SOLAR POWER STATION FROM THE VIEW OF INVESTORS

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ABSTRACT

Faculty of Mechatronics, Informatics and Interdisciplinary Studies (Technical University of Liberec, Czech Republic) solves in recent years several research projects focused on technology in the field of the environment. This paper is primarily focused on the photovoltaic energetic services, let´s say on the financial valuation of these technologies. First the photovoltaic energetic and the process of industrial research and development is mentioned. The list of possible methods that can be used for technologies evaluation follows. In the final part of the paper the specific case study of the power plant photovoltaic project valuation (by Net Present Value) is demonstrated. There are also mentioned the main legislative changes in photovoltaic services in the Czech Republic (valid from year 2011). These changes should restrict the increase of prices of electric energy for the final consumers and, of course, to ensure the incomes to the state budget.

Key words: photovoltaic energy, technology, evaluation, net present value

INTRODUCTION

Technologies are moving with the world! The importance of research, development and innovation is become aware currently by each business entity competing on the market for its competitive advantage. J. A. Schumpeter´s motto "*Who don´t innovate – will die"* was worth in the past, is worth also in the present. Very important is the connection of the technical aspects of the research and development with its economic aspects. Technology is a concept that can be defined, for example, as follows: *"Using of the knowledge to profitable objectives"* (Boer, 2007, p. 29).

This paper is focused mainly on the area of photovoltaic energy, resp. on the valuation of this technology. First the general process of industrial research and development is mentioned in the introduction. The next part is devoted to the possible methods that can be used for technologies evaluation. In the third main part of the paper there is refered the specific case study of photovoltaic project valuation (by Net Present Value). The exhaustibility of non-renewable mineral resources has been for a long time recurrent theme in many discussions; number of professional essays of the authors, headed by J. Simon (Simon, 2006) or B. Lomborg (Lomborg, 2006), proclaim that. Slavík (Slavík, 2009) also says that the often neglected indicator of scarcity of raw materials on the market is their price, which plays a vital role not only in the case of primary raw materials, but also of other goods and services. The question (the hypothesis H_0) stands here: "The companies knowing methods for technologies evaluation are profitable, they may offer these valuation (energetic) services to the other companies and to help its region to achieve any competitive advantage and to strengthen its economic position". In the framework of this paper one of the possible methods of alternative technology valuation for the production of electrical energy is demonstrated (on the example of case study of photovoltaic project valuation), since this topic is very actual now.

Speaking of photovoltaic, we are talking about the production of clean energy. The energy return on already proved, industrially produced solar cells, moves around a range of a few years and it is constantly shortened. Between the three main advantages of photovoltaic conversion of solar energy include:

1) An excellent return on energy, which improves constantly with time and is higher than for coal-fired or nuclear power plants. It is the only, already proven and secure global source of energy capable of satisfying the needs of all society.

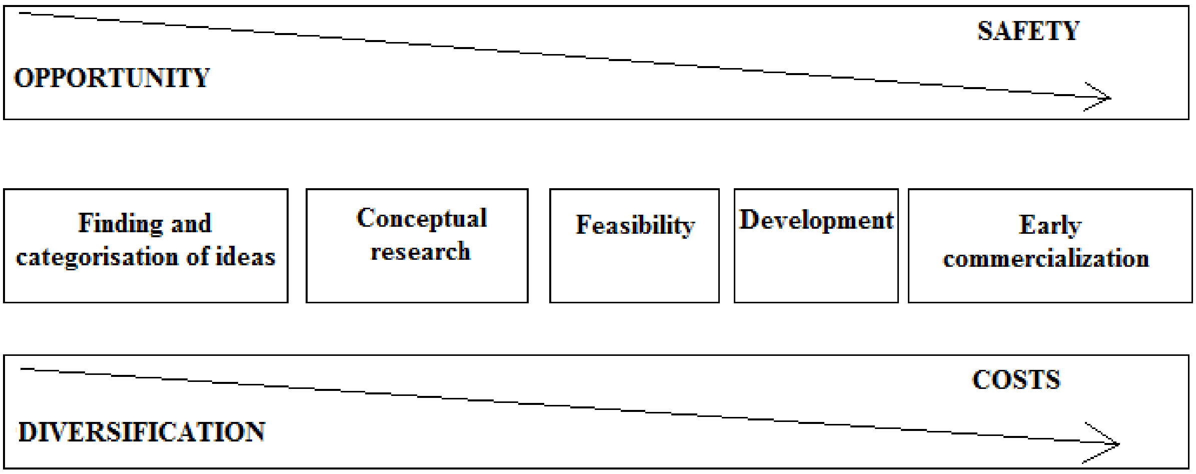
2) Photovoltaic does not harm the environment, or the natural or energy balance of the planet. It does not create the emissions or radioactive waste. It is a phenomenon similar to natural phenomena such as photosynthesis (only with almost 100times greater effect).
3) Massive investments are not needed for the construction of power plants, power plant is modular, secure, easy to maintenance. Similarly, research of new and improved solar cells can be realized in the framework of small interconnected European groups - enormous technical equipment is not needed as for the research of nuclear fission or fusion (Vaněček, 2010).

In the paper the process of industrial research and development of new technologies will be mentioned first; the passage about the valuation of developed technologies, focusing on the photovoltaic, follows. In the framework of the above mentioned case study, we try to illustrate on the specific example, how the valuation process is realized within the current conditions (by usage of redemption prices). The new situation will be also outlined, including possible changes in the Czech legislation and energetic services.

PROCESS OF INDUSTRIAL RESEARCH AND DEVELOPMENT

If the company would like to evaluate its technology, first it is necessary to understand the process, on whose basis its value consists of. This process is divided into five successive phases, each is represented by the degree of risk, opportunity, diversification, and the volume of costs. Chart 1 illustrates this situation:

Chart 1 - Key relationships in the process of research and development



Source: Boer Peter, F. (2007) Oceňování technologií. Podnikatelské a finanční aspekty výzkumu a vývoje. Brno, ZONER software, s.r.o., 2007. ISBN 978-80-86815-66-4. p. 65.

The size of the opportunities and diversification is the minimum for the initial phase, as well as the costs, and also the safety that the technology will be successful and profitable. The opposite is the status of early commercialization, where diversification and an opportunity are at a low level, but it is offset by a high level of certainty. The costs are in this stage very high. In the following part of this paper the different phases will be briefly described and summarized in Table 1, which indicates the dependency of committed persons and financial and commercial aspects of the individual stages of the process phases. The reasons for the process division into several phases are different knowledge and intellectual requirements necessary in that phase. Rarely, one worker participates in all phases of the process.

Finding and Categorisation of New Ideas

The idea for the commercial exploitation of new ideas can come from any level of the enterprise, or beyond. However, generally the new ideas are coming from scientists and researchers. They are able to distinguish potential of this idea within the commercial sphere. In this phase a large amount of ideas is generated.

Conceptual Research

In this stage, the researcher requires formal approval together with the necessary resources to start the project. For this consent, it is necessary to answer the following questions:
1. What are the target market and the early commercialization?

2. Who will sell the results?
3. How does the proposed technology differ from competing solutions?
4. What are its technical advantages?
5. May we expect to obtain the patent protection at home or abroad?
6. May the technology become the basis for other further initiatives?

Here usually a comprehensive study of literature proceeds. The proposer determines whether this technology already exists. The patent lawyers and the firm top management are involved, whereas it is dealing a question of strategic (long-term) measures.

Feasibility Searching

This phase is tasked to determine the needs of the market and the preliminary costs on previously asked questions. There is already established a timetable and responsibilities with the milestones. It is necessary to design the manufacturing process in detail. The number of workers involved is already considerable: from scientists, researchers, engineers, lawyers and marketing specialists to the top manager, who coordinates the whole team. At this stage, the costs increase at a rate depending on the time factor. Also top management is involved here, they usually provide the additional capital after submission of some intermediate results, demonstrating the correct direction for the development of the whole project.

Development and Construction

One of the indicators for achievement of this phase is the publication of the technology to public. For the success of the future it is essential the company to be in its intention trustful and prepared to the hard opponency of public. There is already a good reputation of the company at stake, and the high costs. Project management is changing, the project centre moves from the laboratory experts to marqueters, sellers and experts in production. Together with all of this, the actual future economic value is detected. On the basis of this value the conditional orders for technology utilization are concluded. Then the company will decide which direction its obligation will follow, in order to achieve the maximum profit from the range of possible options. In negotiations with trading partners the firm has already much stronger position because it already disposes of specific data and outputs.

Early Commercialization

Management of the company aims to resolve the remaining problems on the point of the pilot market, which consists of the first orders, which is at the same time the indicator of "finding" at this stage. On the other hand, the costs are still much higher than the company´s revenues. It is, of course, only a temporary phenomenon till the time, when the production of greater quantities will be realized, resp. till the time when the economies of scale start to play their important role. The reason why this phase is still refered to the research and development is the fact that the costs make up here a majority part of the project budget (Boer, 2007, p. 63).

A summary of this section is supplemented by Table 1 showing the connections with the individual phases of the technology generation. It is necessary to add that the whole process of research and development is about finding of diversified, commercially usable ideas and risk regimentation within the ideas´ implementation at the lowest possible costs.

This paper is focused on photovoltaic energy, resp. the valuation of this technology. We can conclude that photovoltaic is situated in an early phase, or advancing phase of commercialization.

Table 1 - Characterization of process phases of research and development

	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4
	Finding and categorisation of new ideas	**Conceptual research**	**Feasibility searching**	**Development and construction**	**Early commercialization**
Committed persons	**researchers** technicians	technicians, lawyers, firm top management	engineers, consultants, researchers, marqueters, responsible manager	marketing specialists, sale, production, operating	micro firm - manager, sale department, production equipment, accounting
Financial and commercial aspects	low, cca 10 % of budget (short-time horizon)	higher costs on capital and time	high costs on market research	finding of the real future economic value	reduction of financial risks by final market penetration

Source: own construction

TECHNOLOGY EVALUATION METHODS

The valuation of technologies is a complex process. First, it is necessary to define the specific technology, which we will appreciate. If we are talking about the valuation of technologies, we refer to the "hard" technologies. Further we have to realize for what purpose the evaluation will be used - whether it should calculate the present value of the technology, or to quantify its future value.

We can choose, for example the simplest method of the purchase price, however, suitable only for certain types of technologies (e.g. valuation of technologies for the car production).

Further, the method of market comparison (i.e. benchmarking). First we have to determine whether this method is feasible (feasibility analysis), then collect and analyze the data, approximately evaluate it (using "benchmarking cluster") and at the conclusion more specify the valuation (e.g. evaluation of the parameters by the different (higher/lower) weight, so we may cause an increase or reduction of the final price of the technology).

Third, let's say the most qualified group of methods, are methods based on the cash flows. In the framework of these methods we calculate net present value and expected net present value of the technologies (Dvořák, 2011b). This paper is focused just on these valuation methods, resp. one selected method: the net present value (see below).

Net Present Value (NPV)

Net present value is an indicator counting only with the future cash flows. It tells us how many financial resources the project will earn us, or lose us, within the project durability life. NPV calculates with future cash flows, which are discounted.

The question remains: How to determine the amount of the discount?

- We can obtain the discount such as a risk-free interest rate (e.g. for long-term foreign capital) + risk premium, taking within the project realization (e.g. 14 days PRIBOR rate + 2 % representing the risk premium).
- Another discount rate assessment – e.g. determination of discount rate at the same amount as the average ROE for the last *x* years, where *x* can be equal to the project durability life (note: ROE = Return on Equity, i.e. indicator of return on equity equals to the share of the profit and equity capital).
- Next method sets the discount rate equal to WACC (Weighted Average Costs of Capital). For the WACC calculation it is necessary to know the rate of interest paid from foreign capital (r_e), the rate of income tax (t), foreign capital (E), equity capital (I), total capital (T, whereas T = E + I) and the required percentage return on equity (r_i).

$$WACC = \left(r_e * (1-t) * (E/T)\right) + \left(r_i * (I/T)\right) \quad (1)$$

One difference can be seen here - the previous methods calculated more or less with the fact that you are looking at the whole investment as you pay it from your own resources, but WACC strictly separates equity resources and foreign resources.

After determining the discount rate we are able to calculate the present value of future cash flows according to this formula:

$$PV = \sum_0^t \frac{CF_t}{(1+r)^t} \qquad (2)$$

where t = project durability life, r = discounted rate, CF = generated cash flow in the given year.

Net present value is equal then to the following mathematical formula:

$$NPV = -In_0 + \sum_0^t \frac{CF_t}{(1+r)^t} \qquad (3)$$

where In_0 = invested financial resources.

From the above mentioned it is clear that NPV acceptable value is any non-negative number. If NPV = 0, then the investment will not earn us anything, and also will not lose us anything. It is obvious that a large part of the company´s assets yields also the non-monetary benefits, which NPV does not consider at all. Any positive NPV value (NPV > 0) is good, resp. the higher value, the better economic situation we can expect (Valach, 2001).

Case Study - Photovoltaic Project Evaluation

At the time of boom of alternative energy technologies it appears as an interesting task the project of the photovoltaic power plant. In the following case study it should be partially exposed, why these investments in this sector will not be for the investors in the Czech Republic so beneficial, as it was the past (thanks to the planned decrease of electricity redemption prices, limiting conditions of state subsidy, etc.). On the market there are many companies providing implementation of photovoltaic so called "on the key". One of these firms (ISOFEN ENERGY, 2010) provided us documents (see partly previous parts) revealing the economic usage of this technology. We obtained these documents on the basis of realized demand for a particular project of solar power plant for family house. In this menu the basic economic indicators of the efficiency and profitability are listed. However, one indicator is missing there: the NPV value of the project in the period of twenty years. And just this task our case study solved. The calculation of guaranteed redemption prices was used, when all electricity produced is sold to the distributor who is obliged to buy it from the producer according to the agreement (at the conclusion of this paper also the issues of "green bonus" will be outlined, i.e. calculation appropriate in the case of large objects with high consumption of electricity produced).

Photovoltaic System Specification

The power plant will be used for the electricity production, its consumption in a family house, and the surplus of electricity will be sold to ČEZ for the specified redemption within the period of twenty years.

Total power: 102.96 kWp
Manufacturer of panels: ERA SOLAR
Power of the panel: 180 Wp
Number of panels: 572
Manufacturer of inverters Kaco Powador 3000xi-XL
Number of inverters: 3

INVESTMENT AMOUNT

The amount of the investments is set at 8,600,000 CZK including VAT 10 %. Total price consists of administration associated with the territorial agreement, the territorial management or construction permit, the processing of application and elaboration of documents for distribution company (connection to the distribution system), project documentation, complete delivery and installation of the photovoltaic system (photovoltaic panels, inverters, mounting system (locksmith designs), electric switch boards, installation, revision). Furthermore, the price includes licence allocation from Energy Regulatory Office, preparing of contracts for the connection, training and advisory activities.

Investment Economics (data valid to 31. 12. 2010)

Let us look at the basic economic and legal facts associated with this investment:

a) Value added tax

§ 48 of Law No. 235/2004 is valid for the photovoltaic installation in family houses, apartment houses, and blocks of houses. The reduced VAT rate of 10 % applies here (on installation and also on the technical means of photovoltaic power plants).

b) Exemption from income tax

Photovoltaic power plants are renewable energy source, therefore the receipts of this activity shall be exempt from this tax according to § 4 sub. 1e) of Law No. 526/1992. The exemption applies in a year when the power plant was first put into operation and in the immediately following five years.

c) Depreciation

Photovoltaic power plant as a whole belongs to depreciation group number 4 – Construction of power stations (works of energy production) SKP 2302 with the depreciation of 20 years.

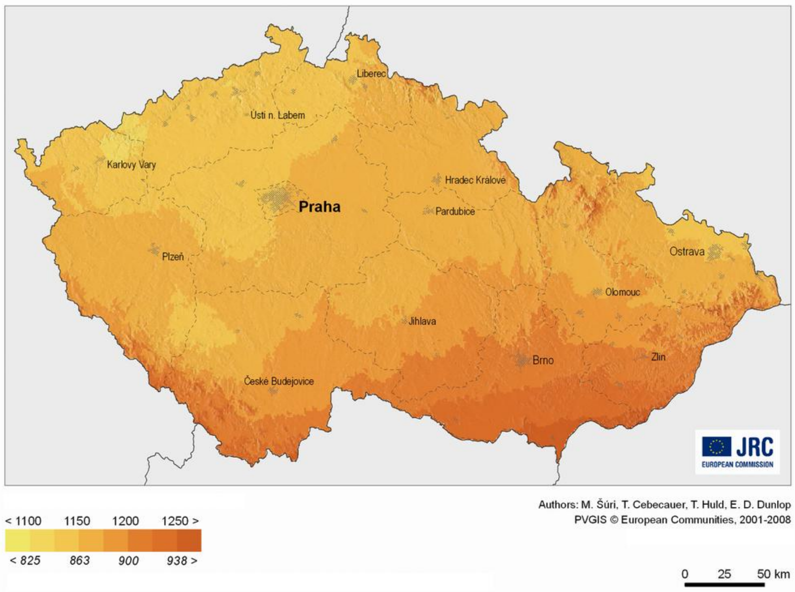
d) Redemption prices

Purchase of the electricity produced is realized for the redemption price fixed by the Energy Regulatory Office. It is valid in the year of putting plants into operation and it is applied for the duration of its lifetime. The intended lifetime of the new plant is 20 years.

Incomes Calculation

Thanks to the long-term measurement of solar radiation, the number of cloudless days and the other variables we now know that in our latitudes at 1 m^2 of the horizontal area fall around 940 - 1,340 kWh of energy. When we think about the efficiency of the photovoltaic panels of 14 % and ideal orientation to the South, then we get 140 kWh from 1 m^2 of electricity per year. For monocrystallic and polycrystallic panels govern, that the installation of 1 kWp covers the area around 8 m^2. This means that the annual income of installed power of 1 kWp is 1,120 kWh. After the deduction of loss on leadership, switch boards, the influence of temperature and angular reflection, etc. we can move in the range of 900 - 1,100 kWh of electricity produced from 1kWp installed power; depending on the geographical area, as shown in Chart 2.

Chart 2- Average annual sum of global solar radiation in the Czech Republic [kWh/m^2]



Source: ČHMÚ, 2010.

The resulting total annual production of solar power plant depends on many factors. Except the geographical position and the climate, it is above all the slope of the installed panels and their orientation to the South. In our conditions the ideal slope is approx. 35°; however a tolerance of ± 15° do not play for the efficiency of the power plant an important role. Orientation to the South is ideally 1 - 3° to the Southwest. In a case study we think about the most optimal variant, i.e. south of the Czech Republic (Jihočeský region), where the average annual sum of global solar radiation is between 1,200 - 1,250 KWh/m^2. On the basis of input data the annual income of photovoltaic system was calculated in the amount of 99,455 kWh.

Project NPV Calculation

The amount of redemption price was set at 12.15 CZK/kWh (Fotovoltaika, 2011) for year 2010 for solar power plants with installed capacity of over 30 kW. According to the novel of Law No. 180/2005, resp. the new Law No. 330/2010, the amount of redemption price may year on year fall by more than 5 %. In the case study with decline of 2.5 % year on year is calculated. The amount of the investment shall be 8,600,000 CZK with 10 % VAT. In the calculation the annual loss of the system efficiency in the amount of 1 % is included.

EBITDA and EBIT Calculation

Table 2 displays the revenues (EBITDA = Earnings Before Interest, Taxes, Depreciation and Amortization) in redemption prices for each period, reduced by its own energy consumption calculated in monetary units. Costs for own consumption are marked in blue. Photovoltaic power plant falls to the 4th tax depreciation group with the period of depreciation of 20 years. The depreciation rate in the first year is 2.15 % of the purchase price and 5.15 % of the residual value. The depreciations of the investment 8,600,000 CZK for each period are shown in red in Table 2, together with the revenues (EBIT = Earnings Before Interest and Taxes) after deduction of depreciations.

Table 2 - Gross investment incomes

year	redemption price [CZK]	annual income [kWh]	annual sale [CZK]	own consumption [CZK]	**EBITDA [CZK]**	residual price [CZK]	depreciation rate	depreciation [CZK]	**EBIT [CZK]**
2010	12.15	99,455.00	1,208,378.25	25,000.00	**1,183,378.25**	8,600,000.00	2.15%	184,900.00	**998,478.25**
2011	11.85	98,460.45	1,166,387.11	25,000.00	**1,141,387.11**	8,415,100.00	5.15%	442,900.00	**698,487.11**
2012	11.55	97,475.85	1,125,855.15	25,000.00	**1,100,855.15**	7,972,200.00	5.15%	442,900.00	**657,955.15**
2013	11.26	96,501.09	1,086,731.69	25,000.00	**1,061,731.69**	7,529,300.00	5.15%	442,900.00	**618,831.69**
2014	10.98	95,536.08	1,048,967.76	25,000.00	**1,023,967.76**	7,086,400.00	5.15%	442,900.00	**581,067.76**
2015	10.71	94,580.72	1,012,516.13	25,000.00	**987,516.13**	6,643,500.00	5.15%	442,900.00	**544,616.13**
2016	10.44	93,634.91	977,331.20	25,000.00	**952,331.20**	6,200,600.00	5.15%	442,900.00	**509,431.20**
2017	10.18	92,698.56	943,368.94	25,000.00	**918,368.94**	5,757,700.00	5.15%	442,900.00	**475,468.94**
2018	9.92	91,771.57	910,586.87	25,000.00	**885,586.87**	5,314,800.00	5.15%	442,900.00	**442,686.87**
2019	9.67	90,853.86	878,943.97	25,000.00	**853,943.97**	4,871,900.00	5.15%	442,900.00	**411,043.97**
2020	9.43	89,945.32	848,400.67	25,000.00	**823,400.67**	4,429,000.00	5.15%	442,900.00	**380,500.67**
2021	9.20	89,045.87	818,918.75	25,000.00	**793,918.75**	3,986,100.00	5.15%	442,900.00	**351,018.75**
2022	8.97	88,155.41	790,461.32	25,000.00	**765,461.32**	3,543,200.00	5.15%	442,900.00	**322,561.32**
2023	8.74	87,273.85	762,992.79	25,000.00	**737,992.79**	3,100,300.00	5.15%	442,900.00	**295,092.79**
2024	8.52	86,401.11	736,478.79	25,000.00	**711,478.79**	2,657,400.00	5.15%	442,900.00	**268,578.79**
2025	8.31	85,537.10	710,886.15	25,000.00	**685,886.15**	2,214,500.00	5.15%	442,900.00	**242,986.15**
2026	8.10	84,681.73	686,182.86	25,000.00	**661,182.86**	1,771,600.00	5.15%	442,900.00	**218,282.86**
2027	7.90	83,834.92	662,338.00	25,000.00	**637,338.00**	1,328,700.00	5.15%	442,900.00	**194,438.00**
2028	7.70	82,996.57	639,321.76	25,000.00	**614,321.76**	885,800.00	5.15%	442,900.00	**171,421.76**
2029	7.51	82,166.60	617,105.33	25,000.00	**592,105.33**	442,900.00	5.15%	442,900.00	**149,205.33**

Source: own calculation

Income Tax and Capital Incomes Calculation

EBIT is for a period of six years from the income tax exemption. The values of the income tax for natural persons in the amount of 15 % are displayed in table No 3. The account balance is within the first six years calculated as a cumulation of profits before tax and depreciation (EBITDA) and in the following years the income tax is deducted from the pre-tax profit (EBIT). The individual account balances are charged with the interest rate of 4 % with a simple interest deposits. Tax on the interest of the capital assets in the amount of 15 % is already taken into account in the calculation. The calculated values are marked in green color in the Table 3.

Table 3 - Income tax and capital incomes

year	EBITDA [CZK]	**income tax [CZK]**	account balance [CZK]	**capital incomes [CZK]**
1	1,183,378.25	0	1,183,378.25	40,234.86
2	1,141,387.11	0	2,324,765.36	79,042.02
3	1,100,855.15	0	3,425,620.51	116,471.10

4	1,061,731.69	0	4,487,352.20	152,569.97
5	1,023,967.76	0	5,511,319.96	187,384.88
6	987,516.13	0	6,498,836.09	220,960.43
7	952,331.20	142,849.68	7,451,167.29	253,339.69
8	918,368.94	137,755.34	8,369,536.23	284,564.23
9	885,586.87	132,838.03	9,255,123.10	314,674.19
10	853,943.97	128,091.60	10,109,067.07	343,708.28
11	823,400.67	123,510.10	10,932,467.74	371,703.90
12	793,918.75	119,087.81	11,726,386.49	398,697.14
13	765,461.32	114,819.20	12,491,847.81	424,722.83
14	737,992.79	110,698.92	13,229,840.60	449,814.58
15	711,478.79	106,721.82	13,941,319.39	474,004.86
16	685,886.15	102,882.92	14,627,205.54	497,324.99
17	661,182.86	99,177.43	15,288,388.40	519,805.21
18	637,338.00	95,600.70	15,925,726.40	541,474.70
19	614,321.76	92,148.26	16,540,048.16	562,361.64
20	592,105.33	88,815.80	17,132,153.49	582,493.22

Source: own calculation

Discount Rate, Cash flow and Discounted Cash Flow Calculation

The investment is financed from own resources, the discount rate is fixed at the average inflation rate of 4 %. Discount for the individual years is calculated according to formula No. (4), where *M* is equal to inflation and *t* are individual years:

$$D = 1/(1+M)^t \qquad (4)$$

Investment is realized and paid during one year. Therefore cash flow in the first year is a negative number. From earnings before taxes and amortization the cost of the investment is deducted. Capital revenues are equal to zero, as the achieved net income was only invested. Income tax is also zero, because EBIT is exempted from the income tax for a period of six years.

In the coming years the cash flow is already a positive number. From EBITDA value in the coming years, we will deduct paid income tax for natural persons in the amount of 15 %, and will add the earnings from capital invested through the net income, which was created in a given year. The incomes from the invested capital at 4 % interest rate are already lowered about the tax on capital assets in the amount of 15 %. The calculated values are shown in the Table 4.

Discounted cash flow (DCF) is calculated by the mathematical product of cash flow and discount in each years, as shown in Table 4, and then the present value of cash flows is obtained by their summarization according to formula *(2)*. From the table then even the net present value of the investment is quantified, which was obtained by the sum of the present value of cash flows and a negative value of the initial investment by the formula *(3)*.

Table 4 - Cash flow and present value

year	cash flow [CZK]	discount rate	discounted cash flow [CZK]	**NPV [CZK]**
1	-7,376,386.89	0.9615	-7,092,395.99	
2	1,220,429.13	0.9246	1,128,408.78	
3	1,217,326.25	0.8890	1,082,203.03	
4	1,214,301.66	0.8548	1,037,985.06	
5	1,211,352.64	0.8219	995,610.73	
6	1,208,476.56	0.7903	955,059.02	
7	1,205,670.89	0.7599	916,189.31	
8	1,202,933.17	0.7307	878,983.27	
9	1,200,261.06	0.7026	843,303.42	
10	1,197,652.25	0.6756	809,133.86	
11	1,195,104.57	0.6496	776,339.93	
12	1,192,615.89	0.6246	744,907.89	
13	1,190,184.15	0.6006	714,824.60	
14	1,187,807.37	0.5775	685,958.76	
15	1,185,483.65	0.5553	658,299.07	
16	1,183,211.14	0.5339	631,716.43	
17	1,180,988.07	0.5134	606,319.27	
18	1,178,812.70	0.4936	581,861.95	
19	1,176,683.40	0.4746	558,453.94	
20	1,174,598.55	0.4564	536,086.78	
	Total		8,049,249.10	**-550,750.90**

Source: own calculation

DISCUSSION

Negative net present value -550,750.90 CZK of photovoltaic power plant project for the family house in the twelve-year-period of the lifetime of the investment is a proof of the fact, why this technology may become relatively less popular and widely used in our Republic in future. The initial investment is not negligible, the geographical location of the Czech Republic in terms of solar radiation is not optimal and the changing legislation is not too fancy on the development of this technology so much.

If we consider any changes of two above mentioned parameters, the resulting net present values should have the following values (see column (3) in Tables 5 and 6), when the photovoltaic system has not changed (see its specification) and the other input parameters would have also the same values.

Table 5 - Net present value of cash flows – change of the parameter „investment“

investment [CZK] (1)	DCF [CZK] (2)	NPV [CZK] (3)
7,600,000.00	9,010,749.10	**1,410,749.10**

Source: own calculation

Table 5 shows the NPV at a possible change of the initial investment, resp. its decline from 8.6 million CZK to 7.6 million CZK. Other input parameters are maintained in the calculation. NPV should amount in this case to a positive value of approximately 1.4 million CZK.

Table 6 - Net present value of cash flows – change of the parameter „geographical location“

investment [CZK] (1)	DCF [CZK] (2)	NPV [CZK] (3)
8,600,000.00	6,797,130.33	**-1,802,869.67**

Source: own calculation

Table 6 shows the NPV at a change of the geographical location of the family house, resp. construction of this house not on the sunny south of the Czech Republic, but in its northern part, where the annual global total Ø solar radiation is between 1,100 - 1 50 kWh/m^2 (ČHMÚ, 2010). The annual income of photovoltaic system in this case probably will not achieve 99,455 kWh, but only 91,336 kWh. Other input parameters are maintained in the calculation. NPV should amount in this case to around -1.8 million CZK.

As mentioned in the introduction of this paper, the case study used the form of guaranteed redemption prices, i.e. the operator of the regional distribution system (or the transmission system operator) ought to buy from the producer all the electricity, which photovoltaic power plant produced. The producer, however, continue to pay for all the removed energy, which is the main disadvantage of this form. The advantage in this case is the guaranteed sales of the energy and "higher" price of electricity (for the year 2010 it was established at 12.25 CZK/kWh, for solar power stations with installed capacity of over 30 kW it was 12.15 CZK/kWh). Unfortunately, according to the novel of Law No. 330/2010 (about support of electricity production from renewable sources) the value of guaranteed redemption prices may fall year on year by more than 5 %. In the study the year on year decrease of only 2.5 % is included, i.e. with the higher decrease of this price the NPV would still achieve lower, for investors, the undesirable values (see column (3) in Table 7).

Table 7 - Net present value of cash flows – change of the parameter „redemption price of energy“

investment [CZK] (1)	DCF [CZK] (2)	NPV [CZK] (3)
8,600,000.00	6,968,341.97	**-1,631,658.03**

Source: own calculation

Table 7 shows the NPV at a possible change of the redemption price of energy, resp. at its year on year decrease about 3.5 % (compared to 2.5 % decline in the case study). Other input parameters are maintained in the calculation. NPV should amount in this case to a negative value of cca -1.6 million CZK.

Except the redemption prices of electricity, the investors can choose the form of so-called “green bonus”. The support in the form of green bonus can be obtained in the case when producer a portion of electricity from his photovoltaic power plant uses by himself and the excess sells out to the transmission system operator. Green bonus can be obtained for all the electricity produced, even the energy, which the producer consumed by himself. It is only up to producer, how with the energy produced shall be disposed; producer must find by himself any customer, who will buy the energy from him. For the consumed electricity the producer already does not pay to its supplier (the amount of the green bonus for year 2010 was established at 11.28 CZK/kWh, for solar power plants with installed capacity of 30kW then 11.18 CZK/kWh). The main advantage includes the fact that the producer does not pay for the consumed electricity; there is no need to establish a new connection, because the photovoltaic power station is connected to the existing distribution frame; to profit (i.e. 11.28 CZK/kWh) it is necessary yet to add the price, that would be paid by producer to his supplier for the energy removed. Speaking of disadvantages, it should be noted that the green bonus for 1 kWh is compared to the guaranteed redemption price around one CZK lower; next it is necessary to find customer of the surplus energy on its own. Although green bonus can bring any profit, it includes also the risk that the producer will not sell all the excessive energy. If we have chosen form of green bonus in the case study, we have acquired under the same unchanged conditions the NPV in the amount of -975,376.32 CZK, i.e. the form of guaranteed redemption prices was more suitable in this case, mainly thanks to low own energy consumption. Of course in the detailed analysis and choice of support forms, it would depend on all aspects like e.g.: market share of the energy sold and consumed, the sale of any excessive energy (yes/no), the amount of the profit margin, etc.

The current novel of the Law No. 330/2010 (about support of electricity production from renewable sources) tries to restrict the support in the field of electrical energy, specifically of photovoltaic power stations. With regard to the construction of solar power plants, which is economically disadvantageous for both the State and for the final customer, since the support would have caused in the existing legislation a significant increase in the total prices of electricity, it is a tendency here to reduce the construction of such plants. For example, with effect from 1 January, 2011it is obtained that the entitlement for the support for the production of electricity from renewable energy sources newly originated only to the producers connected to the electricity system of the Czech Republic, not even for those not connected ones, as it does today. Next with effect from 1 March, 2011 it will be valid that in the case of electricity produced by solar radiation, the support is refered only to the electricity produced in the production of electricity with installed capacity of plants to 30 kW, which is located on the roof construction. It is, compared to the previous legislation, a significant change.

There is a need to mention here the novels and planned changes in other laws, which also have a negative impact to the net present value calculation. For example:

- The Novel of the Law No. 586/1992 (income tax) abolishes the exemption of incomes from the operation of photovoltaic installations from the corporate income tax according to § 4, sub. 1 e). This exemption will be able to take advantage of taxpayers for the last time in the tax period, which began in the year 2010.
- The Novel of the Law No. 330/2010 (support of electricity production from renewable sources) introduces a levy on the amount paid by the transmission system operator in the following way:
  a) in the case of payment by the redemption price the levy of 26 %,
  b) in the case of payment by the green bonus the levy of 28 %. This above mentioned planned levy relates to the photovoltaic power stations with installed capacity of over 30 kW, which were placed into service in the period from 1 January, 2009 to 31 December, 2010.
- Next then the change in energy taxes, changes in the amount of the allocation of State support for the production of electricity from renewable sources, change in the place of VAT performance, etc. (Císařová, 2010).

Essentially, all of the above legislative changes are aimed, as it was already mentioned above, to limit the increase of prices of electric energy for the final consumer and, of course, to ensure the revenues to the State budget.

CONCLUSION

In conclusion, it should be recapitulated that the valuation of technologies is generally a very complex process, since it does not matter only on the method chosen, but also on the individual factors and variables, which the final value affect significantly. However, each business entity (competing on the market for its competitive advantage) recognizes currently the importance of research, development and innovation. Very important is the connection of the technical conceptions of R&D with its economic aspects. The companies knowing methods for technologies evaluation are profitable, they may offer these valuation (energetic) services to the other companies and to help its region to achieve any competitive advantage and to strengthen its economic position. The photovoltaic power plant project case study for the family house (resp. the analysis of the sensitivity of the net present value on the changes of input parameters) is a proof of this claim. Individual findings can be more or less summarized in terms of the net present value method as follows: reduction of costs (i.e. decrease of initial investment, depreciation rates, rates of income tax, value added tax rates, etc.) leads to the growth of the NPV, and vice versa: reduction of earnings (i.e. lower redemption prices of electricity, total global solar radiation, etc.) the value of the NPV reduces and the project get to the unacceptable negative values. The price, as an indicator of scarcity of raw materials often ignored in the market, and the services associated with it, there are more and more important for any economic decisions. Let us trust, therefore, that despite the current photovoltaic legislative restrictions and rules this alternative technology for the production of electricity will be widely used in the future in our republic. Indeed, the environment, we have only one, it is important to protect it!

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Note: 1 USD = approx. 18 CZK