Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

Bachelor Thesis

The Economy of Solar Energy in the Czech Republic

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Thesis title

The economy of solar energy in the Czech Republic

Objectives of thesis

The objective of this thesis is to analyse and clarify the unstable development of solar energy policy in the Czech Republic from 2005 on, taking special regard on the development of solar power purchase price.

Methodology

1) Record of the development of solar power purchase price in time, considering factors that affect purchase price. Output: MS Excel table that estimates the purchase price for the next years based on all the relevant factors.
2) Verification of the output from 1) by comparison with real purchase price achieved by real solar power plants.
   2.1) Adjusting 1) according to the results from 2)
3) Analysis of the relation between purchase price policy and number of solar power plants built, resp. launched.
4) Summary of the development of solar energy policy in the Czech Republic, comment on its impact on solar businesses.

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Recommended information sources

Energy Regulatory Office's Price Decisions

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ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE Provozně ekonomická fakulta

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Statutory Declaration

I declare that I have worked out my Bachelor Thesis "The Economy of Solar Energy in the Czech Republic" by myself under the supervision of the supervisor using literature and other information resources which are cited in the Thesis and mentioned at the end of the Thesis. As the Author of the Thesis I further declare that I did not breach copyright of third parties in connection with its creation.

Prague, 30th March 2012 ______________________________

Ondřej Průša

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The Economy of Solar Energy in the Czech Republic

Ekonomika solární energie v České republice

Summary

The Bachelor Thesis provides an analysis of the development of photovoltaics in the Czech Republic after 2005 with special regard on the evolution of the regulatory policy and purchase price policy as a means of the regulatory policy. After providing theoretical background of the issue of solar power and photovoltaics, thorough chronological study of relevant legislation and other factors that influenced the progress of photovoltaics follows. The development of photovoltaic power plants and appropriate regulatory policy is analysed.

Subsequent analysis of the purchase price policy includes estimates of the future development of purchase prices for existing photovoltaic power plants, taking all the factors that affect the purchase price into account. The estimate is compiled in a summarizing table. The most important part of the analysis is then evaluation of the purchase price policy. It is performed by a computation of payback periods of a sample photovoltaic power plant for different years of launch which were significant from the perspective of the development of the regulatory policy. The payback periods are then compared with appropriate legislation. Final discussion suggests reasons of negative consequences of the regulatory policy and measures that should have been taken in order to mitigate massive expansion of photovoltaics.

Keywords: photovoltaics, photovoltaics in the Czech Republic, purchase price of electricity, feed-in tariff, regulation of photovoltaics, regulatory policy, renewable energy sources policy, solar boom, development of purchase price

Souhrn

Bakalářská práce poskytuje analýzu rozvoje fotovoltaiky v České republice po roce 2005 s důrazem na vývoj regulační politiky a politiky výkupní ceny jakožto prostředku regulační politiky. Po úvodu do teorie solární energie a fotovoltaiky následuje zevrubná chronologická studie relevantní legislativy a dalších faktorů, které ovlivnily rozvoj fotovoltaiky. Je zanalyzován vývoj fotovoltaických elektráren a příslušné regulační politiky.

Následná analýza politiky výkupní ceny zahrnuje odhady budoucího vývoje výkupních cen pro stávající fotovoltaické elektrárny, v němž jsou zohledněny všechny faktory ovlivňující výši výkupní ceny. Vývoj cen je shrnut v souhrnné tabulce. Nejdůležitější částí analýzy je pak zhodnocení politiky výkupní ceny. Je provedeno výpočtem dob návratnosti investice pro vzorovou fotovoltaickou elektrárnu pro vybrané roky spuštění významné z hlediska vývoje regulační politiky. Doby návratnosti jsou dále porovnány s příslušnou legislativou. Závěrečná diskuze nadnáší příčiny negativních důsledků regulační politiky a opatření, která mohla pomoci zmírnit masivní boom fotovoltaiky.

Klíčová slova: fotovoltaika, fotovoltaika v České republice, výkupní cena elektřiny, feed-in tarif, regulace fotovoltaiky, regulační politika, politika obnovitelných zdrojů energie, solární boom, vývoj výkupní ceny

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List of Used Acronyms

CEZ – ČEZ, a. s.

CR – Czech Republic

CSP - Concentrated solar power

CZK – Czech koruna, code of the Czech currency

e.g. – *exempli gratia*, for example

ERO - Energy Regulatory Office

EU – European Union

EUR – EURO, code of the currency of the eurozone

IC – Installed capacity

i.e. - *id est*, that is

kWh – Kilowatt hour

PP – Purchase price

PV – Photovoltaics, photovoltaic

PVPP – Photovoltaic power plant

RE – Renewable energy

RES – Renewable energy source(s)

Wp – Watt-peak

1. Introduction

Conventional non-renewable sources of energy are exhaustible and their depletion is inevitable. It is common sense that sooner or later, the energy mix of the whole world will have to consist mostly of renewable energy sources. Solar energy is a resource in which many scientists see the future of the energy sector. Radiation from the Sun is a free, relatively inexhaustible source of energy. Even if contemporary solar power plants cannot compete with fossil fuels from the perspective of costs of electricity, solar sector (mostly represented by photovoltaics) is growing fast and its ability to compete increases.

By now PVPPs are not efficient enough to operate without subsidies by state. Financial support from the state is not only good to promote the share of renewables in the energy mix. Subsidies boost demand for PVPP components and thus indirectly support technological progress which will lead to self-sufficiency of PV. This is the reason why regulatory policies in this field are truly important.

However, the development of the support scheme for PV in the CR has been rather complicated and its benefits are disputable. In 2010, the Czech Republic was the No. 3 market for PV from the global perspective reaching almost 1.5 GWp of new PV installations connected to the grid. In the next year the country disappeared from the PV market, connecting less than 10 MWp additional capacity.[1]

Czech regulatory policy suddenly got out of control and resulted in a solar boom. For several years, PV became a profitable business for investors. However, after an attempt to mitigate uncontrollable expansion, it turned out to be destructive for many small businesses. Unrestrained development of PV had significant impacts on landscape, public and governmental attitude towards PV and RES in general, employment and know-how. However, rather than analysing the impacts, this Thesis focuses on causes of the boom, i.e. above all on regulatory policy which enabled the boom.

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[1] EUROPEAN PHOTOVOLTAIC INDUSTRY ASSOCIATION. **Market Report 2011**

2. Objectives and Methodology of the Thesis

2.1. Objectives

This Thesis aims to provide an in-depth analysis and evaluation of the regulatory policy of PV in the Czech Republic in the last decade, particularly after 2005. After providing sufficient theoretical background of the issue of PV, a thorough study of the development of PVPPs and appropriate regulatory policy follows. The work aims to analyse the relevant legislation and other factors that influence the progress of PV.

Special regard is taken on analysis of the PP paid to the producers of electricity generated by PVPPs. Future development of the PPs paid to existing PVPPs is estimated as well.

The subsequent objective is to evaluate regulatory policy using data provided by a typical power plant launched in the period of the solar boom. Discussion on the results tries to suggest how the regulatory policy should have been adjusted in order to prevent massive expansion of PV.

2.2. Methodology

A study of relevant legislative framework for renewable resources and PV in particular was the first step in the analysis of the regulatory policy. Types of support schemes and various factors that affect PP were then analysed. A thorough chronological research of the progress of the regulatory policy was performed. Direct results of the policy were continuously illustrated by information on the progress of PVPPs.

Based on the findings of the analysis of the regulatory policy and its development, future values of PPs of electricity from all existing PVPPs connected to the grid were estimated. These values were compiled in a summarizing table.

Subsequently, correctness of the regulatory policy was evaluated by computation of payback periods for PVPPs launched in various years. Payback periods were computed with use of data of an existing power plant and are therefore highly reliable. Resulting payback periods were then compared with a payback period value that the PVPPs should achieve under an appropriate law.

3. Literature Review

3.1. Terminology and Definitions

This Chapter presents overview of key terminology used in the Thesis and corresponding definitions. The terminology is ordered chronologically.

ČEPS, a.s. is the only Czech transmission system operator.

ČEZ, a. s. is a dominant producer of electricity in CR, parent company of CEZ Group, a conglomerate of 96 companies involved in electricity generation, distribution and trade.

Competitiveness, respectively *"generation value competitiveness"* is defined as *"the moment at which, in a specific country, adding photovoltaics to the generation portfolio becomes equally attractive from an investor's point of view to investing in a traditional and normally fossil-fuel based technology."*[2] This definition assumes no support schemes for renewable energy sources involved. Increase in energy prices, improved efficiency of solar panels and decrease in start-up costs of solar power plants can be expected. Under these assumptions, generation value competitiveness could be reached in Italy already in 2014 thanks to favourable climatic conditions and in most of other European countries by 2020.[3]

Distribution system operator (distribution company, distributor) is a company that mediates physical distribution of the electricity from the producers to the customers. Since 2006, three distribution companies operate in the CR and their activity is regionally separated – in other words, the distributor is given and cannot be changed within a region.

In the CR, CEZ Distribuce, a.s. operates in Plzen Region, Karlovy Vary Region, Usti nad Labem Region, Central Bohemia Region, Liberec Region, Hradec Kralove Region, Pardubice Region, Olomouc Region, Moravskoslezky Region and partly in Zlin

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[2] EUROPEAN PHOTOVOLTAIC INDUSTRY ASSOCIATION, **Solar Photovoltaics Competing in the Energy Sector – On the Road to Competitiveness**, p. 20

[3] EUROPEAN PHOTOVOLTAIC INDUSTRY ASSOCIATION, **Solar Photovoltaics Competing in the Energy Sector – On the Road to Competitiveness**, p. 28

and Vysocina Region as well.[4] E.ON Distribuce, a.s. distributes electricity in South Bohemia and South Moravia and PREdistribuce, a.s. operates in Prague and Roztoky u Prahy. The regional division of the distributors is graphically depicted in Supplement No. 7.

Efficiency of a solar panel shows the percentage rate of the transformation of solar energy hitting the panel into the power the panel produces. If a panel receives 100 W of solar energy and produces the power of 15 W, its efficiency is 15 %. This measure basically speaks about the efficiency of use of space - two same-size panels with different efficiency will give different output power. Increasing efficiency at decreasing costs is important for improving competitiveness of photovoltaic industry.[5]

Electricity is a controllable natural force; it is uniform and it cannot be recognized, which comes from renewable sources of electricity and which does not. Furthermore, under current conditions, it cannot be separated or offered separately.[6]

Feed-in tariff *"is an energy supply policy focused on supporting the development of new renewable energy projects by offering long-term purchase agreements for the sale of RE electricity. These purchase agreements are typically offered within contracts ranging from 10-25 years and are extended for every kilowatt-hour of electricity produced. Feed-in tariff payments can be offered as a premium, or bonus, above the prevailing market price."*[7] In the CR, feed-in tariff has a form of Purchase price (see further).

Installed capacity (unit: Wp) of a solar power plant is the nominal power output of all the solar modules in the system.

Kilowatt hour is a billing unit for electricity. One kilowatt of power continuously consumed for one hour is one kilowatt hour.

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4 CEZDistribuce.cz, **Basic Information about the CEZ Distribuce, a.s.**

5 EUROPEAN PHOTOVOLTAIC INDUSTRY ASSOCIATION, **Photovoltaic Energy, Electricity from the Sun**, p. 5

6 KOUBA S., Taxation of Electricity from Solar Power Plants

7 COUTURE D. T., CORY K., KREYCIK C., WILLIAMS E., **A Policymaker's Guide to Feed-in Tariff Policy Design**, p. 6

Payback period (in Czech legislation called "Period of recovery of investment") is the period of time required for the return on an investment to pay back the original investment. Payback period does not take the time value of money and opportunity costs into account.

Period of recovery of investment – see Payback period

Photovoltaics is a method of generation of electric power from solar radiation using solar panels in photovoltaic power plants (explained in Chapter 3.3.2).

Purchase price (see also Feed-in tariff) in the context of this Thesis means a price paid to the electricity producers by the distribution system operator. It can be either paid as a Guaranteed price or Green bonus (see Chapter 4.2). Please note that figures of purchase prices mentioned in this Thesis denote Guaranteed price and do not include premium for decentralised energy production unless stated otherwise.

Renewable energy sources (renewables) are sources of renewable energy which are naturally replenished. Flow resources are included in this category. Flow resources (e.g. solar radiation, wind, geothermal heat and tides) are such renewable energy sources which do not need regeneration.[8]

Watt-peak is a measure of maximum nominal power output the solar power plant can produce under optimal conditions (light intensity of 1000 W/m^2, temperature of the panel at 25 ºC, sunlight spectrum). In reality the nominal power output can be exceeded when the irradiation intensity is higher than 1000 W/m^2 or when the temperature is lower at high light intensity.

3.2. Solar Energy

Solar energy, i.e. the radiation eradiated by the Sun is a flow source of energy. Our planet perpetually receives about 1.8×10^{17} W of solar radiation.[9] In other words, *"approximately 5.7 x 10^{24} J of solar energy are irradiated to the Earth's surface on an*

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[8] ŠINDELÁŘ J., **Natural Resources Management: First Lecture**

[9] POULEK V., LIBRA M., **Photovoltaics: Theory and Practice of Solar Energy Utilization**, p. 8

annual basis"[10]. While a fraction of it is absorbed and used by plants and photosynthetic organisms in photosynthesis, most of this virtually "free" energy is without any further use.

The area of the CR receives about 80,000 TWh of solar energy annually. That exceeds average annual consumption of energy in the CR approximately 250 times.[11]

Solar energy has been utilized by mankind for thousands of year. Solar radiation has naturally been used in agriculture and architecture. Solar heat is an important source of energy for water heating. In the context of this Thesis, the most important quality of solar energy is that it is usable for solar power generation.

3.3. Solar Power and its Application

Solar power is the process of conversion of solar energy into electricity. Two methods of solar power generation are generally recognized as technologically and economically viable and therefore used in practice – concentrated solar power plants and photovoltaic power plants.

CSP plants currently amount to 1.17 GW of IC connected globally (June 2011), 50 % of that located in Spain and further 43 % located in the United States. However, CSP plants of the capacity of about 17.54 GW are under development worldwide (June 2011). Commonly used CSP plants usually reach a sunlight-to-electricity efficiency of approximately 22 to 23 %.[12]

Total IC of **PV plants** amounted to over 67.4 GW globally at the end of 2011. More than 75 % of this capacity is installed in Europe, mostly thanks to stimulative policies.[13] Efficiency of conversion of sunlight into electricity is usually between 12-17 % in the case of PV plants.

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10 MIYAMOTO K., **Renewable biological systems for alternative sustainable energy production**, chapter 2.1.1

11 **Report of the Independent Expert Committee for Assessment of the Energy Needs of the Czech Republic in the Long Term (draft)**, p. 182

12 WANG U., **The Rise of Concentrating Solar Thermal Power**

13 EUROPEAN PHOTOVOLTAIC INDUSTRY ASSOCIATION, **Market Report 2011**

3.3.1. Concentrated Solar Power Plants

Solar power plants based on concentrated solar radiation typically consist of a set of heliostats – mirrors that keep adjusting their position in order to continuously reflect the sunshine to a predetermined spot. In this target, called a receiver, concentrated solar radiation heats steam, respectively oil to temperatures as high as 560 ºC. Heated oil then generates steam in a steam generator which then drives a steam turbine and thus generates power – analogically to the principles of thermal or nuclear power plants. The difference is only in the primary energy source.[14]

Method of CSP is used since 1980s. "Solar one" in California was the first operating CSP plant. Launched in 1985, it has the maximum output $P_{max} = 10\ MW_p$. It is a solar power tower plant – heliostats are placed around a tower and all of them focus solar radiation to the top of the tower – to the receiver. A working fluid is heated there and power generation then proceeds as described above.

Among CSP plants, parabolic trough plants are the most widely spread ones. In these, each heliostat (a linear parabolic mirror in this case) concentrates radiation into a tube positioned in the focal line of the mirror. Heated working fluid is then conventionally processed. Even if slightly less efficient than solar power tower plants, parabolic trough plants now dominate the global market, accounting for 90 % of CSP plants.[15]

CSP plants have a major limit – their nature requires full sunshine without clouds for the power plant to work. Therefore **they are suitable only for sunny regions** with more than 300 sunny days a year on average, i.e. Spain in Europe and California and New Mexico in the United States. Apart from that, the mirrors must be continuously cleaned. Last but not least, precise adjustment of the heliostats is both a technical and economic challenge.[16]

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[14] POULEK V., LIBRA M., **Photovoltaics: Theory and Practice of Solar Energy Utilization**, p. 32, 33

[15] SAWIN L. J., MARTINOT E., **Renewables Bounced Back in 2010, Finds REN21 Global Report**

[16] POULEK V., LIBRA M., **Photovoltaics: Theory and Practice of Solar Energy Utilization**, p. 33

3.3.2. Photovoltaic Power Plants

Basic unit of a PVPP is a solar panel (also called solar module) which consists of a series of solar cells. Solar cell is made of a semiconducting material, usually crystalline silicon. In the cell, solar energy is converted into electricity by the PV effect. When the solar cell is exposed to light, electrons are emitted and voltage is generated. Voltage is then collected from the panels to the transformers and converters and alternating current is generated.

The panels are connected in a parallel way. This implies that the output voltage of the system cannot be higher than the output voltage of the weakest panel. The weakest panel limits the output voltage; the panels must therefore be well monitored.

In 2008, 93 % of the world market share of PV panels was covered by technologies based on crystalline silicon.[17] Current technologies use polycrystalline or amorphous silicon; previously used monocrystalline silicon is not as efficient and easy-to-process for solar cells. Thin film technology covers the rest of the market share; it requires much less material, however, it is less efficient. Compared with crystalline silicon panels, a thin-film panel requires 15-40 % more space. Thin film technology is likely to develop in the future and may be more successful than crystalline silicon based panels; its use is, however, not as significant in the present years. [18]

The top 3 manufacturers of solar panels in 2011 were First Solar (USA, 2 MW yearly production; dominant manufacturer of the thin-film technology), Suntech Power (China, 1.87 MW yearly production) and Yingli Green Energy (China, 1.55 MW yearly production). Top 10 manufacturers produced 12.5 GW and covered 44 % of the global market sector in 2011.[19]

A PV system can either be connected to the electric grid (on-grid system) or it can be autonomous (off-grid). On-grid system supplies all or a part of produced electric current

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[17] CAMPILLO J., FOSTER S., **Global Solar Photovoltaic Industry Analysis with Focus on the Chinese Market**, p. 7

[18] RenewableEnergyWorld.com, **Thin-film's Share of Solar Panel Market to Double by 2013**

[19] JACQUES C., **Lux Research Reveals 2011 Top 10 Module Manufacturers**

to the power grid. Off-grid system is not connected to the grid; it usually includes a storage battery and the producer consumes all the electricity the system produces. An off-grid system does not require any license by the Energy Regulatory Office and is therefore independent of regulatory policies.

Unlike the CSP plants, PVPPs do not need direct sunlight for electricity generation. Even if PV is not as efficient as CSP, it offers a much wider scope of usage. Solar modules can be placed on roofs and in locations with less sunny days. These characteristics make **PVPPs universal source of solar power**.

4. Analysis of the Regulatory Policy

4.1. Legislative Framework

Energy Regulatory Office (ERO) was set up on 1st January 2001 under **Act No. 458/2000 Coll.** of 28th November 2000, on the Conditions of Business and State Administration in Energy Industries and Changes to Certain Laws (the Energy Act). Since then, the Office operates as an executive body which monitors and regulates the energy sector. ERO awards licences for business in the energy industries, among others to PV business. Licence by ERO is a condition for the connection of the PVPP to the grid; only an off-grid PV system can be run without a licence.

Under the **Act No. 180/2005 Coll.** on the Promotion of Electricity Production from Renewable Energy Sources and Amending Certain Acts (**Act on Promotion of Use of Renewable Sources**) with legal force since 1st June 2005, PV is among the supported renewable sources of energy.

Under the latter Act, ERO shall determine the purchase prices for electricity from renewable sources so as to "*create conditions for fulfilment of the indicative target for the share of electricity production from renewable sources in the gross consumption of electricity, which equals to 8 % in 2010*"[20]. A **fifteen-year period of recovery of investment** shall be achieved *"with promotion by purchase prices, under the condition of compliance with the technical and economic parameters, including in particular the costs*

[20] **Act on Promotion of Use of Renewable Sources, Article 6, Paragraph 1 a)**

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 (...)"[21]

Furthermore, under the Act No. 180/2005 Coll. the purchase prices guaranteed to new facilities for the subsequent year shall **not be lower than 95 %** of the value of the present year. However, under the amendment Act No. 137/2010 Coll. of 21th April 2010 with legal force since 1st January 2011, the previous sentence shall not apply for PPs of those renewable sources which may at current PPs achieve recovery of investment in less than 11 years.

Act No. 330/2010 Coll. of 3rd November 2010 amending the Act No. 180/2005 Coll. brought about following changes:

- Feed-in tariff shall be only provided to PVPPs of the IC smaller than 30 kWp which are placed on a roof or on a perimeter wall of a building registered in the land register (in force since 1st March 2011).
- Off-grid systems launched before 1st January 2011 which will be connected to the grid by 31st December 2011 are eligible for appropriate feed-in tariff.

Act No. 402/2010 Coll. of 14th December 2010 which came into legal force on 1st January 2011 amended the Act on Promotion of Use of Renewable Sources. Under this amendment, a levy is imposed on electricity produced in PVPPs launched between 1st January 2009 and 31st December 2010. **A levy shall be paid on electricity produced between 1st January 2011 and 31st December 2013**. The levy was set as high as 26 % for producers using Guaranteed price support and 28 % for producers using Green bonus support. Power plants of the IC less than 30 kW which are placed on a roof or on a perimeter wall of a building registered in the land register are exempt from the levy.[22] Moreover, this amendment introduced a 32 % gift tax on emission permits which the PV producers get for free in 2011 and 2012. Last but not least, the Act No. 402/2010 Coll. imposed a higher levy on transfer of the agricultural land.

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21 **Act on Promotion of Use of Renewable Sources, Article 6, Paragraph 1 b)**

22 **Act No. 402/2010 Coll., Title III**

Public Notice No. 140/2009 Coll. guarantees that the Guaranteed purchase prices for electricity from PV and most of other renewable sources will **increase by at least 2 %** and no more than 4 % annually with respect to the consumer price index. Under this Notice, support both in form of Guaranteed price and Green bonus shall be paid to the producer over the expected life of the generating PVPP.[23] **Public Notice No. 475/2005 Coll.** set expected life of the new plant to 15 years, later amendment (Public Notice No. 364/2007 Coll. in legal force since 1st January 2008) extended this period to **20 years**. Notice No. 475/2005 Coll. also regulates required efficiency of use of the primary energy content: PV cells must be designed and located so that at least 150 kWh per square metre of the solar active surface area can be generated annually. Annual decrease of nominal performance of solar panels of 0.8 % is assumed.[24]

Aside from the mentioned legislative, following legislation relates to PV:

- **Public Notice No. 426/2005 Coll.** on Details of the Business Licensing in the Energy Sectors
- **Public Notice No. 51/2006 Coll.** Providing the Conditions for Connection to the Electricity Grid
- **Public Notice No. 150/2007 Coll.** on Methods of Price Regulation in the Energy Industries and Procedures for Price Regulation.

4.2. Types of State Support

PV as well as all other renewable energy sources in the CR are supported by feed-in tariffs since June 2005 under the Act No. 180/2005 Coll.. The support scheme offers two types of support. The producer can

a. either sell all the produced electricity to the distribution system operator at a PP guaranteed for PV electricity by ERO – and get support in form of **Guaranteed price** for produced electricity

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23 **Public Notice No. 140/2009 Coll., Article 2, Paragraph 8**

24 **Public Notice No. 475/2005 Coll., Appendix 3**

b. or consume part of the produced electricity by himself and supply the rest to the grid – and get support in form of so-called **Green bonus**.

The producer can switch between these types of support once a year at the maximum. After this change, the producer would be paid such PP as if he had been using selected type of support since the launch of the power plant (i.e. the PP from the year of the launch would be increased with respect to the consumer price index). [25]

Distribution system operators are legally obliged to purchase all the produced electricity if the producer runs the **Guaranteed price** scheme. Producers who choose this form of support are usually large-scale electricity producers who do not have use for most of the produced electricity and rather run the PVPP as a business.

Green bonus is a premium paid for all the electricity (both self-consumed and sold to the grid) produced by a PV system. Distribution system operators are legally obliged to pay this Green bonus to the producer for all the electricity the producer produces, no matter whether the producer supplies it to the grid or not.[26] It is by approximately 1 CZK/kWh lower than Guaranteed price. It is therefore suitable in cases when the producer is able to consume enough electricity by himself, especially in the summer months when the production is the greatest. Furthermore, price of electricity is important – the higher the price, the more beneficial the Green bonus. This form of support is ideal for energy-demanding industries, family houses or administrative buildings with air conditioning.

The progress of Guaranteed price is guaranteed under the Public Notice No. 140/2009 Coll. to increase by at least 2 % and no more than 4 % annually. The height of the Green bonus is set by the ERO based on consumer price of electricity.

In the CR, the ratio of PVPPs using the Guaranteed price vs. Green bonus is unclear. Neither ERO, nor ČEPS, a.s. has any data suggesting how many PVPPs receive feed-in tariff in form of Green Bonus and how many sell their production at Guaranteed price. It is only distribution companies who have the evidence. Author requested this data from the distributors, however, ČEZ Distribuce, a.s. and E.ON Distribuce, a.s. (i.e.

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[25] **Act on Promotion of Use of Renewable Sources, Article 4, Paragraph 3**

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

electricity distributors for the whole CR excluding Prague) rejected to provide the data. PREdistribuce, a.s. register 369 PVPPs of IC of 4.3 MWp using Green bonus and 77 PVPPs of IC of 8.3 MWp (i.e. approximately 65 % of IC of PVPPs in Prague) using Guaranteed price (January 2012). Nevertheless, this figure does not have a high information value as the region of Prague is different from the rest of the CR. Respekt magazine estimated the ratio for the CR to 1,800 MWp of PVPPs using Guaranteed price and remaining 150 MWp using Green bonus. The magazine points out that Green bonus support usually prevails in EU countries.[27]

4.3. Early Years of Photovoltaics

By early years Author means the years before 1st June 2005 when the Act No. 180/2005 Coll. on Promotion of Use of Renewable Sources came into legal force. The "early pioneers" were usually small, often experimental PV facilities. Most of these systems were off-grid and supplied electricity in localities without a connection to the grid. The first on-grid PVPP was built by CEZ in 1997 in the Mravenečník locality. Its IC is 10 kWp and it is reached by 200 monocrystalline silicon cells of the total area of 100 m^2. In 2003 the power plant was relocated to Dukovany and is currently used for demonstrative purposes. Until 2004, this was the only PVPP in the CR connected to the grid. In 2004, 2 PVPPs with the total IC of 20 kWp were in operation. As on 1st January 2005, 9 PV plants had been launched with IC of 120 kWp in total.

Before the Act No. 180/2005 Coll., support of renewable sources was integrated in the Act No. 458/2000 Coll. on business conditions and public administration in the energy sectors (the Energy Act). However, the general support provided by the Energy Act did not create sufficient certainty for investors to invest into the development of these energy sources, in particular from the perspective of guarantees of the long-term development of price controls in this area.[28]

In the years 2002 to 2005 the feed-in tariff for electricity from PVPPs had a form of minimal PP rather than guaranteed purchase price. ERO set out price decisions which

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27 SACHER T., SPURNÝ J**., The Great Solar Theft**, p. 55

28 ERO, **The 2005 Report on the Activities and Finances of the ERO**, p. 26

guaranteed the lowest price PV plants would be paid by the distribution system operators for produced electricity. This minimal price was set constant in the years 2002, 2003 and 2004 at 6 CZK/kWh and was increased for the year 2005 to 6.04 CZK/kWh. PV was the most subsidised of all supported types of renewable energy, however, its use in practice was negligible – PV counted for less than 0.1% of all renewable energy sources used in CR in 2004.[29]

Another form of governmental support of PV was the program "**Sun to Schools**" (Slunce do škol). This program - presented in 1999 by the Ministry of the Environment of the CR and Ministry of Education, Youth and Sports - offered subsidy of up to 100 % for very small PV systems for schools. The purpose of this program was to illustrate and promote possibilities of solar power as a renewable resource. Between the years 2000 – 2003, State Environmental Fund of the CR paid more than 150 million CZK in support of nearly 1,200 projects.[30] The IC of these off-grid systems was usually smaller than 100 Wp and the energy they produced was consumed by the schools. However, the project is associated with certain controversies regarding the selection of the suppliers of the technologies. The effectiveness of such illustration of usefulness of solar power is also disputable as the costs of the PV electricity from the system were simply higher than the benefits from the produced electricity.[31]

In the early years, the start-up costs of PVPPs and solar modules in particular were high and their efficiency not good enough. Furthermore, CR was lacking a systematic support scheme for PV investors. All in all, the conditions were not favourable enough for PV business to develop significantly.

4.4. 2006, 2007: Beginning of State Support

On 1st June 2005, the **Act No. 180/2005 Coll. on Promotion of Use of Renewable Sources** came into legal force. As mentioned in Chapter 4.1, the main features of the Act in relation to PV were:

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29 ERO, **The 2004 Report on the Activities and Finances of the ERO**, p. 20

30 State Environmental Fund of the CR, **Annual Reports 2000 - 2003**

31 KAVON R., **Sun to Schools – Program Costs Exceed 150M, What is it Really Like?**

- PPs shall be set so as to allow achievement of a **fifteen-year period of recovery of investment**
- **PPs** guaranteed to new facilities for the subsequent year **shall not be lower than 95 %** of the value of the present year
    - Since 1st January 2011, the previous sentence shall **not apply** for PPs of those renewable sources which may at current PPs achieve recovery of investment **in less than 11 years**
- Support shall be realized by means of Guaranteed Price or Green Bonus (see Chapter 4.2)
- PPs for existing facilities shall be annually increased with respect to the consumer price index
- Indicative **target for the share of electricity production** from renewable sources in the gross consumption of electricity is **8 %** in 2010

Under the Act No. 180/2005 Coll., Energy Regulatory Office set the Guaranteed purchase prices for the year 2006 to 6.28 CZK/kWh for PVPPs launched before 1st January 2006 and to 13.2 CZK/kWh for facilities launched since the latter date. Green bonus prices were set 0.61 CZK/kWh lower.[32] Price decision for the year 2007 only increased the prices by 2 % to 13.46 CZK/kWh both for existing and new PV facilities. For the year 2008, ERO kept PP for new power plants constant at 13.46 CZK/kWh. Moreover, in those years solar entrepreneurs could gain subsidies for building a PVPP from the European Union Structural Funds of up to 46 % of the eligible costs.[33]

These circumstances slowly raised awareness about PV among entrepreneurs and the number (respectively the IC) of **PVPPs began to rose**: on the 1st January 2006, 12 PV plants with IC of 150 kWp were in operation, a year later this number rose to 28 power plants of 350 kWp and finally on the 1st January 2008, 249 PV plants with IC of 3.4 MWp were operating in the CR.

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32 ERO, **Price Decision No. 10/2005**

33 BOUŠKA J., KNÍŽEK P., **Preparation and Financing of the Construction of Power Plants Based on Renewable Energy Sources**, p. 30

4.5. 2008, 2009: First Phase of the Boom

Under Public Notice No. 475/2005 Coll. the PVPPs launched till 2007 were granted a support by feed-in tariff over their whole lifetime which was set to 15 years. For facilities launched since 1st January 2008, the lifespan, respectively **support**, **was prolonged to 20 years** under Public Notice No. 364/2007 Coll..

At the same time, the **CZK/EUR rate kept falling**. In 2005 when the PPs based on the Act No. 180/2005 Coll. were implemented, the rate was around 29 CZK/EUR. However, the average rate for 2008 was only 25 CZK/EUR with minimum at a mere 23 CZK/EUR in July 2008. After a sudden fluctuation to 29 CZK/EUR in February 2009 it decreased back to approximately 26 CZK/EUR in 2009 and 2010, respectively less than 25 CZK/EUR in the 2nd half of 2010.

CZK/EUR rate is the most determining factor of the price of solar panels in the Czech environment and solar panels form the largest part of the initial investment to PVPP. Other factors include among others sudden increase in world production of crystalline silicon and decrease in demand in Spain. The overall trend of the development of the height of initial investment to PVPPs in the CR is suggested by the Figure No. 1 and Supplement No. 2.

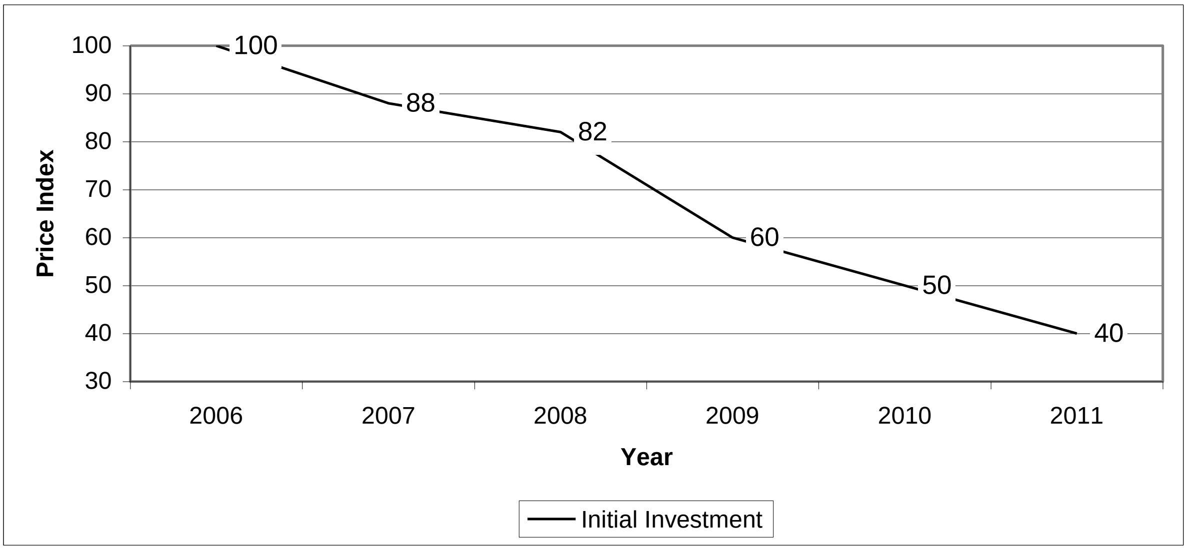

Figure No. 1, Development of the Height of Initial Investment in PV in the CR (Price Index). Source of Data: Czech Renewable Energy Agency, www.czrea.org. Author's Work.

Combination of prolonged guarantee of support and decrease in the initial investment had an obvious impact: investors' **interest in PV rose dramatically**. In a reaction to that, ERO started to differentiate between large and small investors in its price decisions and introduced a different PP for power plants of IC less than 30 kWp and larger ones. In spite of the fact that ERO cut down the PP by 5 % to 12.79 CZK/kWh for installations above 30 kWp and to 12.89 CZK/kWh for smaller ones, the number of PVPPs launched by 1st January 2009 reached 1,475, IC amounting to 65.74 MWp.

In Germany, an Act similar to the Czech Act No. 180/2005 Coll. was amended in 2008, PPs continually decreased and solar boom was successfully prevented. Czech authorities however underestimated the situation. In February 2009, EGÚ Brno, a.s. (Czech consulting company in the field of energetic) estimated the IC of 36 MWp by the end of 2010. Czech Renewable Energy Agency predicted approximately 150 MWp, the most daring prediction of September 2009 expected 300 MWp by the end of 2009.[34] Later development proved how far these numbers were from reality.

4.6. 2010: Peak of the Boom

By 31st January 2010, distribution companies registered and approved applications of PVPPs and wind power plants for connection to the grid of the total IC higher than 8,000 MWp.[35, 36] This figure is approximately 4 times higher than the capacity reserved in the grid for these two RES. Therefore ČEPS, a.s., Czech transmission system operator asked the distributors to stop approving new applications. On 16th February 2010 this so-called "**STOP status**" came into force. During this status, the distributors stopped accepting applications for connection to the grid. In other words, no single solar panel could join the grid – regardless the size, location or type of support. Only grid-off systems

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[34] Czech Renewable Energy Agency, **Brief History of RES Support in the CR**

[35] SACHER T., SPURNÝ J., **The Great Solar Theft**, p. 55

[36] Approved application for connection to the grid is not the same as license by the ERO; the application is rather a "confirmation" that the power plant can be connected to the grid when it is finished and licensed by ERO. Distributors had to approve all the applications under law, however, they did not inform official bodies in time that the volume of applications exceeded the capacity of the grid.

were not concerned by the “STOP status”, however no support was granted to these installations.

The “STOP status” was reasoned by a limited capacity of the grid reserved for RES. The limit was set because these sources are unstable and might be a potential threat to the grid. This argument is however disputed because small home PVPPs could probably hardly threaten the transmission system.

Despite the “STOP status” solar boom reached its peak in 2010. PVPPs launched in 2010 were eligible for PP of 12.15 CZK/kWp (plants larger than 30 kWp) or 12.25 CZK/kWp (plants smaller than 30 kWp). Nevertheless, it was known that the PPs would fall dramatically next year (2011: 7.5 CZK/kWh for PVPPs < 30 kWp, 5.9 CZK/kWh for PVPPs > 30 kWp and < 100 kWp, 5.5 CZK/kWh for PVPPs > 100 kWp) under the Act No. 137/2010 Coll. Moreover, under the Act No. 330/2010 Coll. no feed-in tariff support shall exist for any PVPP larger than 30 kWp launched after 1st March 2011.

As a result, the **number of PV installations rocketed** to 12,861 facilities in operation on the 1st January 2011. The total IC of these power plants reached 1,952.7 MWp, i.e. nearly 2 GWp, which is the capacity of the Temelín Nuclear Power Station[37].

Unfortunately, this boom did not have much in common with the substance of PVPPs as small, decentralised sources of energy for households and companies. As mentioned above, only ¼ of applying solar projects could be successfully connected to the grid. High PP of 12.15 CZK/kWh was only guaranteed to plants connected by 31st December 2010. It was distributors who chose which projects would be connected in time. Several figures that illustrate distributors’ disputable way of choice follow:

- By the end of October 2010, the total number of PVPPs in CR was 11,251 with IC of 1,028.4 MWp, by the end of December 2010, this figure rose to 12,861 with IC of 1,952.7 MWp.[38] A simple computation (1,952,700-1,028,400)/(12,861-11,251) gives the average **IC of a PVPP connected in the last two months of**

[37] Unlike a nuclear power plant, PVPPs do not generate electricity continuously, therefore annual generation differs.

[38] Source of Figures: **Monthly Data Summaries of Electric Power System of the Czech Republic for October and December 2010**, ERO

solar boom as high as 574 kWp. Average size of PVPPs launched by the end of October 2010 was 91 kWp[39]

- Six PVPPs out of the 10 **largest PVPPs in the CR were connected to the grid in December 2010**

- Three PVPPs out of the 10 **largest PVPPs in the CR are owned by CEZ** (parent company of CEZ Distribuce, a.s.) – these include the largest Czech PVPP in Ralsko (3L Invest a.s., 38.3 MWp, connected to the grid on 29th December 2010), PVPP in Ševětín (Gentley a.s., 29.9 MWp, connected to the grid on 14th December 2010) and PVPP in Mimoň (Area-Group CL a.s., 17.7 MWp, connected to the grid on 29th December 2010)

Above-mentioned figures support opinions that distributors gave preference to their own projects and generally supported large projects to small. These findings correspond with medial suspicions[40, 41] about unfair or even corruptive background of the connection process in the end of 2010. ERO officers were also under pressure in that period. Some are accused of bribery for issuing licenses for unfinished projects in order to help them gain high purchase price by launching them in time.[42]

It is necessary to mention that **ERO tried to prevent the boom**. In June 2009 ERO Chairman Josef Fiřt alerted that it was necessary to amend the Act No. 180/2005 Coll. and to introduce radical cuts in the PP. Josef Fiřt warned Members of Parliament that the development of PV is uncontrollable and attracts speculative investors.[43] Nevertheless, it took 1.5 year till the amendment that made larger cuts possible (Act No. 137/2010 Coll. of 21st April 2010) came into force on the 1st January 2011.

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[39] 91 kWp = 1,028,400 kWp / 11,251

[40] SACHER T., SPURNÝ J**., The Great Solar Theft**, p. 56

[41] BAROCH P., **Own Projects Connected by CEZ in Time, Smaller Ones Got a Raw Deal**

[42] AKTUALNE.CZ, **Solar Business: First Case of Bribery Before the Court**

[43] E15 News, **State Wants to Stop Energy Speculators**

4.7. 2011, 2012: Present Situation

Since 1st March 2011, amendments of the Act on Promotion of Use of Renewable Sources that regulate solar boom are in legal force. Support is only guaranteed to the electricity produced in **power plants with IC smaller than 30 kWp** which are placed on a roof construction or on a perimeter wall of a building registered in the land register.[44] The Guaranteed price for plants connected in 2012 is 6.16 CZK/kWh, the Green bonus is 5.08 CZK/kWh.

After the conference of ČSRES[45] on 19th September 2011 distribution companies put an end on the "STOP status" and started accepting new applications. Nevertheless, each application is assessed individually with respect to its potential threat to the grid. General limitations regarding size and location of PVPP follow from the Act No. 330/2010 Coll. However, the greatest limit is the **limited annual capacity** reserved for solar and wind power plants in the grid. ČEPS, a.s. promised to connect PVPPs of only approximately 65 MWp in 2012. For the next years, the annual limit on new connections will probably be around 50 MWp. Thanks to the limited size of the PVPPs, these limits allow to connect roughly 2,000 - 5,000 roof systems.

The limits of the capacity of the grid differ among regions and some regions have already exceeded them. In the end of January 2012, the possibilities of new PVPPs for connection to the grid in different regions were as shown in the Figure No. 2.

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[44] **Act on Promotion of Use of Renewable Sources, Article 3, Paragraph 5**

[45] Association of Czech distribution companies and transmission system operator

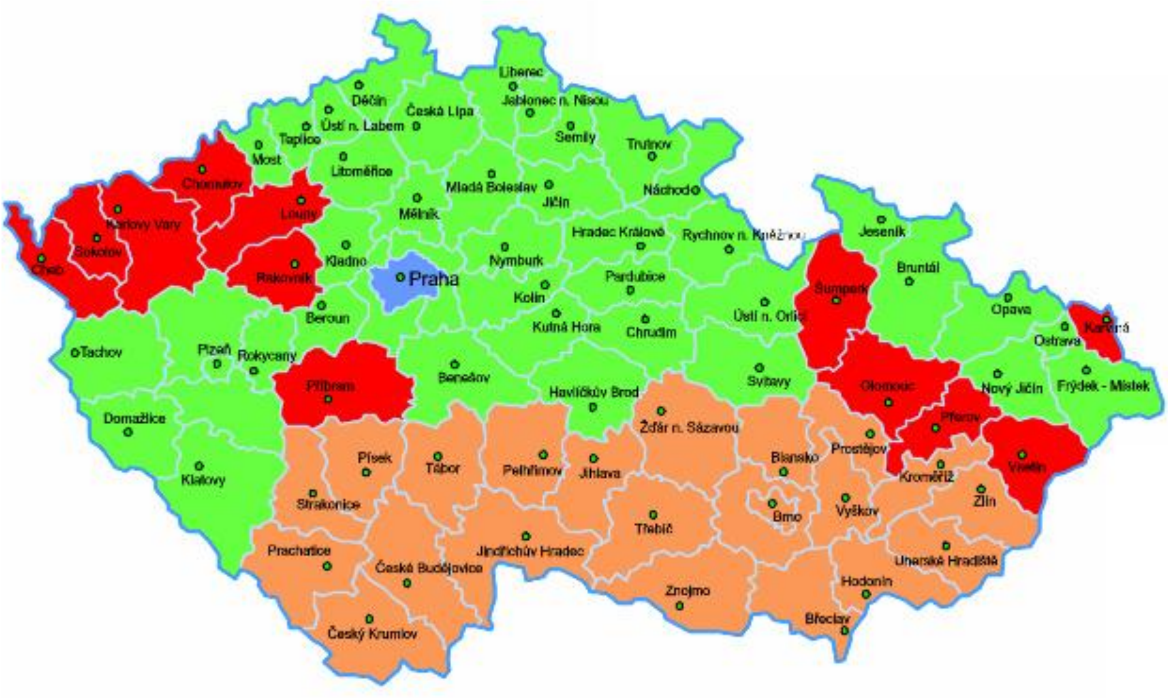


Figure No. 2, Possibilities for Connection of PVPPs to the Grid in the End of January 2012. Source: ekobydleni.eu

- PREdistribuce, a.s. allows connection
- E.ON Distribuce, a.s. exceeded the limits for connection on 13th January 2012; temporary "STOP status"
- CEZ Distribuce, a.s. – limit exceeded until 2020; long-time "STOP status"
- CEZ Distribuce, a.s. – connection allowed

As shown in the previous paragraphs, measures have been taken so that the PV boom could not continue in 2011. However, these measures could not stop existing PVPPs from receiving the extraordinarily high support[46] they were granted by the legislation in force in the time of launch. Therefore Act No. 402/2010 Coll. was passed in the end of December 2010. As analysed in the Chapter 4.1, this Act imposed a levy of 26 % (Guaranteed price) or 28 % (Green bonus) on electricity produced between 1st January 2011 and 31st December 2013 in PVPPs launched between 1st January 2009 and 31st December 2010.

46 Chapter 5.3 proves that this support really was extraordinary

This levy is associated with numerous complaints by PV investors. Some blame it to be retroactive[47] which is probably not true as it changes legal consequences after its enactment. Nevertheless, it is obvious that this law brought about uncertainty about the stability of the Czech business environment in the RES sector. Last but not least, the CR may be facing arbitrages because of this law[48].

5. Analysis of the Purchase Price Policy

5.1. Estimate of the Development of Purchase Prices

Under all the appropriate legislation analysed in the Chapter 4, Guaranteed prices for all the PVPPs that are connected to the Czech transmission system are estimated by Author in the table in Supplement No. 1. The estimate respects all the decisive factors that affect the Guaranteed price and its duration:

- **Year of launch** of the PVPP
- **IC** of the PVPP
- **Lifespan** of the PVPP
- **Levy of 26 %** (imposed on electricity produced in PVPPs launched in 2009 and 2010 paid on electricity produced from 2011 to 2013)
- Centralised or decentralised **type of production**

The estimate was made only for Guaranteed price, not for Green bonuses as the Green bonus value is announced annually by ERO in Price Decisions based on consumer price of electricity. Unlike in case of Guaranteed price, the future values of Green bonus cannot be precisely estimated.

47 Retroactive is such law which has legal consequences in the time before it was enacted

48 BAROCH P., **A Hundred of Solar Businesses Asking Czech Govt for Compensation Worth Billions**

5.2. Analysis of the Payback Period

As analysed in Chapter 4.1, the purchase price should be set so that it meets following requirements (Act No. 180/2005 Coll.):

- A **fifteen-year period of recovery of investment** for the power plant shall be achieved
- The PPs guaranteed to new facilities for the subsequent year shall not be lower than 95 % of the value of the present year
    - Since 1st January 2011, the previous sentence shall not apply for PPs of those renewable sources which may at current PPs achieve **recovery of investment in less than 11 years**

In the analysis of the payback period, Author has used data of an existing PVPP launched in 2010 and computed its payback period using the estimate of the development of PP for the year of launch 2010 (Supplement No. 1). Then the payback period was recomputed with PPs from the years of launch 2006 and 2011. To make this computation meaningful, initial investment of the power plant was recomputed using the indexes from the Figure No. 1 (See Supplement No. 2). This should illustrate how the payback period differed based on different years of launch given a power plant with the same technical parameters. The resulting payback periods for each year were then compared with Act on Promotion of Use of Renewable Sources, Article 6, Paragraph 1 b) ("*The ERO shall always determine the purchase prices for electricity from renewable sources (...) so as (...)* ***fifteen-year period of recovery of investment*** *is achieved with promotion by purchase prices*").

Why is the payback period for the PVPP launched in the years 2006, 2010 and 2011 important?

2006 was the first year for which **systematic support** of PV by PP under the Act No. 180/2005 Coll. was introduced. In the later years ERO was limited by maximal decrease of the Guaranteed price of 5 %. However, in the year 2006 the PP should have been set precisely so as to meet the desired payback period of 15 years.

In **2010** the **solar boom peaked** as described in the Chapter 4.6. Most of the IC was connected in that year. Production from PVPPs launched that year was taxed later by 26 %

in order to mitigate excessively favourable conditions. Therefore it is interesting to examine if this measure helped to meet the optimal fifteen-year payback period.

2011 brought about considerable **cut in support**. Actually, plants larger than 30 kWp could only join the grid by the end of February. Guaranteed prices for PVPPs larger than 100 kWp dropped by more than 50 % of the 2010 values. The PP should again precisely fit with the legal payback period.

The sample PVPP has following parameters[49]:

- IC: 1,750 kWp
- Location: South Bohemian Region
- Time of launch: 2nd half of 2010
- Date of launch used in the computations: 1st January of corresponding year
- Type of production: Decentralized (eligible for a PP premium of 0.027 CZK/kWh)
- Annual decrease of nominal performance: 90 % after 10 years, 80 % after 25 years
- Expected annual supply to the grid: 1,670.3 MWh[50]

5.3. Results of the Analysis

Given all the parameters and constraints, following figures on the mentioned PVPP resulted from the computations:

- **Launched in 2006**, the power plant would achieve a **payback period of 14 years**, however, after 15 years guarantee of support ends

[49] Unfortunately, the Investor of the sample PVPP did not wish to publish more specific details about the facility.

[50] Gradually decreases with the decrease of performance.

- **Launched in 2010** (which is the case of the sample power plant), the plant would achieve a **payback period of 9 years** and it would be profitable for the next 11 years

- **Launched in 2011**, the power plant would achieve a **payback period of 14 years** and then it would earn to its owner for the next 6 years

Charts with data are available in Supplement No. 3, Supplement No. 4 and Supplement No. 5.

Figure No. 3 shows the cumulative cash flows of a PVPP of the same technical parameters launched in different years:

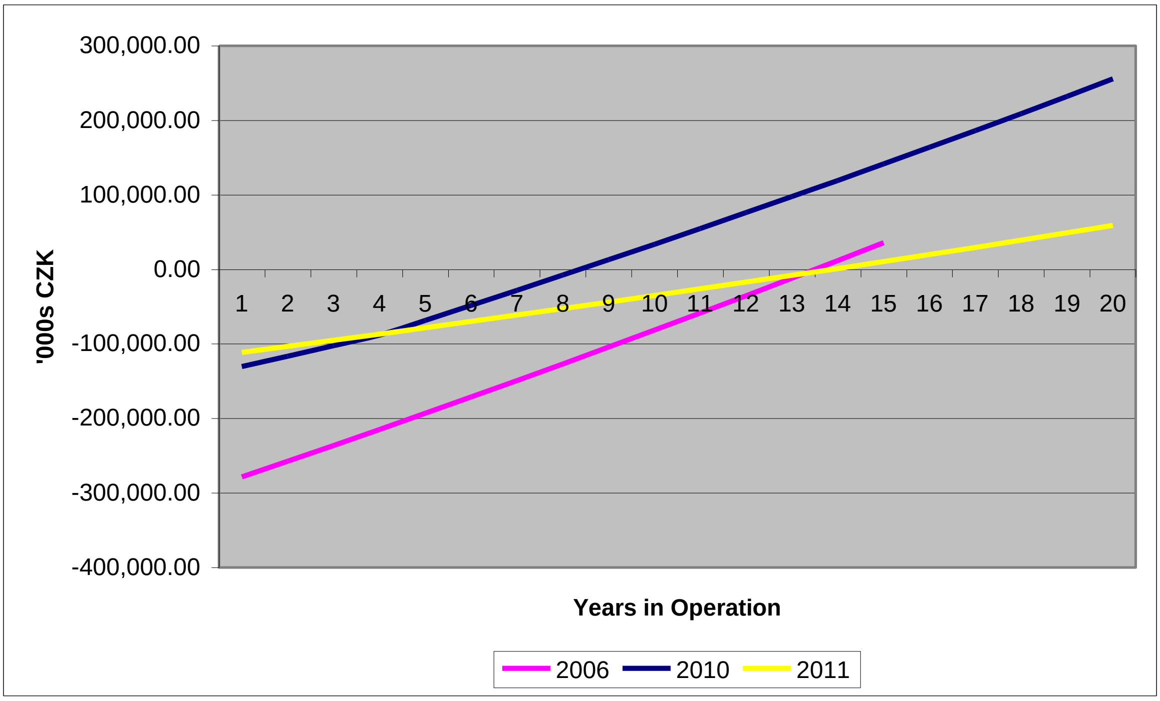


Figure No. 3: Cumulative Cash Flows of a Sample PVPP of the Same Technical Parameters Launched in Different Years. Author's Work.

6. Evaluation of the Results and Discussion

Payback period computed as a measure to evaluate the **Purchase Price Policy** gave following results. Period of recovery of investment for PVPP launched in 2006 almost perfectly corresponds to the period of recovery of investment of 15 years under the Act on Promotion of Use of Renewable Sources. **2006** was the first year for which systematic support of PV by PP under the Act No. 180/2005 Coll. was introduced. In that year, it was the responsibility of ERO to introduce such PP which would be in accordance with the law. Analysis of the PP policy proved that **ERO succeeded**.

However, PVPP launched in **2010** achieved payback period in 9 years. Even if this figure does not confirm the statements of critics of the support saying that PVPPs launched in this year often achieve a six-year period of recovery of investment, it is **40 % shorter** than it should be under the law. This period is also shorter than 11 years which justifies the cut in PP which ERO introduced for the next year under the Act No. 137/2010 Coll.

Similarly to the result of the year 2006, the period of recovery of investment for PVPP launched in **2011** almost perfectly corresponds to the legal period of recovery of investment of 15 years. As explained in the previous paragraph, in 2011 ERO had to introduce a significant cut of PPs so that they matched with a fifteen-year payback period. The analysis has experimentally verified that **ERO was successful**.

It is obvious from the previous paragraphs that ERO proceeded in accordance with the law. Blaming the Office of causing the solar boom by setting inappropriate purchase prices is therefore false. ERO set the purchase prices as low as it could under the existing legislation as soon as it started anticipating threat of excessive PV expansion. Moreover, it alerted the government about the threat of the boom in the mid 2009 as mentioned above. However, without a legislative change, ERO could only lower the purchase prices by 5 % annually, which it did for the years 2009 and 2010.

It was the government who reacted too slowly. The **legislation should have been changed quickly** in order to allow more radical cuts in PP. Germany introduced such cuts as soon as in 2008 and has successfully prevented the boom. Nevertheless, under the then legislation, price decisions of ERO could not reflect external conditions which were favourable for PV. It took almost 15 months from the first signs of troubles till appropriate law was passed. Influence of lobby groups was discussed in media in this context. Someone may raise an objection that putting the amendment into force too quickly might have been interpreted as creation of unstable business environment as it would threaten investors with unfinished projects. Nevertheless, later attempt to mitigate high yields of PV investors (the 26 % levy) was definitely worse from the perspective of stability of business environment.

One positive aspect of the boom is indisputable: the **CR met the indicative target of 8 %** for the share of electricity production from renewable sources in the gross consumption of electricity in 2010.[51] However, Author is of the opinion that the end does not justify the means in this case. Solar boom in 2009 and 2010 enabled large speculative investors to profit, whereas small businesses and households very often got a raw deal.

As a matter of interest, the highest PPs were set for the power plants launched in the years 2007 and 2008, however, the real boom occurred in 2009 and especially in 2010. The development of PPs vs. IC of PVPPs is summarized in Figure No. 4 which follows.

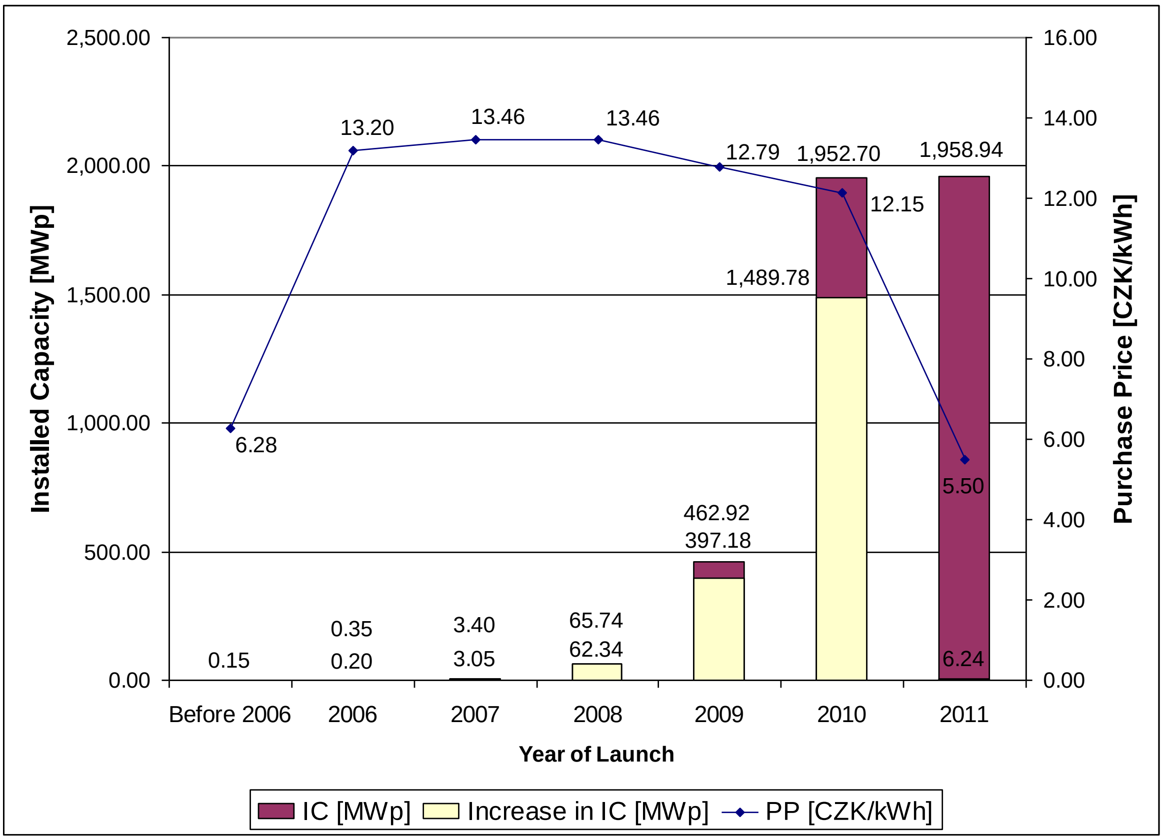


Figure No. 4: The Development of PPs vs. IC of PVPPs in the CR.[52] Source of Data: Energy Regulatory Office, eru.cz. Author's Work.

[51] For the development of the share of electricity from PV and other RES on the gross consumption in CR see Supplement No. 6.

[52] The PP in the years 2009, 10 and 11 is the PP for PVPP larger than 30 kWp, respectively 100 kWp.

Figure No. 4 at the first sight suggests that there is no positive relationship between the PP and the IC of PVPPs. It actually took several years since the increase of the PP till the IC of power plants increased. According to the analysis of regulatory policy there have been several reasons for this **time lag**:

- **Decrease of start-up costs** of PV over time. Start-up costs have been generally falling by more than 10 %, i.e. more than 5 % which was the maximal decrease ERO could implement under the Act No. 180/2005 Coll. Therefore it was more advantageous to launch a PVPP later when significantly lower start-up costs outweighed slightly lower PP.

- **Development of the CZK/EUR rate** which had a direct impact on the price of solar modules. The rate was around 29 CZK/EUR in 2005 when the PPs based on the Act No. 180/2005 Coll. were implemented. However, the rate fell to an average of 25 CZK/EUR in 2008 and after an average of 26.4 CZK/EUR in 2009 it decreased back to less than 25 CZK/EUR in the 2nd half of 2010. Together with a prolonged twenty-year period of Guaranteed price since 2008, investment into PV became highly favourable in 2009 and 2010.

- **Time of public awareness** about the issue. Mass media started informing about exceptionally favourable conditions for PVPPs no sooner than in 2008. After increased publicity, PV dragged attention of a wide scope of entrepreneurs and small investors.

7. Conclusions

The analysis of the regulatory policy of PV in the CR after 2005 successfully demonstrated how the policy evolved and how it affected the development of photovoltaic power plants. Not only did the Thesis provide theoretical background of solar power and PV, it also included a detailed study of legislation connected with PV and types of support the PVPPs could get from the state. Above all, an in-depth study of the development of the regulatory policy and PV was performed.

The most valuable part of the Thesis from the perspective of PV businesses is the estimate of the development of PPs paid to the producers of PV electricity. Based on initial parameters of the PVPP such as time of launch and its IC, the producer of electricity can easily find out the PPs which he would be paid for each kWh produced over the whole lifespan of the plant. Such a complete summary of PPs did not exist before and it is a significant contribution to the issue of PV in the CR. The development was summarized in a table which may later serve as a base for a program that estimates the PPs after input of the PVPP parameters.

The regulatory policy was finally evaluated by computation of payback periods of a power plant with the same technical parameters for different years of launch. The subsequent comparison of resulting payback periods for each year with Act on Promotion of Use of Renewable Sources has shown that the PPs in 2010 (when the boom peaked) were not in accordance with the Act. However, ERO could not do anything about that because the same Act forbade lowering PPs more significantly than by 5 % annually.

Analysis of the payback period is especially beneficial thanks to the fact that it virtually identifies the culprit of the solar boom. It is the then government who is to blame for uncontrollable expansion of PV. If the government reacted quickly enough and passed a bill that would allow larger cuts to the PPs in time, the drawbacks of the development of PV could have been diminished. Unlike the government, ERO proceeded precisely accordingly to the law and it did its best to mitigate the boom.

8. List of Resources

8.1. Printed Documents

POULEK Vladislav, LIBRA Martin. **Photovoltaics: Theory and Practice of Solar Energy Utilization**. 1st edition. ILSA, Prague, 2010. 169 pages. ISBN 978-80-904311-2-6

MIYAMOTO Kazuhisa. **Renewable Biological Systems for Alternative Sustainable Energy Production**. 1st edition. Food & Agriculture Org., 1997. 108 pages. ISBN 9789251040591

McENVOY Augustin, MARKVART Tom, CASTANER Luis. **Practical Handbook of Photovoltaics: Fundamentals and Applications**. 2nd edition. Academic Press, 2011. 1268 pages. ISBN 9780123859341

SACHER Tomáš, SPURNÝ Jaroslav. **The Great Solar Theft**. Respekt, 2011, No. 30, p. 52

8.2. On-line Resources

Act No. 180/2005 Coll. (Act on Promotion of Use of Renewable Sources) [on-line]. 2005-03-31 [2012-02-24]. PDF. Available at http://www.eru.cz/user_data/files/legislativa/english/acts/aj_180zak.pdf

Act No. 330/2010 Coll. [on-line] [in Czech]. 2010-11-03 [2012-02-25]. Available at http://biom.cz/cz/legislativa/fyto-legislativa/3302010-sb

Act No. 402/2010 Coll. [on-line] [in Czech]. 2010-12-14 [2012-02-25]. PDF. Available at http://www.mojeenergie.cz/?download=_/_ld825/sb0144-2010-402-2010.pdf

AKTUALNE.CZ. **Solar Business: First Case of Bribery Before the Court**, [on-line] [in Czech]. Aktuálně.cz News, 2012-03-01 [2012-03-10]. Available at http://aktualne.centrum.cz/domaci/regiony/liberecky/clanek.phtml?id=735433

BAROCH Pavel. **A Hundred of Solar Businesses Asking Czech Govt for Compensation Worth Billions**, [on-line] [in Czech]. Aktuálně.cz News, 2011-10-05 [2011-11-25]. Available at http://aktualne.centrum.cz/domaci/soudy-a-pravo/clanek.phtml?id=716354

BAROCH Pavel, **Own Projects Connected by CEZ in Time, Smaller Ones Got a Raw Deal**, [on-line] [in Czech]. Aktuálně.cz News, 2011-01-18 [2012-02-24]. Available at http://aktualne.centrum.cz/domaci/zivot-v-cesku/clanek.phtml?id=688314

BOUŠKA Jan, KNÍŽEK Petr. **Preparation and Financing of the Construction of Power Plants Based on Renewable Energy Sources** [on-line] [in Czech]. Association of Entrepreneurs for the Use of Energy Resources, 2006 [2012-02-27]. PDF. Available at http://mpo-efekt.cz/dokument/20.zip

CAMPILLO Javier, FOSTER Stephen. **Global Solar Photovoltaic Industry Analysis with Focus on the Chinese Market**, [on-line]. Västerås, Sweden: Mälardålen

University, Department of Public Technology, 2008-05-14 [2011-11-05]. PDF. Available at www.diva-portal.org/smash/get/diva2:127961/FULLTEXT01

COUTURE D. Toby, CORY Karlynn, KREYCIK Claire, WILLIAMS Emily. **A Policymaker's Guide to Feed-in Tariff Policy Design**, [on-line]. Washington, D.C., USA: U.S. Department of Energy, National Renewable Energy Laboratory, 2010-07 [2011-11-05]. PDF. Available at http://www.nrel.gov/docs/fy10osti/44849.pdf

CEZDistribuce.cz. **Basic Information about the CEZ Distribuce, a.s.** [on-line]. CEZ Distribuce, a.s., 2010 [2012-02-15]. Available at http://www.cezdistribuce.cz/en/about-the-company/basic-information.html

CZECH RENEWABLE ENERGY AGENCY. **Brief History of RES Support in the CR** [on-line] [in Czech]. Czech RE Agency, 2011-03-25 [2012-02-24]. Available at http://www.czrea.org/cs/druhy-oze/strucna-historie-podpora-oze

E15 News. **State Wants to Stop Energy Speculators** [on-line] [in Czech]. E15 News, 2009-09-22 [2012-02-24]. Available at http://zpravy.e15.cz/byznys/prumysl-a-energetika/stat-chce-zarazit-spekulanty-s-energii

EKOLOGICKÉ BYDLENÍ. **Possibilities for Connection of PVPPs to the Grid in the End of January 2012 (picture)**, [on-line]. Ekologické bydlení, 2012-01-25 [2012-03-15]. JPG. Available at http://www.ekobydleni.eu/i/mapa-ceska-republika-solarni-elektrarny-stop-stav-pripojovani-580x360.jpg

ERO. **Price Decisions**, [on-line] [in Czech]. Energy Regulatory Office, 2005 - 2011. PDF. Available at http://eru.cz/dias-browse_articles.php?parentId=38&deep=off&type=

ERO. **Monthly Data Summaries of Electric Power System of the Czech Republic**, [on-line] [in Czech]. Energy Regulatory Office, 2010 [2012-03-10]. Available at http://eru.cz/dias-browse_articles.php?parentId=130&deep=off&type=

ERO. **The 2004 Report on the Activities and Finances of the ERO**, [on-line]. Energy Regulatory Office, 2005 [2012-02-15]. PDF. Available at http://www.eru.cz/user_data/files/vyrocni%20zpravy/anglicky/vyrocka04_aj.pdf

ERO. **The 2005 Report on the Activities and Finances of the ERO**, [on-line]. Energy Regulatory Office, 2006 [2012-02-15]. PDF. Available at http://www.eru.cz/user_data/files/vyrocni%20zpravy/anglicky/vyrocka05_aj.pdf

EUROPEAN PHOTOVOLTAIC INDUSTRY ASSOCIATION. **Photovoltaic Energy, Electricity from the Sun**, [on-line]. European Photovoltaic Industry Association, April 2010 [2011-10-18]. PDF. Available at http://www.epia.org/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/EPIA_docs/publications/epia/Electricity_from_the_Sun_2010_update.pdf&t=1331118054&hash=edb92d504bc1c5d3c5aff35a26455539

EUROPEAN PHOTOVOLTAIC INDUSTRY ASSOCIATION. **Market Report 2011** [on-line]. European Photovoltaic Industry Association, January 2012 [2012-02-18]. PDF. Available at http://www.epia.org/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/EPIA_docs/publications/epia/EPIA-market-report-2011.pdf

EUROPEAN PHOTOVOLTAIC INDUSTRY ASSOCIATION. **Solar Photovoltaics Competing in the Energy Sector – On the Road to Competitiveness** [on-line]. European Photovoltaic Industry Association, 2011-09-05 [2012-02-18]. PDF. Available at http://www.epia.org/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/EPIA_docs/publications/epia/Competing_Full_Report.pdf&t=1331118054&hash=0562fbf108eeebf44bc66cc484be10b5

JACQUES Carole. **Lux Research Reveals 2011 Top 10 Module Manufacturers** [on-line]. Lux Research, Inc., 2012-03-14 [2012-03-17]. Available at http://www.luxresearchinc.com/images/stories/brochures/Press_Releases/RELEASE_Q1_2012_Supply_Tracker_3_14_12.pdf

KAVON Robi. **Sun to Schools – Program Costs Exceed 150M, What is it Really Like?** [on-line] [in Czech]. TZB-info, 2004-04-11 [2012-02-20]. Available at http://www.tzb-info.cz/1929-nedelni-komentar-slunce-do-skol-projekt-stal-jiz-pres-150-mil-kc-ale-co-se-skryva-pod-poklickou

KOUBA Stanislav. **Taxation of Electricity from Solar Power Plants**, [on-line] [in Czech]. Brno: Masaryk University, Faculty of Law, 2010-11-10 [2012-01-25].

PDF. Available at http://www.law.muni.cz/sborniky/dny_prava_2010/files/prispevky/03_ekonomicke_aspekty/Kouba_Stanislav_%284375%29.pdf

Public Notice No. 475/2005 Coll. [on-line]. Available at http://www.eru.cz/user_data/files/legislativa/english/notice_180/aj_vyhl_2005_475.pdf

Public Notice No. 140/2009 Coll. [on-line] [in Czech]. Available at http://eru.cz/user_data/files/legislativa/legislativa_CR/Vyhlaska/140_2009/140_2009_ve%20zneni_393_11.pdf

Public Notice No. 364/2007 Coll. [on-line] [in Czech]. Available at http://www.czrea.org/files/pdf/zakony/364_2007_Sb.pdf

RenewableEnergyWorld.com**. Thin-film's Share of Solar Panel Market to Double by 2013** [on-line]. Renewable Energy World, 2009-11-13 [2012-01-20]. Available at http://www.renewableenergyworld.com/rea/news/article/2009/11/thin-films-share-of-solar-panel-market-to-double-by-2013

Report of the Independent Expert Committee for Assessment of the Energy Needs of the Czech Republic in the Long Term (draft), [on-line] [in Czech]. Czech Government, Independent Expert Committee for Assessment of the Energy Needs of the Czech Republic in the Long Term, 2008-09-30 [2012-01-25]. PDF. Available at http://www.vlada.cz/assets/media-centrum/aktualne/Pracovni-verze-k-oponenture.pdf

SAWIN L. Janet., MARTINOT Eric. **Renewables Bounced Back in 2010, Finds REN21 Global Report** [on-line]. Renewable Energy World, 2011-09-29 [2012-01-20]. Available at http://www.renewableenergyworld.com/rea/news/article/2011/09/renewables-bounced-back-in-2010-finds-ren21-global-report

ŠINDELÁŘ Jiří. **Natural Resources Management: First Lecture** [on-line]. Prague: Czech University on Life Sciences in Prague, Department Of Management, 2011-10-05 [2012-02-21]. MS PowerPoint Presentation. Available at http://pef.czu.cz/~sindelar/NRM/Prezentace_NRM01_final.ppt

STATE ENVIRONMENTAL FUND OF THE CR. **Annual Reports 2000 – 2003** [on-line]. State Environmental Fund of the CR, [2012-02-20]. Available at http://www.sfzp.cz

TZB-info. **Czech Distributing Companies by Regions (picture)**, [on-line]. TZB-info, 2010 [2012-03-15]. JPG. Available at http://www.tzb-info.cz/docu/texty/0002/000211o1.gif

WANG Ucilia. **The Rise of Concentrating Solar Thermal Power**, [on-line]. Renewable Energy World, 2011-06-06 [2012-01-20]. Available at http://www.renewableenergyworld.com/rea/news/article/2011/06/the-rise-of-concentrating-solar-thermal-power

9. Supplements

Guaranteed Price [CZK/kWh]

	PVPP Parameters: Launch	PVPP Parameters: IC (kWp)	2006	2007	2008	2009	2010	2011	2012
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	14.29	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	**01, 02 2011**	**>30 <100**						**5.90**	**6.02**
Theoretical									6.02
Real		**>100**						**5.50**	**5.61**
Theoretical									5.61
Real	**2012**	**<30**							**6.16**
Theoretical									

Supplement No. 1 (part 1/4): Estimate of the Development of Guaranteed Price for All the PVPPs over Their Lifespan Based on Appropriate Legislation. See the Comments. Author's Work.

Comments on Supplement No. 1 (part 1/2):

- Theoretical prices are computed as 2 % annual increase; increase can be between 2 - 4 % but is usually around the lower value
- Real prices are prices issued by ERO in Price Decisions
- PVPPs launched in 2009 and 2010 are taxed by 26 % in 2011, 12, 13; **plants smaller than 30 kW situated on a roof or on a perimeter wall of a building shall be excluded from the levy**
- For plants launched 2005, 06, 07 a fifteen-year support is assumed under Public Notice No. 475/2005 Coll.

Guaranteed Price [CZK/kWh]

	PVPP Parameters: Launch	IC (kWp)	2013	2014	2015	2016	2017	2018	2019
Real	**Before 2006**								
Theoretical	**Before 2006**		7.27	7.42	7.57	7.72	7.87	8.03	8.19
Real	**2006**								
Theoretical	**2006**		15.26	15.56	15.88	16.19	16.52	16.85	17.18
Real	**2007**								
Theoretical	**2007**		15.26	15.56	15.88	16.19	16.52	16.85	17.18
Real	**2008**								
Theoretical	**2008**		14.88	15.18	15.48	15.79	16.11	16.43	16.76
Real	**2009**	**<30**							
Theoretical	**2009**	**<30**	10.33	14.24	14.52	14.81	15.11	15.41	15.72
Real	**2009**	**>30**							
Theoretical	**2009**	**>30**	10.26	14.14	14.42	14.71	15.00	15.30	15.61
Real	**2010**	**<30**							
Theoretical	**2010**	**<30**	9.62	13.27	13.54	13.81	14.08	14.36	14.65
Real	**2010**	**>30**							
Theoretical	**2010**	**>30**	9.55	13.16	13.42	13.69	13.96	14.24	14.53
Real	**2011**	**<30**							
Theoretical	**2011**	**<30**	7.80	7.96	8.12	8.28	8.45	8.62	8.79
Real	**01, 02 2011**	**>30 <100**							
Theoretical	**01, 02 2011**	**>30 <100**	6.14	6.26	6.39	6.52	6.65	6.78	6.92
Real	**01, 02 2011**	**>100**							
Theoretical	**01, 02 2011**	**>100**	5.72	5.84	5.95	6.07	6.19	6.32	6.44
Real	**2012**	**<30**							
Theoretical	**2012**	**<30**	6.28	6.41	6.54	6.67	6.80	6.94	7.08

Supplement 1 (part 2/4): Estimate of the Development of Guaranteed Price for All the PVPPs over Their Lifespan Based on Appropriate Legislation. See the Comments. Author's Work.

Comments on Supplement No. 1 (part 2/2):

- For PVPPs launched since 2008 a twenty-year support is assumed under Public Notice No. 364/2007 Coll.
- Since March 2011 only PVPP of **IC < 30 kWp situated on a roof or on a perimeter wall of a building are supported**
- Premium for decentralised production is not included. This premium was 0.064 CZK/kWh for power plants connected to low voltage level, 0.027 CZK/kWh for high voltage level and 0.020 CZK/kWh for very high voltage level. However, the premium is cancelled since 2012.

Guaranteed Price [CZK/kWh]	PVPP Parameters								
	Launch	IC (kWp)	2020	2021	2022	2023	2024	2025	2026
Real	**Before 2006**								
Theoretical			8.35	8.52					
Real	**2006**								
Theoretical			17.53	17.88					
Real	**2007**								
Theoretical			17.53	17.88	18.24				
Real	**2008**								
Theoretical			17.09	17.44	17.79	18.14	18.50	18.87	19.25
Real	**2009**	**<30**							
Theoretical			16.04	16.36	16.68	17.02	17.36	17.70	18.06
Real		**>30**							
Theoretical			15.92	16.24	16.56	16.90	17.23	17.58	17.93
Real	**2010**	**<30**							
Theoretical			14.94	15.24	15.55	15.86	16.18	16.50	16.83
Real		**>30**							
Theoretical			14.82	15.11	15.42	15.73	16.04	16.36	16.69
Real	**2011**	**<30**							
Theoretical			8.96	9.14	9.33	9.51	9.70	9.90	10.09
Real	**01, 02 2011**	**>30 <100**							
Theoretical			7.05	7.19	7.34	7.49	7.63	7.79	7.94
Real		**>100**							
Theoretical			6.57	6.70	6.84	6.98	7.11	7.26	7.40
Real	**2012**	**<30**							
Theoretical			7.22	7.36	7.51	7.66	7.81	7.97	8.13

Supplement 1 (part 3/4): Estimate of the Development of Guaranteed Price for All the PVPPs over Their Lifespan Based on Appropriate Legislation. See the Comments. Author's Work.

Guaranteed Price [CZK/kWh]

	PVPP Parameters							
	Launch	**IC (kWp)**	2027	2028	2029	2030	2031	2032
Real	**Before 2006**							
Theoretical								
Real	**2006**							
Theoretical								
Real	**2007**							
Theoretical								
Real	**2008**							
Theoretical			19.64	20.03				
Real	**2009**	**<30**						
Theoretical			18.42	18.79	19.16			
Real		**>30**						
Theoretical			18.29	18.65	19.03			
Real	**2010**	**<30**						
Theoretical			17.17	17.51	17.86	18.22		
Real		**>30**						
Theoretical			17.02	17.36	17.71	18.06		
Real	**2011**	**<30**						
Theoretical			10.30	10.50	10.71	10.93	11.14	
Real	**01, 02 2011**	**>30 <100**						
Theoretical			8.10	8.26	8.43	8.60	8.77	
Real		**>100**						
Theoretical			7.55	7.70	7.86	8.01	8.17	
Real	**2012**	**<30**						
Theoretical			8.29	8.46	8.63	8.80	8.97	9.15

Supplement 1 (part 4/4): Estimate of the Development of Guaranteed Price for All the PVPPs over Their Lifespan Based on Appropriate Legislation. See the Comments. Author's Work.

Development of Initial Investment

Year	Price Index (Base 2006)	Price Index (Base 2010)
2006	100	200
2007	88	176
2008	82	164
2009	60	120
2010	50	100
2011	40	80

Supplement No. 2: Development of Initial Investment in PV in the CR. Price Index Base 2010 computed by Author. Source of Data: Czech Renewable Energy Agency, www.czrea.org.

Launch on 1 January 2006

Year No.	Year	Performance	Supply to the Grid [MWh]	PP [CZK/kWh]	Sales to the Grid ['000s CZK]	Operating costs ['000s CZK]	Cumulative Cash Flow
1	2006	100.0%	1,670.3	13.23	22,092.40	1,325.54	-278,468.30
2	2007	99.0%	1,653.5	13.48	22,289.79	1,341.54	-257,520.06
3	2008	98.0%	1,636.8	13.82	22,621.17	1,357.54	-236,256.44
4	2009	97.0%	1,620.1	14.10	22,843.98	1,373.54	-214,786.00
5	2010	96.0%	1,603.4	14.40	23,084.73	1,385.08	-193,086.36
6	2011	95.0%	1,586.7	14.69	23,304.41	1,398.26	-171,180.21
7	2012	94.0%	1,570.0	14.99	23,530.11	1,411.81	-149,061.90
8	2013	93.0%	1,553.3	15.29	23,744.55	1,424.67	-126,742.03
9	2014	92.0%	1,536.6	15.59	23,958.19	1,437.49	-104,221.33
10	2015	91.0%	1,519.9	15.90	24,170.91	1,450.25	-81,500.68
11	2016	90.0%	1,503.2	16.22	24,382.59	1,462.96	-58,581.04
12	2017	89.3%	1,492.1	16.54	24,685.20	1,481.11	-35,376.95
13	2018	88.7%	1,481.0	16.87	24,990.19	1,499.41	-11,886.17
14	**2019**	88.0%	1,469.8	17.21	25,297.54	1,517.85	**11,893.51**
15	2020	87.3%	1,458.7	17.56	25,607.21	1,536.43	**35,964.29**
Total			23,355.7		356,602.96	21,403.51	

Supplement No. 3: Data of the Sample PVPP, Launch 2006. See the Comments. Source: Author's computations based on Investor's data.

Comments on Supplement No. 3:

- Decentralised Production Premium included (0.027 CZK/kWh)
- Operating Costs 6.0 % of Sales
- Initial Investment 299,235,200 CZK
- Payback Period 14 years

Launch on 1 January 2010

Year No.	Year	Performance	Supply to the Grid [MWh]	PP [CZK/kWh]	Sales to the Grid ['000s CZK]	Operating costs ['000s CZK]	Cumulative Cash Flow
1	2010	100.0%	1,670.3	12.18	20,338.63	1,220.32	-130,499.26
2	2011	99.0%	1,653.5	9.20	15,212.60	1,236.32	-116,522.97
3	2012	98.0%	1,636.8	9.38	15,353.57	1,252.32	-102,421.72
4	2013	97.0%	1,620.1	9.57	15,504.73	1,268.32	-88,185.31
5	2014	96.0%	1,603.4	13.19	21,144.56	1,268.67	-68,309.42
6	2015	95.0%	1,586.7	13.45	21,341.94	1,280.52	-48,248.00
7	2016	94.0%	1,570.0	13.72	21,538.78	1,292.33	-28,001.54
8	2017	93.0%	1,553.3	13.99	21,735.00	1,304.10	-7,570.64
9	**2018**	92.0%	1,536.6	14.27	21,930.49	1,315.83	**13,044.02**
10	2019	91.0%	1,519.9	14.56	22,125.13	1,327.51	33,841.64
11	2020	90.0%	1,503.2	14.85	22,318.83	1,339.13	54,821.34
12	2021	89.3%	1,492.1	15.14	22,595.76	1,355.75	76,061.36
13	2022	88.7%	1,481.0	15.45	22,874.87	1,372.49	97,563.73
14	2023	88.0%	1,469.8	15.75	23,156.13	1,389.37	119,330.50
15	2024	87.3%	1,458.7	16.07	23,439.52	1,406.37	141,363.65
16	2025	86.7%	1,447.5	16.39	23,725.02	1,423.50	163,665.17
17	2026	86.0%	1,436.4	16.72	24,012.58	1,440.75	186,237.00
18	2027	85.3%	1,425.3	17.05	24,302.19	1,458.13	209,081.05
19	2028	84.7%	1,414.1	17.39	24,593.80	1,475.63	232,199.23
20	2029	84.0%	1,403.0	17.74	24,887.38	1,493.24	**255,593.36**
Total			30,482.0		432,131.53	26,920.59	

Supplement No. 4: Data of the Sample PVPP, Launch 2010. See the Comments. Source: Author's computations based on Investor's data.

Comments on Supplement No. 4:

- Decentralised Production Premium included (0.027 CZK/kWh)
- Operating Costs 6.0 % of Sales
- Initial Investment 149,617,600 CZK
- Payback Period 9 years

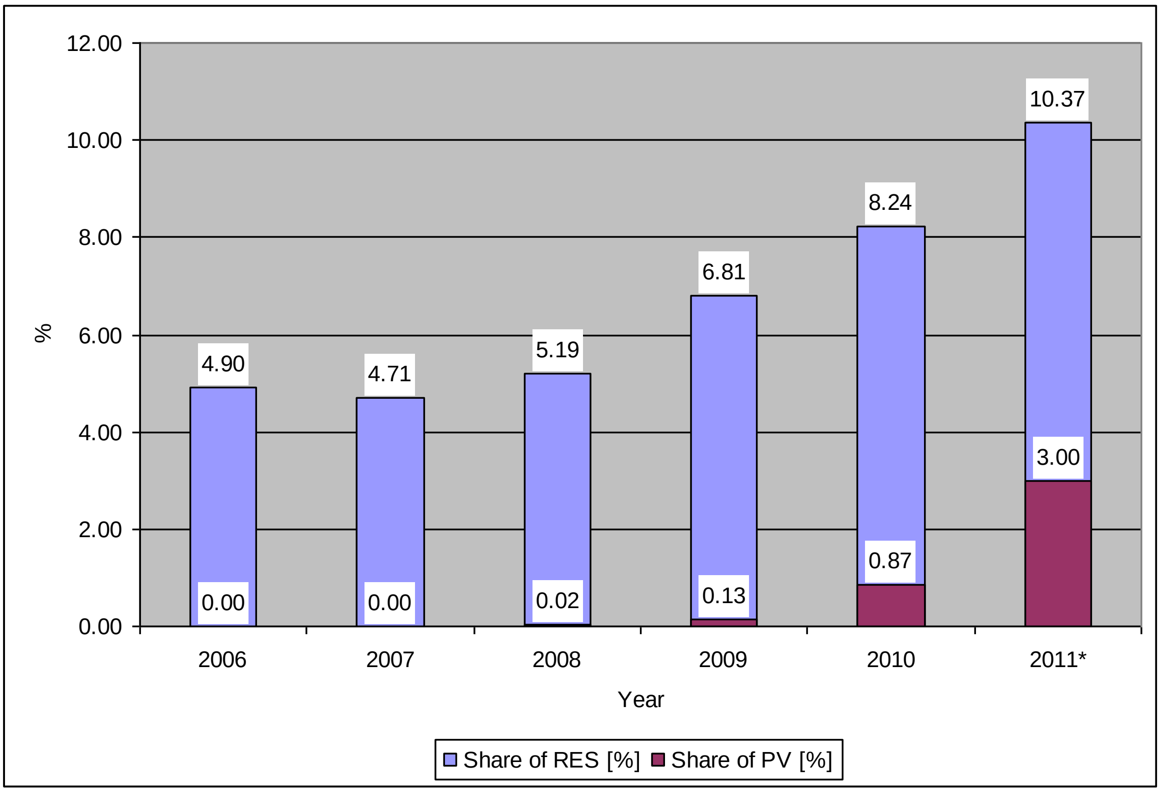
Launch on 1 January 2011

Year No.	Year	Performance	Supply to the Grid [MWh]	PP [CZK/kWh]	Sales to the Grid ['000s CZK]	Operating costs ['000s CZK]	Cumulative Cash Flow
1	2011	100.0%	1,670.3	5.53	9,231.47	1,107.78	-111,570.37
2	2012	99.0%	1,653.5	5.63	9,309.44	1,123.78	-103,384.70
3	2013	98.0%	1,636.8	5.74	9,395.46	1,139.78	-95,129.02
4	2014	97.0%	1,620.1	5.86	9,494.00	1,155.78	-86,790.80
5	2015	96.0%	1,603.4	5.98	9,583.76	1,150.05	-78,357.09
6	2016	95.0%	1,586.7	6.10	9,672.75	1,160.73	-69,845.07
7	2017	94.0%	1,570.0	6.22	9,761.50	1,171.38	-61,254.94
8	2018	93.0%	1,553.3	6.34	9,849.97	1,182.00	-52,586.97
9	2019	92.0%	1,536.6	6.47	9,938.11	1,192.57	-43,841.43
10	2020	91.0%	1,519.9	6.60	10,025.87	1,203.10	-35,018.66
11	2021	90.0%	1,503.2	6.73	10,113.20	1,213.58	-26,119.05
12	2022	89.3%	1,492.1	6.86	10,238.24	1,228.59	-17,109.40
13	2023	88.7%	1,481.0	7.00	10,364.27	1,243.71	-7,988.84
14	**2024**	88.0%	1,469.8	7.14	10,491.27	1,258.95	**1,243.47**
15	2025	87.3%	1,458.7	7.28	10,619.24	1,274.31	10,588.40
16	2026	86.7%	1,447.5	7.43	10,748.15	1,289.78	20,046.77
17	2027	86.0%	1,436.4	7.57	10,878.00	1,305.36	29,619.41
18	2028	85.3%	1,425.3	7.72	11,008.77	1,321.05	39,307.13
19	2029	84.7%	1,414.1	7.88	11,140.46	1,336.85	49,110.74
20	2030	84.0%	1,403.0	8.03	11,273.03	1,352.76	**59,031.00**
Total			30,482.0		203,136.96	24,411.90	

Supplement No. 5: Data of the Sample PVPP, Launch 2011. See the Comments. Source: Author's computations based on Investor's data.

Comments on Supplement No. 5:

- Decentralised Production Premium included (0.027 CZK/kWh)
- Operating Costs 12.0 % of Sales (doubled to compensate for lower PP)
- Initial Investment 119,694,100 CZK
- Payback Period 14 years



Supplement No. 6: RES Electricity Share on the Gross Consumption in the CR. Source of Data: Energy Regulatory Office, eru.cz. Author's Work.

Comment on Supplement No. 6:

- Share of RES figure for 2011 estimated (data not available yet): Share of PV in 2011 + Share of other RES in 2010.

Supplement No. 7: Czech Distributing Companies by Regions. Source: TZB-info, tzb-info.cz. Adjusted by Author.