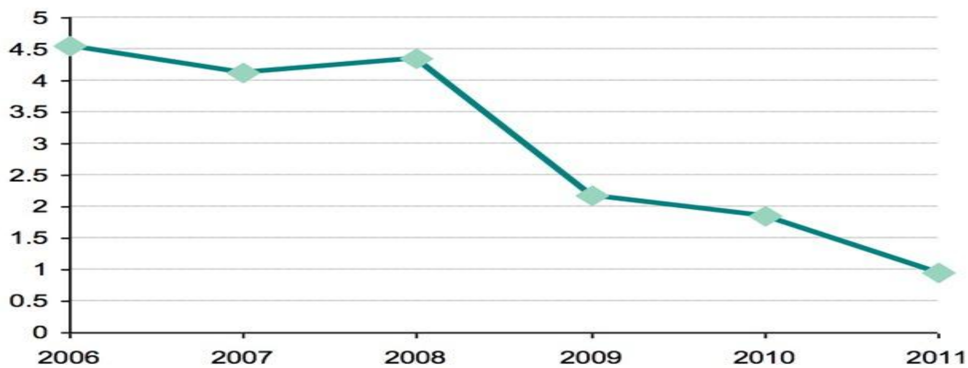
Capital costs: The upfront purchase of all system equipment including PV modules and balance of system equipment makes up approximately 80% of total system costs. The remaining 20% of system cost is for the actual installation.

Maintenance costs: 1% of system cost is comprised of maintenance costs. Maintenance should be undertaken every 6-12 months, if the modules and inverter have been installed correctly then maintenance costs should be minimal. The array should last at least 20 years, and most modules are covered by a 20-25 years warranty so if premature failure does occur it is often possible to replace or repair the modules free of charge.

Replacement costs: PV modules are expected to last at least 25 years and most system components are expected to last at least 20 years. Some system components may not last as long as the panels and will require replacement such as inverters, monitoring equipment, bypass diodes, cables etc. Protection from the elements and wildlife will increase the lifetime of this equipment and hence reduce these costs.

The costs of solar PV cells are falling by around 45% per year. China, one of the biggest PV cell producers has reduced the production costs by 4.5 times in just the last five years as shown in Figure 4.

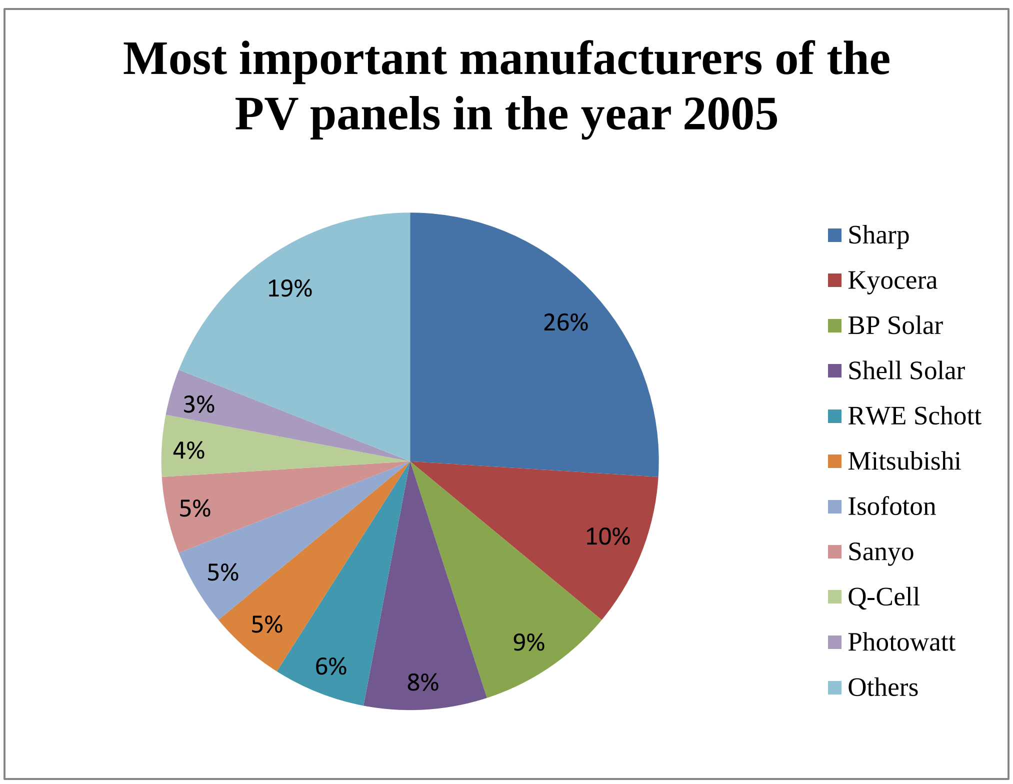
Fig. 4: As more modules are produced and sold, the cost per installed kWp falls



Source: The conversation. Newsflash: solar power costs are falling below fossil fuels

The figure 5 shows the most important manufacturers of the PV panels in the year 2005.

Fig. 5: Shares of the biggest producers of PV panels on the global production



Source: Photon International data. My own illustration

The production of photovoltaic cells started in the Czech Republic in 2005. The German company RWE-Schott has a plant situated in Valašské Meziříčí in Moravia, and the Japanese company Kyocera built a new factory near Kadaň.

3.2.5 Environmental Impact of PV

Photovoltaic systems are extremely environmentally friendly electricity producers. They convert solar radiation a primary energy source directly into final energy without the need for any fuel. In doing so, they produce neither emissions nor toxic waste nor noise. Malfunctions are not dangerous for people or the environment. The relatively large surface area required is only critical in certain circumstances because with PV systems on buildings in particular, the systems utilize existing surfaces and infrastructures.[14]

There are environmental impacts associated with the production, use and disposal of PV modules. The main impacts are related to the silicon production which is the main component of the solar panels. The silicon fuel cycle has inputs of energy, materials, requires capital equipment and each step also has potential hazards associated. The first step is a standard mining operation with associated hazards to the miners and inputs of diesel fuel and machinery.

The CO_2 emissions in the crystalline silicon PV technology production is around 400 000 tones per gigawatts/year of energy output.[15] For comparison, the most efficient coal plant emits 9 million tons of CO_2 per gigawatts/year, whilst a boiling water reactor nuclear plant emits 75 000 tons of CO_2 per gigawatts/year. The CO_2 emissions estimated for the various current PV cell technologies are shown in table 4.

[14] WELLER Bernhard, HEMMERLE Claudia, JAKUBETZ Sven, UNNEWEHR Stefan. Photovoltaics. Technology, architecture, installation

[15] MARKVART Tomas. Solar Electricity

Table 4: Carbon dioxide emitted in the production of PV modules (in units of kilotons per gigawatts/year)

Cell material	Production scale	Efficiency (%)	Lifetime (years)	CO_2
Monocrystalline silicon	Small	12	20	400
	Large	16	30	150
Polycrystalline silicon	Small	10	20	400
	Large	15	30	100
Thin-film silicon	Small	10	20	130
	Large	15	30	50

Source: MARKVART Tomas. Solar Electricity

Photovoltaic systems are almost entirely benign in operation and potential environmental hazards occur at the production and disposal stages. Silicon is a very stable material and its release into the environment poses no hazards. In the production of silicon cells the hazards are similar to those encountered in the microelectronics industry and monitoring and control procedures are well established for even the largest production rates envisaged.

4. Results

4.1 Legislative Background

The Energy Regulatory Office (ERO) was established on 1st January 2001 by the Act No. 458/2000 Coll. of 28th November 2000. The main function of the ERO is the implementation of regulations in the energy sector.[16] Other functions of the ERO include: price regulation, promoting the use of renewable and secondary energy sources and combined heat and power, protect the interests of customers and consumers and to promote competition in the energy sector.

[16] Energy Regulatory Office

The ERO is in charge of establishing the purchase prices for electricity from renewable sources to create conditions for fulfillment of the indicative target for the share of electricity production from renewable sources in the gross consumption of electricity, which equals to 8 % in 2018.[17]

A 15 year period of recovery of initial investment should be achieved under the condition of compliance with the technical and economic parameters, including in particular the costs of an installed unit of capacity, efficiency of use of the primary energy contents in the renewable source and the period of use of the plant.[18]

Amendments of the Act No. 180/2005 Coll. established that the guaranteed purchase prices to new plants for the next year cannot drop a maximum of 5% from the state support of electricity from renewable energy sources. However this change does not apply for power plants that achieve their payback period in less than 11 years.

The later act No. 330/2010 Coll. of 3rd November 2010 introduced new provisions to the Energy Act establishing that Guaranteed Prices will be provided only to power plants with installed capacity lower than 30 kWp which are located on a roof or building integrated.

The Act No. 402/2010 Coll. came into legal force on 1st January 2011 and introduced some modifications to the Act No. 180/2005 Coll. on the Promotion of Electricity Production from Renewable Sources, establishing a levy of 26% for power plants granted subsidies in form of Guaranteed Prices and a levy of 28% for plants receiving Green Bonuses, only the PV power plants with installed capacity lower than 30 kWp are exempt to pay the levy. The levy should be paid by the power plants launched in the years 2009 and 2010 over the total electricity generated from the 1st January 2011 to the 31st December 2013.[19]

17 Act on Promotion of Use of Renewable Sources, Article 6, Paragraph 1 a)
18 Act on Promotion of Use of Renewable Sources, Article 6, Paragraph 1 b)
19 Act No. 402/2010 Coll. Title III

The Public Notice No. 140/2009 Coll. established an increase in the FITs and Green Bonuses for electricity produced from PV by a minimum of 2% and a maximum of 4% per year and these subsidies shall be paid to the energy producer during the expected life period of the power plant.[20]

The expected life time of a PV power plant was established under the Public Notice No. 475/2005 Coll. to be 15 years, this period was extended to 20 years according to the Public Notice No. 364/2007 Coll. in legal force since 1st January 2008.[21]

4.2 State Subsidies

Under the Act No. 180/2005 Coll. on the Promotion of Use of Renewable Sources, PV energy is among the supported renewable sources. The state provides two types of support:

1. Guaranteed Price: The distribution system operator is obliged to buy all the electricity generated at a guaranteed purchase price determined by ERO in the price decisions.
2. Green Bonus: Consume part of the produced electricity and supply the rest to the grid.

Feed in tariffs and green premiums cannot be combined. Producers can opt for one of the two methods of support for renewable electricity once a year.

PV power plants that have been granted subsidies in form of Guaranteed Prices sell to the distribution system operators all the generated electricity. These producers that are supported with Guaranteed Prices instead of Green Bonuses generally run big PV power plants with IC superior to 30 kWp without using the produced electricity, the power plant is rather a business.

[20] Public Notice No. 140/2009 Coll. Article 2, Paragraph 8
[21] Public Notice No. 475/2005 Coll. Appendix 3

The system of Green Bonus is provided in the Act No. 180/2005 on support for electricity generation from renewable energy resources, it is a premium paid for the total electricity generated by a PV power plant. When a renewable electricity producer opts for support in the green premium regime, the distribution system operators are legally obliged to pay the Green bonus to the producer for all the generated electricity, regardless whether the electricity is self-consumed or supplied to the grid.[22] The level of the green premium in CZK/MWh is adjusted on annual basis for each type of renewable sources, and published in the EROs price decisions. The Green Bonus support scheme is perfect for producers that have the possibility to consume part of the produced electricity such as: households, administrative buildings and industries.

In the case of support for electricity generation from renewable sources in the form of feed in tariffs, the regional distribution system operator is obliged to buy the entire quantity of the renewable electricity from its producer. In the case of support in the form of green premiums, the producer itself has to find its customers for the electricity it produces. Feed in tariffs and green premiums are at all times paid to the producer by the regional distribution system operator depending on to which system the producer is connected.

Under public notice no. 150/2007, feed in tariffs and green premiums are applied throughout the service life of electricity generating plants. Feed in tariffs are annually increased with regard to the producer’s price index, by at least 2% but no more than 4% and the green premium is established by ERO in relation to the consumer price of electricity.

4.3 Beginning of Photovoltaic era in the Czech Republic

The installation of PV facilities started in CZ after the 1st June 2005 when the Act No. 180/2005 Coll. on Promotion of Electricity Production from Renewable Energy Sources came into legal force. The first solar installations were small and served to provide electricity in regions not connected to any distribution system operator.

[22] Act on Promotion of Use of Renewable Sources, Article 4, Paragraph 7

Before the Act No. 180/2005 Coll. a general support was provided to energy producers from renewable sources, however, this initial support did not offer enough guaranties to attract investors to invest in the renewable sources of energy.[23] From the years 2002 to 2004 the electricity generated from renewable sources had a minimal purchase price of 6, - CZK/kWh and the price increased to 6.04, -CZK/kWh for the year 2005. PV was the most supported of all types of renewable energy sources, however, it represented less than 0.1% of all renewable energy sources in Czech Republic in 2004.[24]

In the very beginning the initial costs for installing solar facilities were very high and their efficiency low, besides, there wasn't a systematic support scheme for PV investors. The initial conditions were not favorable for the PV industry to develop.

4.4 First stage of State Support: 2006, 2007

The Act No. 180/2005 Coll. on Promotion of Use of Renewable Sources established a support scheme that did not existed before, introducing significant changes in the PV industry. The main provisions introduced in relation to PV were the period of recovery of investment of 15 years, the purchased prices guaranteed to new facilities for the next year not lower than 95% of the value of the present year (not applicable for PV power plants with a payback period inferior to 11 years), the subsidies in form of Guaranteed Prices or Green Bonus and an increase in the purchase prices per year in relation to the consumer price index. The act also fixed the Guaranteed purchase prices for the year 2006 in 6.28 CZK/kWh for PV power plants launched before 1st January 2006 and to 13.2 CZK/kWh for facilities launched afterwards. Green bonus prices were set 0.61 CZK/kWh lower.[25]

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[23] ERO, The 2005 Report on the Activities and Finances of the ERO, p. 26

[24] ERO, The 2004 Report on the Activities and Finances of the ERO, p. 20

[25] ERO, Price Decision No. 10/2005.

4.5 First Stage of the Solar Boom: 2008, 2009

During this period, the interest to invest in solar power increased dramatically due to a number of factors:

1. Facilities launched from 1st January 2008, the support was extended to 20 years according to the Public Notice No. 364/2007 Coll.
2. Fall in the rate CZK/EUR. In 2005 the rate was around 29 CZK/EUR. However, the average rate for 2008 and 2009 was only 25 CZK/EUR with minimum of 23 CZK/EUR in July 2008.
3. Global increase in the production of crystalline silicon and decrease of the demand in Spain made the price for solar panels go down.

The combination of extended guarantee of subsidies and decrease in the initial investment were the initial forces that triggered the "solar boom" in the next years.

4.6 Peak of the Boom: 2010

In an attempt to prevent the massive investment in solar energy, ERO reduced the purchase prices by 5% as stipulated under the current legislation. A "Stop Status" was installed on February 2010 the distributor companies stopped accepting new application for connection to the grid, because the electricity produced from renewable sources are unstable and could represent a threat to the grid. Despite the "Stop Status" solar boom reached its peak in 2010 since PV power plants launched in this year had granted purchase prices of 12.15 CZK/kWp (plants larger than 30 kWp) or 12.25 CZK/kWp (plants smaller than 30 kWp). During the solar boom, the number of PV facilities reached to a total of 12,861 installations on the 1st January 2011.

4.7 Recovery after the Solar Boom: 2011, 2012

In June 2009 ERO proposed to the Parliament to make some legislation changes and introduce radical cuts in the purchase price because the development of PV was uncontrollable.

The Act No. 137/2010 Coll. came into legal force on the 1st January 2011, under this act, only the power plants with IC<30 kWp located on the roof or building integrated were eligible to claim incentives and as of January 2011, a 26% levy from the FiT and a 28% levy from Green Bonuses are applied for three years (2011—2013) on solar power plants commissioned in 2009-10. Rooftop and building integrated solar devices with an installed capacity of up to 30 kW are exempted from these levies.

At the end of 2011, the share of energy from RES in the Czech Republic reached 10.55%. With the Czech Republic still 3% away from meeting its EU targets, a number of opportunities for new investment were available and, despite a cooling off in the PV sector, investment in renewable energy projects in the Czech Republic continued in 2012.

4.8 Present Situation: 2013, 2014

The table 5 shows the Guaranteed purchase prices and Green Bonuses stated by the Energy Regulatory Office (ERO) for the year 2013 under the Price Decision No. 4/2012 from the 26th November 2012. The support in form of Green Bonus was set in 2.86, - CZK/kWh for installations 0-5 kWp and 2.28, - CZK/kWh for installations 5-30 kWp. The price is approximately 0.55 CZK higher. The ERO also announced that the support would be further reduced starting from 1st July 2013.[26]

[26] GS Energy. The best way to purchase PV panels and inverters

Table 5: Purchase prices of electricity produced from PV based on Appropriate Legislation

Supported source	Date of commissioning		Installed capacity [kW]		Fixed price	
	From	To	From	To	Feed-in tariff	Green bonuses
Electricity produced from solar energy	1.1.2012	31.12.2012	0	30	6,284	5,734
	1.1.2013	30.6.2013	0	5	3,41	2,86
	1.1.2013	30.6.2013	5	30	2,83	2,28
	1.7.2013	31.12.2013	0	5	2,99	2,44

Source: GS Energy. The best way to purchase PV panels and inverters

The global solar industry would not have been able to develop in the way it has without government financial and policy support. An amendment to the renewable energy subsidies law was recently approved, under the Act No. 165/2012 Coll. introducing significant changes from 1 January 2014, including:

1. The end of subsidies for solar energy produced in facilities opened after 31 December 2013.
2. The termination of subsidies for facilities whose ownership structure is non-transparent (i.e. Czech companies with anonymous shares or foreign companies that fail to disclose the identity of their beneficial owners).
3. The extension of the period of validity of the special tax on sale by energy producers (but not re-sellers) of solar energy produced in facilities opened before 31 December 2010, though the rate will be decreased from 26 to 10%.[27]

[27] Emerging Europe's Energy Sector: A period of change. Energy law update

Renewable energy facilities that begin operation after 31 December 2013 will not be eligible to receive the feed-in tariff (FiT), or any other subsidy payments. This includes small and residential systems under 30kWp, which were the last form of state-supported PV installation. Owners of solar power plants installed since 2010 will now be required to pay a 10% tax for the full life of each power station. The tax was originally planned to be levied at 26%.

However it is unlikely that the introduced changes in the energy sector would mean a complete end to the installation of new solar power capacity in the Czech Republic. While electricity generation would no longer be a profit-making industry, building renewable energy facilities would still save money on energy costs that could still offer returns. Rather, the law would mean that electricity costs could be saved and that despite the lack of subsidy, the electricity produced by photovoltaic installations could potentially still give a return on investment around halfway through the expected 30-year lifespan of a PV plant.

4.9 Analysis of the Payback Period and Results

In order to make a proper analysis of the Payback Period, the first step was to estimate the guaranteed prices for all the PV power plants connected to the grid taking in consideration the influence of the current legislation in every period.

Table 6: Estimate of the development of Guaranteed Price for PV power plants over their lifespan based on appropriate legislation from the years 2006-2012

		Launch	IC (kWp)	2006	2007	2008	2009	2010	2011	2012
Guaranteed Price [CZK/kWh]	**Real**	**Before 2006**		**6,28**	**6,41**	**6,57**	**6,71**	**6,85**	**6,99**	**7,13**
	Theoretical				6,41	6,54	6,70	6,84	6,99	7,13
	Real	**2006**		**13,20**	**13,46**	**13,80**	**14,08**	**14,37**	**14,66**	**14,96**
	Theoretical				13,46	13,73	14,08	14,36	14,66	14,95
	Real	**2007**			**13,46**	**13,80**	**14,08**	**14,37**	**14,66**	**14,96**
	Theoretical					13,73	14,08	14,36	14,66	14,95
	Real	**2008**				**13,46**	**13,73**	**14,01**	**14,30**	**14,59**
	Theoretical						13,73	14,00	14,27	14,59
	Real	**2009**	**<30**				**12,89**	**13,15**	**9,93**	**10,13**
	Theoretical							13,15	9,93	10,13
	Real		**>30**				**12,79**	**13,05**	**9,86**	**10,06**
	Theoretical							13,05	9,85	10,05
	Real	**2010**	**<30**					**12,25**	**9,25**	**9,44**
	Theoretical								9,25	9,44
	Real		**>30**					**12,15**	**9,18**	**9,36**
	Theoretical								9,17	9,36
	Real	**2011**	**<30**						**7,50**	**7,65**
	Theoretical									7,65
	Real		**>30 <100**						**5,90**	**6,02**
	Theoretical									6,02
	Real		**>100**						**5,50**	**5,61**
	Theoretical									5,61
	Real	**2012**	**<30**							**6,16**
	Theoretical									

Source: My own computation

The figures in table 6 show the estimate of the purchase prices according to the legislation changes. The prices are computed as 2% annual increase, the increase can be between 2-4%, but usually around the lower value. The PV power plants launched in 2009 and 2010 are taxed by 26 % from 2011-2013, plants smaller than 30 kWp are excluded from the levy. For plants launched from 2005-2007, 15 years support is guaranteed under Public Notice No. 475/2005 Coll. and Purchased prices to new facilities for the next year cannot be lower than 95% of the value of the present year. (Not applicable for PV power plants with a payback period inferior to 11 years).

Table 7: Estimate of the development of Guaranteed Price for PV power plants over their lifespan based on appropriate legislation from the years 2013-2019

Guaranteed Price [CZK/kWh]	Launch	IC (kWp)	2013	2014	2015	2016	2017	2018	2019
Real	**Before 2006**								
Theoretical			7,27	7,42	7,57	7,72	7,87	8,03	8,19
Real	**2006**		**15,29**						
Theoretical			15,26	15,56	15,88	16,19	16,52	16,85	17,18
Real	**2007**		**15,28**						
Theoretical			15,26	15,56	15,88	16,19	16,52	16,85	17,18
Real	**2008**		**14,89**						
Theoretical			14,88	15,18	15,48	15,79	16,11	16,43	16,76
Real	**2009**	**<30**	**10,35**						
Theoretical			10,33	14,24	14,52	14,81	15,11	15,51	15,72
Real		**>30**	**10,27**						
Theoretical			10,26	14,14	14,42	14,71	15,00	15,30	15,61
Real	**2010**	**<30**	**9,63**						
Theoretical			9,62	13,27	13,54	13,81	14,08	14,36	14,65
Real		**>30**	**9,57**						
Theoretical			9,55	13,16	13,42	13,69	13,96	14,24	14,53
Real	**2011**	**<30**	**7,82**						
Theoretical			7,80	7,96	8,12	8,28	8,45	8,62	8,79
Real		**>30 <100**	**6,16**						
Theoretical			6,14	6,26	6,39	6,52	6,65	6,78	6,92
Real		**>100**	**5,74**						
Theoretical			5,72	5,84	5,95	6,07	6,19	6,32	6,44
Real	**2012**	**<30**	**6,30**						
Theoretical			6,28	6,41	6,54	6,67	6,80	6,94	7,08

Source: My own computation

The figures in table 7 show the purchase prices according to the legislation changes between the years 2013-2019. For PV power plants launched since 2008 a 20 year support is assumed under Public Notice No. 364/2007 Coll. Since March 2011 only PV power plants of IC < 30 kWp situated on a roof or on a perimeter wall of a building are supported. Under the Act No. 402/2010 Coll. of 14th December 2010 a levy is imposed on PV plants launched between 1st January 2009 and 31st December 2010 on the electricity produced between 1st January 2011 and 31st December 2013. The levy was set as 26 % for guaranteed price support and 28 % for Green bonus support. Power plants of installed capacity lower than 30 kWp which are placed on a roof or building integrated are exempt from the levy.

The analysis of the payback period was done using as an example an existing PV power plant launched in the year 2010 and estimated its payback period in different years of launch to demonstrate the influence of the current legislation in a PV plant with the same technical parameters from the beginning of the PV development in the Czech Republic.

The sample PV power plant has the following parameters:

- IC: 1,750 kWp
- Time of launch: 2010
- Type of production: Decentralized
- Annual decrease of performance: 90 % after 10 years, 80 % after 25 years
- Expected annual supply to the grid: 1,670.3 MWh

Table 8: Sample PV power plant launched in 2006

Launch of 1st January 2006

Year No.	Year	Performance	Supply to the Grid [MWh]	PP [CZK/kWh]	Production Premium ['000s CZK]	Sales to the Grid ['000s CZK]	Operating costs ['000s CZK]	Cumulative Cash Flow
1	2006	100,0%	1.670,30	13,20	45,10	22.047,96	1.322,88	-278.465,02
2	2007	99,0%	1.653,60	13,46	44,65	22.257,42	1.335,44	-257.498,40
3	2008	98,0%	1.636,89	13,80	44,20	22.589,14	1.355,35	-236.220,42
4	2009	97,0%	1.620,19	14,08	43,75	22.812,29	1.368,74	-214.733,12
5	2010	96,0%	1.603,49	14,37	43,29	23.042,12	1.382,53	-193.030,23
6	2011	95,0%	1.586,79	14,66	42,84	23.262,27	1.395,74	-171.120,85
7	2012	94,0%	1.570,08	14,96	42,39	23.488,43	1.409,31	-148.999,34
8	2013	93,0%	1.553,38	15,29	41,94	23.751,16	1.425,07	-126.631,31
9	2014	92,0%	1.536,68	15,56	41,49	23.910,68	1.434,64	-104.113,78
10	2015	91,0%	1.519,97	15,88	41,04	24.137,17	1.448,23	-81.383,80
11	2016	90,0%	1.503,27	16,19	40,59	24.337,94	1.460,28	-58.465,54
12	2017	89,3%	1.491,58	16,52	40,27	24.640,87	1.478,45	-35.262,86
13	2018	88,7%	1.481,56	16,85	40,00	24.964,22	1.497,85	-11.756,49
14	**2019**	**88,0%**	**1.469,86**	**17,18**	**39,69**	**25.252,26**	**1.515,14**	**12.020,33**
15	2020	87,3%	1.458,17	17,53	39,37	25.561,75	1.533,71	36.087,75

Source: My own computation

If the PV power plant had been launched in the year 2006, the initial investment would be 299 235 200, - CZK and eligible for a decentralized production premium (0.027 CZK/kWh) after discounting the operating costs of 6.0% of sales, then the PV power plant would achieve a Payback Period of 14 years, however the Guaranteed price would finish after 15 years as shown in table 8.

Table 9: Sample PV power plant launched in 2010

Launch on 1st January 2010

Year No.	Year	Performance	Supply to the Grid [MWh]	PP [CZK/kWh]	Production Premium ['000s CZK]	Sales to the Grid ['000s CZK]	Operating costs ['000s CZK]	Cumulative Cash Flow
1	2010	100,0%	1.670,30	12,15	45,10	20.294,15	1.217,65	-130.496,01
2	2011	99,0%	1.653,60	9,18	44,65	15.180,02	910,80	-116.182,14
3	2012	98,0%	1.636,89	9,36	44,20	15.321,33	919,28	-101.735,89
4	2013	97,0%	1.620,19	9,57	43,75	15.505,23	930,31	-87.117,24
5	2014	96,0%	1.603,49	13,16	43,29	21.101,90	1.266,11	-67.238,15
6	2015	95,0%	1.586,79	13,42	42,84	21.294,65	1.277,68	-47.178,33
7	2016	94,0%	1.570,08	13,69	42,39	21.494,42	1.289,67	-26.931,19
8	2017	93,0%	1.553,38	13,96	41,94	21.685,17	1.301,11	-6.505,18
9	**2018**	**92,0%**	**1.536,68**	**14,24**	**41,49**	**21.882,27**	**1.312,94**	**14.105,64**
10	2019	91,0%	1.519,97	14,53	41,04	22.085,21	1.325,11	34.906,77
11	2020	90,0%	1.503,27	14,82	40,59	22.278,46	1.336,71	55.889,11
12	2021	89,3%	1.491,58	15,11	40,27	22.537,74	1.352,26	77.114,86
13	2022	88,7%	1.481,56	15,42	40,00	22.845,60	1.370,74	98.629,72
14	2023	88,0%	1.469,86	15,73	39,69	23.120,96	1.387,26	120.403,11
15	2024	87,3%	1.458,17	16,04	39,37	23.389,08	1.403,34	142.428,22

Source: My own computation

If the PV power plant had been launched in the year 2010, the initial investment would be 149 617 600, - CZK and eligible for a decentralized production premium (0.027 CZK/kWh) after discounting the operating costs of 6.0% of sales, then the PV power plant would achieve a Payback Period of 9 years, and it would make a profit for the next 11 years as shown in table 9. These figures correspond to the period of the Solar Boom were large support was guaranteed to solar energy (12.15, -CZK for plants of IC>30 kWp and 12.25, -CZK for plants of IC<30 kWp).

Table 10: Sample PV power plant launched in 2011

Launch on 1st January 2011

Year No.	Year	Performance	Supply to the Grid [MWh]	PP [CZK/kWh]	Production Premium ['000s CZK]	Sales to the Grid ['000s CZK]	Operating costs ['000s CZK]	Cumulative Cash Flow
1	2011	100,0%	1.670,30	5,50	45,10	9186,65	551,20	-111013,55
2	2012	99,0%	1.653,60	5,61	44,65	9276,68	556,60	-102248,83
3	2013	98,0%	1.636,89	5,74	44,20	9395,77	563,75	-93372,60
4	2014	97,0%	1.620,19	5,84	43,75	9461,92	567,71	-84434,66
5	2015	96,0%	1.603,49	5,95	43,29	9540,75	572,45	-75423,06
6	2016	95,0%	1.586,79	6,07	42,84	9631,78	577,91	-66326,33
7	2017	94,0%	1.570,08	6,19	42,39	9718,81	583,13	-57148,26
8	2018	93,0%	1.553,38	6,32	41,94	9817,36	589,04	-47878,01
9	2019	92,0%	1.536,68	6,44	41,49	9896,19	593,77	-38534,10
10	2020	91,0%	1.519,97	6,57	41,04	9986,22	599,17	-29106,01
11	2021	90,0%	1.503,27	6,70	40,59	10071,91	604,31	-19597,82
12	2022	89,3%	1.491,58	6,84	40,27	10202,39	612,14	-9967,30
13	2023	88,7%	1.481,56	6,98	40,00	10341,26	620,48	-206,52
14	**2024**	**88,0%**	**1.469,86**	**7,11**	**39,69**	**10450,73**	**627,04**	**9656,86**
15	2025	87,3%	1.458,17	7,26	39,37	10586,33	635,18	19647,38
16	2026	86,70%	1.447,50	7,40	39,08	10711,50	642,69	29755,27
17	2027	86,0%	1.436,40	7,55	38,78	10844,82	650,69	39988,19
18	2028	85,3%	1.425,30	7,70	38,48	10974,81	658,49	50342,99
19	2029	84,7%	1.414,10	7,86	38,18	11114,83	666,89	60829,11
20	2030	84,0%	1.403,00	8,01	37,88	11238,03	674,28	71430,74

Source: My own computation

If the PV power plant had been launched in the year 2011, the initial investment would be 199 694 100, - CZK and eligible for a decentralized production premium (0.027 CZK/kWh) after discounting the operating costs of 6.0% of sales, then the PV power plant would achieve a Payback Period of 14 years and it would make a profit for the next 6 years as shown in table 10.

5. Conclusions

The study of the legislation towards PV in the Czech Republic showed the consequent changes after the year 2005 when the Act No. 180/2005 Coll. on the Promotion of Electricity Production from Renewable Energy Sources was implemented and the influence of further amendments to the mentioned act that affected the development of photovoltaic power plants.

This paper provides a theoretical background about PV showing the importance of the utilization of renewable resources of energy due to the scarcity of fossil fuels and their negative effects on the environment. After, a chronological study of the relevant legislation and other factors influencing the development of photovoltaic power plants was conducted. The most important part of this thesis is the estimation of the purchase price paid to the producers of electricity from PV taking into account the launch time and the installed capacity.

The analysis of payback periods for a PV plant with the same technical structure in different launch years was done. The payback period resulting for each year in accordance with Act of Promotion of Use of Renewable Sources shows that purchase prices in the year 2010 during the peak of the Boom were not according to the Act, but ERO could not do much about it as that same Act forbids making purchase prices drop more than 5% per year.

The final conclusion to this thesis is that the ERO acted according to the law in an attempt to prevent the "Solar Boom" because the mentioned office set the purchase prices as low as it could under the existing legislation, therefore without a legislative change, ERO could only lower the purchase prices by 5% per year. It was the government who reacted too slowly to introduce radical cuts in the purchase prices of the electricity produced from PV.

The positive aspect of the "Solar Boom" is that it allowed the Czech Republic to achieve the EU targets for the share of electricity produced form renewable sources and the negative aspect is that the "Solar Boom" promoted the inversion of capital in the solar business in a period where large subsidies were granted leading investors to make a profit.

6. List of Resources

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