

EXPECTED NET PRESENT VALUE – INSTRUMENT FOR PROFITABLE INVESTMENT

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Abstract

Each business entity competing for its competitive advantage on the market is currently aware of the importance of research, development and innovation. The hypothesis states: “The companies knowing methods for technologies’ evaluation are profitable”. This paper is focused mainly on the area of the economy of renewable energy sources, resp. on the valuation of selected technology in this area. First the process of industrial research and development is mentioned in the introduction; the list of possible methods that can be used for various technologies evaluation follows; and in the final part of the paper the specific real case study of the small Hydroelectric Power Plant project valuation is demonstrated. The method of ENPV (including the decision tree, probabilities and net present value) was chosen; four possible scenarios are presented in the paper. Finally the best scenario has been selected and the hypothesis confirmed.

Introduction

Technologies are moving with world! Each business entity competing for its competitive advantage on the market is currently aware of the importance of research, development and innovation. J. A. Schumpeter’s motto “Who don’t innovate – will die” was worthful in the past and is worthful also in the present. Very important is the connection of the technical aspects of the research and development with its economic aspects. According to Boer [2] the technology is a concept that can be defined, for example, as follows: “Using the knowledge for profitable objectives”.

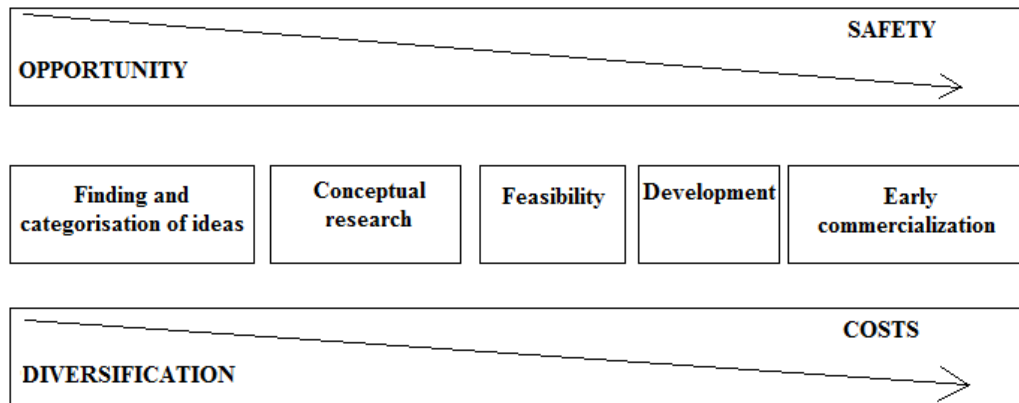
This paper is focused mainly on the area of the economy of hydroelectric energy, resp. on the valuation of this technology. First the general process of industrial research and development is mentioned in the introduction. The next part is devoted to the possible methods that can be used for technologies evaluation. In the third main part of the paper there is referred to the specific case study of the small hydroelectric power plant project valuation (by Expected Net Present Value). Four possible scenarios are presented here. Finally the best scenario is selected.

The exhaustibility of non-renewable mineral resources has been for a long time a recurrent topic of many discussions; number of professional essays by authors headed by J. Simon [10] or B. Lomborg [7], proclaim that. Slavík [11] 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) states: “The companies knowing methods for technologies’ evaluation are profitable and may help their regions to achieve any competitive advantage and to strengthen their 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 small hydroelectric power plant project), since this issue is particularly topical today.

1 Process of Industrial Research and Development

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



Source: [2], p. 65

Fig. 1 Key relationships in the process of research and development

The size of the opportunities and diversification is the minimum for the initial phase, as well as the costs, and also the security 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 at this stage very high. Summarization follows in *Tab. 1*.

Tab. 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, marketers, 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

This paper is focused on hydroelectric energy, resp. on valuation of this technology. We can conclude that hydroelectric energy is situated in the 4th phase, resp. in the phase of advancing commercialization.

2 Process of Industrial Research and Development

The valuation of technologies is a complex process. First, it is necessary to define the specific technology which we will assess. 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 Dvořák [4] calculates net present value and expected net present value of the technologies. This paper is focused just on these valuation methods, resp. one selected method: expected net present value - ENPV (see below).

2.1 Expected Net Present Value (ENPV)

The expected net present value method is based on the concept of structured transfer of know-how and it takes into account the risk that certain payments are not realized. The procedure for the valuation of this technology with this method according to Valach [14] is following:

1. Creation of the decision tree with possible options for future development and determination of the scenarios probability (probability = pn), see Fig. 2:

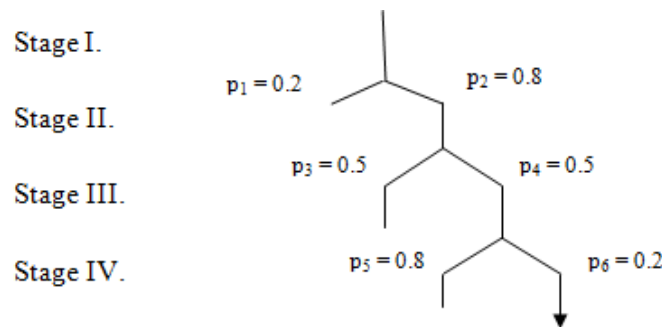


Fig. 2 Decision tree

2. Determination of the financial flows J_n for each branch of the decision tree. The calculation procedure of J_n is the same as for the methods of NPV.

3. Calculation of the NPVs for all financial flows J_n for each decision tree branch, according to the formula (1).

$$NPV_s = \sum_{n=1}^N \frac{J_n}{(1+D)^n} \quad (1)$$

where:

N number of stages,

D discount factor.

4. Calculation of the probability of each branch of the decision tree (known also as the "scenario"). The probability of each branch shall be equal to the arithmetic product of the probabilities of each event within the branches.

5. ENPV is calculated by the sum of the individual NPVs weighted by the probabilities of each branch according to the formula (2), where "p" means "probability" (see Fig. 2).

$$ENPV = \sum_s p_s * NPV_s \quad (2)$$

3 Case Study (ENPV) - Small Hydroelectric Power Plant Project Evaluation

General Information

We assume that the construction of the power plants will be realized in a place where some water scheme already exists, i.g. a weir. For this reason, the investments for construction work will be smaller than if it were the construction of completely new water work.

The building costs are estimated at 5 mil. CZK, and the costs of the machinery and the connection to supply network are established in the amount of 7 mil. CZK. These costs will be invested in Stage I, they are the same for all the cash flow scenarios described below. The lifetime of the device is expected at least 30 years, without other major investments. The discount rate, or yield of alternative investment, has been calculated at a rate of 7 % (it is an average profitability of chosen financially secure funds of first half year 2011). The optimal installed power on the basis of the characteristics of the water flow and water scheme will be 20 kW. The redemption price of the electricity produced we assume for all scenarios in the amount of 2.40 CZK/kWh [13]. Each scenario varies in the estimated annual supply of electrical energy to the network and in the annual costs of the operation as a percentage of initial investment at individual stages.

3.1 Decision Tree

The valuation method ENPV starts with the frame of the decision tree of possible scenarios. Fig. 3 shows that in our case the tree has a total of four branches of financial flows, where J = financial flows, p = probability that there is a foreseeable development of the cash flow.

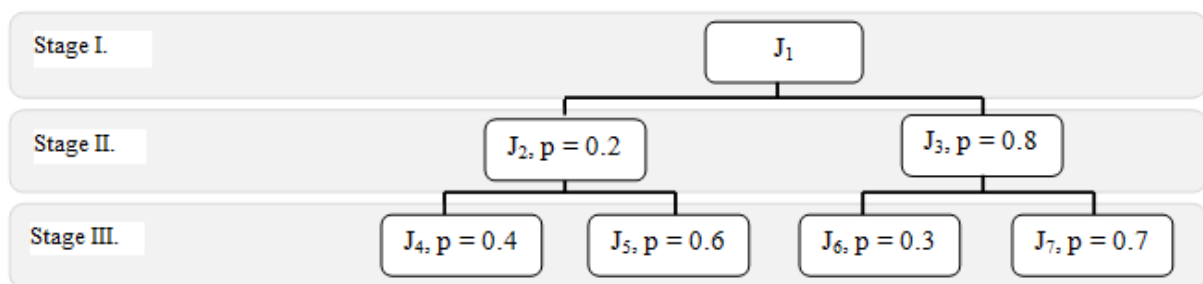


Fig. 3 Case Study - Decision tree

For each decision tree branch the cash flow was compiled. Cash flow J1 remains the same for all four scenarios. For the better predicative facility of the individual scenarios also with ENPV another three additional parameters were calculated:

- Net Present Value (NPV),
- Discounted Payback Period (DPP),
- Internal Rate of Return (IRR).

3.2 Scenarios of ENPV Calculation

- Scenario I

Tab. 2 shows the ENPV calculation for the scenario I. It assumes that, in the regular period (i.e. in Stage III), there will be the annual delivery to the network of 800 MWh, in the testing period it will be about 100 MWh per year fewer, i.e. 700 MWh per year. The costs for annual operations of the power plants in Stage II are expected at the amount of 3.5 % of total initial investment, in Stage III then only 3 % of the initial investment.

The expected net present value (ENPV) at 7 % of the discount rate is calculated at 1,514,738 CZK. The results of the other indicators resulting from *Tab. 2* are: NPV = 2,704,889 CZK, DPP = 19 years, IRR = 9 %.

Tab. 2 Scenario I – ENPV

	Stage I	Stage II - Testing period				Stage III - Regular period			
year	1	2	3	4	5	6	...	30	31
year of discount	0	1	2	3	4	5	...	29	30
A) Revenues									
revenues from energy supply	0	1,400,000	1,400,000	1,400,000	1,600,000	1,600,000	...	1,600,000	1,600,000
Total	0	1,400,000	1,400,000	1,400,000	1,600,000	1,600,000	...	1,600,000	1,600,000
B) Costs									
costs for annual operations	0	420,000	420,000	420,000	360,000	360,000	...	360,000	360,000
building works	5,000,000	x	x	x	x	x	...	x	x
machinery and connection to supply network	7,000,000	x	x	x	x	x	...	x	x
Total	12,000,000	420,000	420,000	420,000	360,000	360,000	...	360,000	360,000
Net Cash Flow (J_n)	-12,000,000	980,000	980,000	980,000	1,240,000	1,240,000	...	1,240,000	1,240,000
PV J_n	-12,000,000	915,888	799,972	945,990	884,103	826,264	...	174,298	162,895
NPV	-12,000,000	-11,084,112	-9,428,170	-8,482,180	-7,598,077	-6,771,813	...	2,541,994	2,704,889
DPP = 19 years	IRR = 9 %		probability = 0.8 * 0.7 = 0.56					ENPV	1,514,738

- Scenario II

In the same way as in *Tab. 2* ENPV was observed in scenarios II, III and IV.

After the completion of the testing period in which we supply to the network of 700 MWh, the plant will supply annually to the network of 850 MWh in regular period. The annual costs in the testing period have been estimated in the amount of 3.5 % of the initial investment. After the completion of testing, we estimate that the annual costs would fall to 396,000 CZK, i.e. 3.2 % of the initial investment in the technology.

The expected net present value (ENPV) is 827,647 CZK. The results of additional calculated parameters are the following: NPV = 3,448,528 CZK, DPP = 18 years, IRR = 10 %.

- Scenario III

The third decision tree branch was calculated on the basis of the following criteria: in Stage II we expect the supply of electricity to the network of 600 MWh per year, in Stage III of 700 MWh per year. The annual costs in the testing period have been expected at 4.2 % of the initial investment. In the regular period we assume their decline to 2.9 % of the initial investment.

The expected net present value (ENPV) is 9,604 CZK. The results of the other indicators: NPV = 120,055 CZK, DPP = 30 years, IRR = 7 %.

- Scenario IV

The fourth branch of the decision tree summarizes this paragraph of this paper. In the testing period we expect the supply of electricity to the network of 600 MWh per year. In the regular/standard period then the delivery increases by 300 MWh per year, i.e. to 900 MWh per year. The annual costs for the testing period are 4.2 %, for the regular period 3.3 % of the initial investment.

The expected net present value (ENPV) in this scenario is calculated in the amount of 427,713 CZK. The results of the other indicators are: NPV = 3,564,278 CZK, DPP = 18 years, IRR = 10 %.

The aim of this case study is to evaluate the technology in the field of the environment. The selected technology is the production of energy from renewable resources by means of small hydroelectric power plants. The method of "Expected Net Present Value" – ENPV was chosen for the evaluation. Theoretical calculation was described in the previous part of this paper.

4 Discussion

From the above mentioned it is evident that the most optimistic scenario for our investment is scenario No I. Within its course in 30 years we gain cash flows at a rate of 1,514,738 CZK, while the original amount of the investment was 12 mil. CZK. The calculation using the simpler NPV method is even more optimistic because according to the net present value in 30 years we acquire the amount of 2,704,889 CZK; the discounted payback period is then 19 years. The internal rate of return is higher than the discount rate, about 2 %. You can see the total comparison of all scenarios in the following *Tab. 3*.

Tab. 3 Scenarios I, II, III and IV

Indicator	Scenario I	Scenario II	Scenario III	Scenario IV
ENPV [CZK]	1,514,738	827,647	9,604	427,713
NPV [CZK]	2,704,889	3,448,528	120,055	3,564,278
DPP [years]	19	18	30	18
IRR [%]	9	10	7	10

In contrast, the least advantageous option represents the scenario No III. In a period of 30 years it will bring us only 9,604 CZK, which is, with the initial investment and chosen lifetime period, a very low amount. In case this scenario occurs, we should raise the supply of electricity to the network in Stage II and III. At the same time, there should be a pressure to reduce the annual costs in the testing period. Also the other indicators (NPV = 120,055 CZK, DPP = 30 years and IRR = 7 %) consider this scenario as the worst, the least profitable one.

However, we have to mention that the final results depend on many factors, particularly in the annual supplies of electricity to the network, redemption price, discount rate and probabilities. According to Synek [12] the decision tree and its structure are the most important factors in ENPV method. In certain sectors its structure has already been fixed (based on several years of experience), in the new sectors and technologies its structure is far from stable so far.

Conclusion

Technologies are moving the world! Very important is the connection of the technical conceptions of R&D with its economic aspects. This paper was focused mainly on the area of technologies valuation. First the general process of industrial research and development was mentioned; the list of possible methods for technologies evaluation followed. In the final part the specific real case study of the small hydroelectric power plant project valuation by ENPV was demonstrated. Four possible scenarios were presented here and the best scenario No I was selected. We can claim here that the hypothesis was verified: "The companies knowing methods for technologies' evaluation are profitable and may help their regions to achieve any competitive advantage and to strengthen their economic position". In other words, if the firms are able to evaluate their technologies by appropriate methods, they become profitable. It may attract other investors to the region, so the economic position of the region could be strengthen.

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OČEKÁVANÁ ČISTÁ SOUČASNÁ HODNOTA - NÁSTROJ EFEKTIVNÍCH INVESTIC

Význam výzkumu, vývoje a inovací si uvědomuje v současné době každý podnikatelský subjekt soupeřící na trhu o konkurenční výhodu. Zde stojí hypotéza: "Společnosti znající metody pro oceňování technologií mají pozitivní ekonomické výsledky". Tento příspěvek je zaměřen především na oblast ekonomiky obnovitelných zdrojů energie, resp. na ocenění vybrané technologie v této oblasti. Nejprve je v úvodu zmíněn proces průmyslového výzkumu a vývoje; následuje výčet možných metod, pomocí kterých lze ocenit různé technologie a v závěrečné části je naznačen konkrétní reálný příklad ocenění projektu malé hydraulické vodní elektrárny. Byla zvolena metoda ENPV (zahrnující rozhodovací strom, pravděpodobnost a čistou současnou hodnotu); v příspěvku jsou uvedeny čtyři možné scénáře. V závěru byl vybrán ekonomicky nejvýhodnější scénář a hypotéza byla potvrzena.

DER ERWARTETE REINE NETTOWERT - INSTRUMENT DER EFFEKTIVEN INVESTITIONEN

Jedes Unternehmenssubjekt, das auf dem Markt einen Konkurrenzvorteil anstrebt, kennt die Bedeutung der Forschung, Entwicklung und Innovationen. Hier gilt die Hypothese: "Die Gesellschaften, die die Methoden für die Bewertung der Technologien kennen, haben positive ökonomische Ergebnisse". Dieser Beitrag konzentriert sich vor allem auf das Wirtschaftsgebiet der erneuerbaren Energiequellen bzw. auf eine Bewertung bestimmter Technologien auf diesem Gebiet. In der Einleitung wird ein Prozess der Forschung und Entwicklung in der Industrie erwähnt. Dann folgt eine Übersicht über die Methoden, mit Hilfe derer verschiedene Technologien bewertet werden können, und abschließend ein konkretes Bewertungsbeispiel des Projektes eines kleinen Wasserkraftwerkes. Es wurde die Methode des „erwarteten reinen Nettowerts“ ausgewählt. Sie enthält Entscheidungsstruktur, Wahrscheinlichkeit und reinen Nettowert. Im Beispiel werden vier mögliche Szenarien angeführt, dann das ökonomisch vorteilhafteste Szenario ausgewählt und die Hypothese bestätigt.

OCZEKIWANA AKTUALNA WARTOŚĆ NETTO - NARZĘDZIE EFEKTYWNYCH INWESTYCJI

Znaczenie badań, rozwoju i innowacji uświadamia sobie obecnie każdy podmiot gospodarczy walczący na rynku o przewagę konkurencyjną. Tu pojawia się hipoteza: "Spółki znające metody wyceny technologii osiągają pozytywne wyniki ekonomiczne". Niniejszy artykuł koncentruje się przede wszystkim na ekonomice odnawialnych źródeł energii, czyli na wycenie wybranej technologii w tej dziedzinie. Najpierw we wstępie omówiono proces badań przemysłowych i rozwoju, po czym przedstawiono metody, przy pomocy których można wycenić różne technologie a w zakończeniu pokazano konkretny realny przykład wyceny projektu małej elektrowni wodnej. Wybrano metodę oczekiwanej aktualnej wartości netto (obejmującej drzewo decyzyjne, prawdopodobieństwo i aktualną wartość netto). W artykule przedstawiono cztery możliwe scenariusze. W części końcowej wybrany został scenariusz najkorzystniejszy pod względem ekonomicznym, potwierdzający postawioną hipotezę.