Renewable Energy: Research, Development and Policies

Effectiveness of Investment to Renewable Energy Sources in Slovakia

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NOVA

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EFFECTIVENESS OF INVESTMENT TO RENEWABLE ENERGY SOURCES IN SLOVAKIA

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PREFACE

Renewable Energy Sources (RES) are considered as sources of the future. But yet in present time RES achieve more and more importance. Such sources bring real alternative of conventional sources, which stocks are limited and gradually spending. RES have minimal influence to the climax and there is possibility to decrease number of emissions of damaging elements. In spite of number of conveniences, RES development is still rather slow and limited. There exist presuppositions that RES installment and its development is exceedingly not effective and costly, since there are available rather cheaper conventional sources. But a problem of RES development is economical system, acting according principle “cheaper production, faster achievement of high profit.” RES development, their financial and environmental return last for some period, it means results cannot be expected immediately. Therefore, it is necessary to invest to RES with aim to achieve broader space and time for Technologies and innovation improving. Consequently, it will lead to higher effectiveness of energy transmitting as well as shorter payback period.

The presented monograph deals with evaluation of investment to RES, mainly from the view of investment to photovoltaic energy, biomass, geothermal energy in case of Slovakia. Authors analyzed investments, considered in comparing with a situation in European Union, regarding actual legislative and economic support of business with RES. Whole business with RES is last, but not least underlined with possible financing by various alternative ways.

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Chapter 1

PRESENT STATE OF BUSINESS WITH RES IN EUROPEAN UNION AND SLOVAKIA

The European Union as a whole is dependent on the import of primary energy sources – around 50%. Accepted liabilities in the area of fair protection present other influence to the energetic strategy of the EU; therefore, this strategy is mainly concentrating in the area of energy to the RES using and energetic effectiveness, with not negligible potential in the individual member states (Jenner et al., 2013). More years' program of activities in area of energetic had become main tools for achievement of the indicative goal for energy production from RES (Intelligent Energy – Europe, etc.). Member state in EU agreed in 2009 on increasing of energy production from RES. Its goal till 2020 is to achieve 20% rate of RES (Volner, 2012). In 2011 its rate was estimated at the level 13.4% that presented growth about 0.9%. Europe is investing considerably in renewable energies for a sustainable future, with both Iberian countries (Portugal and Spain) promoting significantly new hydropower, wind, and solar plants (Jerez et al., 2013).

In Slovakia, electrical energy is provided mainly by nuclear and heat power stations, with the remainder being produced in hydroelectric power stations. In this sector renewable energy sources (RES) still represent a minimal share in Slovakia (Horbaj & Tauš, 2008). Nonetheless, the years 2009 and 2010 specifically represented a turning point in legislation promoting RES, with the introduction of both a guaranteed repurchase period for buying electricity produced using the various RES and a ‘fixed’ price. This resulted in greater investor interest in the building of energy sources for the production of heat and electricity including those derived from biomass (Freitas et al., 2007).

As for other countries, co-assessment of the natural and renewable energy resources in US it is growth without dramatic environmental detrimental effects (Subhadra, 2013). Fostering development of a renewable energy industry is critical to ensuring energy security and sustained economic development. The United States recently lost its status as a global leader in new financial investment in renewable energy, while investment in renewable energy has increased in the developing world (Chacon, 2013).

And for example Taiwan is highly vulnerable to energy security, but geographic conditions for the development of solar energy applications have created a considerable advantage. However, the total installed solar energy capacity is far less than might be expected (Liu et al., 2013).

Decisions whether to invest to RES are made according number of economic indicators. These indicators evaluate the yield (return) of the resources invested. Several methods are used in the theory and practice of investment evaluation with aim to increase efficiency of investment projects. For evaluation of investment to RES, we have chosen payback period (time required for a return on investment and net present value (Balog & Magyar, 2011).

An increasing production of renewable energy requires planning strategies that are able to coordinate the higher-level energy goals with local-level land use interests (Nabielek et al., 2018). While the spatial scope of energy objectives is usually set up on a federal state or national scale, decisions to allocate and implement renewable energy sites are often taken on a municipal scale. This leads to a lack of regional coordination, as the task to achieve a balanced regional energy demand and renewable energy production cannot be solved by individual municipalities alone and calls for cooperation on a regional level.

As for the wood presenting RES, Olsson and Hillring (2014) investigated wood fuel market from the view of prices of wood chips and wood pellets. There are indicators that wood markets with pellets are integrated, but this is not the case of wood chips due to the lack of transparency resulting from the significant product heterogeneity for wood chips.

Photovoltaics (PVs) are crucial in the transition to a more sustainable energy system. Besides large PV installations, household adoption of PVs will be an important contribution; however, the adoption of PVs on a household level faces many barriers, with gathering and understanding information being one of the major barriers. Palm and Eriksson (2018) concluded that when dividing the households into different ideal types, it is possible to detect what kind of information measures different groups need. To get a future increase of the number of installed PVs, it is important to develop different measures in parallel, to meet the needs from the different groups.

Also hydroelectric power or hydropower means the power generated by the help of flowing water with force, presenting one the best source of renewable energy in the world (Rahman et al., 2017). Hydropower is considered a renewable energy resource because it uses the earth's water cycle to generate electricity. As far as global is concerned, only a small fraction of electricity is generated by hydro-power. There is also useful to use a hybrid renewable energy source, consisting of solar photovoltaic, wind energy system and a micro-hydro system (Mosobi et al., 2015). Such system is suitable for supplying electricity to isolated locations or remote villages far from the grid supply.

An important issue when making investment decisions related to the construction of new power plants based on renewable energy sources is optimal selection of technologies for the best integration of new power plants in the electricity system, taking into account the physical limitations (Markov et al., 2016).

Chapter 2

METHODOLOGY

As for the economic assessment of the proposed technology, decisions on whether to proceed with and implement a project, or on selecting a particular project from a number of different versions, are taken on the basis of a number of economic indicators. These indicators evaluate the yield (return) of the resources invested in the project. Several methods are used in the theory and practice of financial management for assessing the efficiency of investment projects. The methods used most are:

1. *Simple payback period* – time required for a return on investment (T_p);
2. *True payback period* (calculated using discounted cash flow from the project);
3. *Net present value* (NPV);
4. *Internal rate of return* (IRR).

SIMPLE PAYBACK PERIOD

The time required for a return on investment (T_p). The simple payback period is defined as the time required recovering the total cost of investment in a project through future revenue. This means the period of time it takes for the investor to earn back the resources invested in the project. Determining the period of recovery is not complicated and is based on project cash flow, consisting of income and expenditure made over the life of the project (Fotr & Souček, 2007).

$$Tp = \frac{IC}{CF} \tag{1}$$

Where: IC = invested cost,
CF = annual cash flow from project.

The determined payback period of the project is then compared with the standardized value chosen by the company (generally according to past experiences and other investment opportunities). This period differs according to the sector in which the company operates. If the payback period is lower than the normalized value, then the project should be approved. The shorter the period of return, the more advantageous the project is.

The main advantage of this method is that it is simple and easy to understand the calculations; however, the shortcomings of this indicator include the following primarily:

- it ignores project income received once the period of recovery is over,
- it emphasizes very rapid financial returns of the project,

- it does not consider time, i.e., the different time values of money obtained or invested at different times.

This shortcoming can be avoided if a true payback period is used, as given below.

TRUE PAYBACK PERIOD

True payback period, or as some authors call it – a discounted payback period – is defined as the depreciable capital investment divided by the projected positive annual cash flow from the project. The payback period in discounted cash flow T_D is calculated accordingly:

$$\sum_{t=1}^{T_D} CF_t \bullet (1+r)^{-t} - IN = 0 \tag{2}$$

Where: CF_t = cash flow from project in year t (changes to cash flow following project implementation),

r = discount rate (hurdle rate, alternative capital costs, real interest rate), $(1+r)^{-t}$ = discounting factor,

t = evaluated period (1-T_D),

T_D = year in which investment will be returned,

IC = investment costs.

NET PRESENT VALUE

Net present value (NPV) – is the sum of discounted cash flow during the lifetime of the investment, i.e., throughout the period of construction and operation. Cash flow is expressed as the difference between income and expenditure in the individual years of the project life cycle (Jílek, 2009).

NPV generally lead to the same results when selecting the type of investment. The basic problem in using them in practice does not concern calculation techniques, but the validity of the input data, primarily the data on expected cash flow from the investment (Sayadi et al., 2014).

Evaluating investment projects with the help of expected income and expenditure assessments is popular primarily because it takes the time factor into consideration in calculations. It also takes into consideration the period following which financial expenditure on investment during construction becomes deadweight and the period when revenue is made. Thus, it provides a much more precise total overview of the efficiency of individual projects (Pirč & Grinčová, 2008).

$$NPV = \sum_{t=1}^{T_{Ž}} CF_t \bullet (1+r)^{-t} - IC \quad (3)$$

Where: CF_t = cash flow from project in year t (changes to cash flow following project implementation),

r = discount rate (hurdle rate, alternative cost of capital, real interest rate),

t = evaluated period (1-n years),

$T_{Ž}$ = life cycle of the project,

IC = investment costs.

Net present value is used relatively frequently in real life, mainly since:

- it takes the life of the investment (project) into consideration,
- it accounts for the time value of money (discounting process).

Given these advantages, this method represents important criteria for undertaking decisions on whether to approve or reject a project. The business should implement all projects that have a positive net present value and reject those with a negative net present value. The higher the NPV, the more economically advantageous the project is. Net present values of projects can be added together and thus the total revenue gained through realizing different investment projects can be quantified (Chiang et al., 2010). One of the disadvantages of these criteria relates to the difficulties involved in determining the discount rate and that NPV as an absolute index does not express an exact measure of project profitability. For these reasons, the internal rate of revenue method is sometimes preferred. For the mining projects, this criterion is calculated under uncertainty associated with the relevant parameters of say commodity price, discount rate, etc. (Smejkal et al., 2003).

INTERNAL RATE OF REVENUE (IRR)

The following are applied in calculating the internal rate of revenue:

***IRR = r*,** if $$NPV = \sum_{t=1}^{T_L} CF_t \bullet (1+r)^{-t} - IC = 0 \quad (4)$$

Where: CF_t = cash flow from project in year t (changes to cash flow following project implementation),

r = discount rate (hurdle rate, alternative cost of capital, real interest rate),

t = evaluated period (1-n years),

T_L = life cycle of the project,

IC = investment costs.

By the definition IRR is the discount rate that results in an NPV of zero for a sequence of future cash flows in terms of revenues, costs, and initial investment. Both the internal rate of revenue and NPV generally lead to the same results when selecting the type of investment. The basic problem in using them in practice does not concern calculation techniques, but the validity of the input data, primarily the data on expected cash flow from the investment.

Evaluating investment projects with the help of expected income and expenditure assessments is popular primarily because it takes the time factor into consideration in calculations. It also takes into consideration the period following which financial expenditure on investment during construction becomes deadweight and the period when revenue is made. Thus, it provides a much more precise total overview of the efficiency of individual projects.

Decisions whether to invest to RES are made according number of economic indicators. These indicators evaluate the yield (return) of the resources invested. Several methods are used in the theory and practice of investment evaluation with aim to increase efficiency of investment projects. Also, cost effectiveness analysis can be used for photovoltaic systems by households (Burtt & Dargusch, 2015), with annual payback period calculation and regression of these against the actual uptake of present value with associated emission reductions, creating a relationship by sensitivity analysis. In the whole solar power plant, multi criteria decision making methods are very important, where one factor is risk of investment.

Risk analysis is part of all investment projects where the factor of risk and uncertainty play a key role. One of the tools of risk analysis for providing of increased quality of decision making is a Monte Carlo simulation. Principle of Monte Carlo simulation consists in generating of extensive file containing scenarios, for which the recalculation of monitored financial indicators of the investment project is made. The output provides obtaining of statistical characteristics and metrics that serve as the basis for the decision to adopt respectively refusal of the investment project or for optimizing and control of the process. The benefits and costs of increasing solar electricity generation depend on the scale of the increase and on the time frame over which it occurs (Baker, et al., 2013).

Financial analysis, as an element of technical and economic study, presents an essential tool for investors' decisions. It means first of all the decision, to which project to invest (investment decision), as well as the decision about the resources (financial decision). The basis for actual investment and financing decisions present criteria of economic efficiency, which measures the return on invested capital. They can be divided to traditional criteria, such as average profitability and payback period. A second group of criteria consists of criteria based on discounting: net present value, internal rate of return and profitability index. But simulation Monte Carlo presents further tool for analysis of investment risk with aim to increase quality of decision.

Simulation *Monte Carlo* consists from following steps:

1. *Creation of mathematical model* - model is presented with regard to the calculation of cumulative balance after 15 years´ period of investment project service. 15 years' period is chosen due to the fixed repurchase prices of electric power that are guaranteed during the given period.
2. *Determination of risk factors* - risk factors presents variables that enter to the calculation of cumulative balance according calculation in first step. Real value of factors is not known in present time. Volume of influence of risk factor change to the change of monitored factor – mainly cumulative balance in certain years, determines sensitivity of the model. Through analysis of sensitivity key factors are changed, and their uncertainty is regarded in simulation Monte Carlo. Choice of division type for risk factors and setting up of their parameters depends on expert evaluation or knowledge obtained from historical data. Commonly there is used normal and triangle

division. Normal division is defined by average value and standard deviation. Triangle division obtains defined lower and upper level, except most probable value of risk factor, and this level should be overstepped by pessimistic or optimistic scenario. Casual choice presents a common way for choice of values from specified division during simulation.

3. *Determination of statistical dependence of factors* - risk factors used in the model can be dependent on each other. Linear relations can be detected by correlation. Theoretically, there are infinitely many possible forms of dependence. The problem of mutual interdependence is reflected in the multiplication of random variables, where also covariance respectively correlation between the factors is taken into consideration. In addition to dependence among factors there is necessary to identify dependence of one variable in a time sequence. If there is such dependence, it is not possible to ignore it in the simulation.
4. *Simulation Monte Carlo* - during 4^{th} step there are determined factors – indexes, by which simulation will be carried out and there is also determined number of generated scenarios that will be generated by simulation. The single simulation creates a set of combinations of defined values according to given parameters of distribution and choice. For each combination representing one scenario there is calculated an analyzed variable – indicator that is subject of searching. In our case it presents cumulative balance. In this step computer support has its use and it provides realization of simulation with a range of one million observations lasting a few seconds.
5. *Results of simulation* - simulation output present the probability of cumulative balance division for the given year and the statistical characteristics determining the average, variance, minimum, maximum and selected percentiles. When determining the payback period there is considered 2.5-

percentile or a minimum value of cumulative balance, which is compared with a zero instead of comparing mean value with zero. Calculated expected value of the cumulative balance in a given year can be determined by an interval of probable values.

Chapter 3

Legislative and Economical Tools of RES Support in Slovakia

In present time renewable energy sources and their effectiveness is subject of discussion in domestic, as well as foreign studies and expert publications. Using of energy from RES has its big perspective to the future, but energy from RES is still rather financially demanded, comparing with conventional energy sources. There is much effort to search possible photovoltaic power using with analyzing of RES investment effectiveness. Using of photovoltaic power achieves more and more importance. Such source brings real alternative of conventional sources, which stocks are limited and gradually spending. Photovoltaic power has minimal influence to the climax, but in spite of conveniences, development of photovoltaic power plants is still rather slow and limited.

Despite the sunshine conditions in the Slovak Republic are better than in the Czech Republic or Germany, Slovakia keeps relatively behind current trends in the construction of photovoltaic power plants. It is due to the fact that the legislation to promote renewable energy sources (RES) in Slovakia was adopted recently.

There are still presuppositions that photovoltaic installing and their development is exceedingly not effective and costly, since we are available rather cheaper conventional sources. But problem of photovoltaic development are also legislation and economical system, acting according principle "cheaper production, faster achievement of high profit." Photovoltaic development, its financial and environmental return last for some period, it means results cannot be expected immediately. Therefore, it is necessary to invest to photovoltaic with aim to achieve broader space and time for technologies and innovation improving, and consequently it will lead to the higher effectiveness of energy transmitting as well as shorter payback period.

European Union as a whole is dependent on import of primary energy sources – around 50%. Member state in EU agreed in 2009 on increasing of energy production from RES. Its goal till 2020 is to achieve 20% rate of RES (Jerez et al., 2013). In 2011 its rate was estimated at the level 13.4% that presented growth about 0.9%. Europe is investing considerably in renewable energies for a sustainable future, with both Iberian countries (Portugal and Spain) promoting significantly new hydropower, wind, and solar plants (Jerez et al., 2013). The potential of solar energy is higher than other renewable source, although several limits exists (Aste et al., 2013). For example, effect of technological evolution on the overall performance of photovoltaic power generation or establishing performance benchmarks for a much larger variety kinds of photovoltaic power plants and technologies.

On the other hand, developed countries are going from darkness to darkness in the field of electricity power sector, which presents one of the chronic problem and they meet huge and serious problem. Therefore, for example in Yemen renewable energy sources are considered as one of the optimal solutions for the power sector, mainly solar energies (Alkholidi, 2013). Some studies prove that solar photovoltaic power plants have great potential and high cost effectiveness for meeting the energy demand (Chandel et al., 2014).

Europe has potential of photovoltaic energy, where ongoing photovoltaic development increases contribution of solar energy exponentially. Within this significant potential, it is important for investors, operators, and scientists alike to provide answers to the mechanism, advantages and evolution of photovoltaic technologies.

And for example in Greece the law of photovoltaic was provided for first time in 2006, appealing feed in tariff incentives for photovoltaic. Two subsequent laws formed an even more attractive investment and licensing context both for photovoltaic installation. Photovoltaic capacities exceeded the national target for 2020 and caused continuously tremendous delays. The effectiveness of this legislative framework cannot be judged solely by the response of prospective investors, but also effective provisions as well as techno-economics assessment (Karteris & Papadopoulos, 2013). There is necessary to assess also market characteristics (e. g. electricity price and production cost) that influence photovoltaic policy strength. There was proved interaction of photovoltaic policy design, electricity price, and electricity production cost that is a more important determinant of photovoltaic development than policy enactment alone (Jerez et al., 2013). Also Knez and Jereb (2013) proved the use of alternative renewable energy sources, registered successful investments in the field of solar power plants in Slovenia. But whether or not such projects present a profitable investment is issues of individuals as well as companies have to deal with.

In Slovakia, electrical energy is provided mainly by nuclear and heat power stations, with the remainder being produced in hydroelectric power stations. In this sector renewable energy sources (RES) still represent a minimal share in Slovakia (Kudelas et al., 2009). Nonetheless, the years 2009 and 2010 specifically represented a turning point in legislation promoting RES, with the introduction of both a guaranteed repurchase period for buying electricity produced using photovoltaic power. This resulted in greater investor interest in the building of energy sources for the production of heat and electricity including those derived from photovoltaic (Tauš & Taušová, 2009).

As a member state of the EU, Slovakia is bound by Directive 2009/28/EC on the promotion of the use of energy from renewable sources to increase the share of RES used to 14% of final gross energy consumption and to 10% in transport. The National Action Plan for Energy from RES anticipates that the proportion of RES used in gross energy consumption will in fact be 15.3% (Decree No 225/2011).

A present trend in Slovakia in the searched area is so-called G-component that has negative influence to the economical result of the company with retrospective force (www.sapi.sk). It presents payment for reservation of performance of energy producer with force from 1st January 2014. G-component influences mostly and mainly producers, producing energy from solar energy. In the frame of RES support equipment for solar energy production, connected to distribution net in 2010 and 2011 obtained claim of a rather generous support. Law about RES support supports energy producers by the way of additional payment for 15 years. Through G-component there is possible real decreasing of higher mentioned support, which has negative influence to the profitability of investment for construction of equipment for electricity production.

Legislative Tools and Economic Support of Photovoltaic Energy Using

Law No 309/2009 Coll. about support of RES was accepted since 1st September 2009, which provides that the distributor has obligation to connect source to the network and guarantee the purchase price of produced electric power for a period of 15 years from the time of power plant establishment. The price is determined by the Regulatory Office for Network Industries (RONI) and for concrete years it is determined by RONI Decree No.7/2009.

The price of electricity for the equipment of a producer reconstructed or upgraded before 1st January 2010, entered into service before 1st January 2010 or put into service in 2010, it is engaged in §8 Decree in the Law No 225/2011. The price of electricity produced from photovoltaic power for equipment of its producer, installed to operation in 2010 is determined by direct determination of the fixed price in EUR per megawatt hour of solar power with a total installed capacity of the producer of electricity (see Table 1).

Table 1. Price of electric energy, produced from RES (EUR/MWh)

Year	Period	Installed performance of equipment from producer of energy	Fixed price of electric energy per MWh
2010	1.1.2010-31.12.2013	To 100 kW including	430.72 EUR/MWh
		Over 100 kW	425.12 EUR/MWh
2011	1.1.2011-30.6.2011	To 100 kW	387.65 EUR/MWh
		Over 100 kW including	382.61 EUR/MWh
	1.7.2011-31.12.2011	To 100 kW	259.17 EUR/MWh
2012	1.1.2012-30.6.2012	To 100 kW	194.54 EUR/MWh
	1.7.2012-31.12.2012	To 100 kW	119.11 EUR/MWh
2013	1.1.2013	To 100 kW	119.11 EUR/MWh

Source: www.instore.sk.

The price of electricity for equipment of producer, installed into operation from January 1st 2011 to June 30th, 2011, is dealt in § 9 of the Decree in Law No. 225/2011. Price of electricity produced from photovoltaic power in producer´s equipment placed into operation from January 1st, 2011 to June 30th, 2011, is determined by direct determination of the fixed price in EUR per megawatt hour of solar power with a total installed capacity of electricity producer. The price of electricity for equipment of a producer, installed into operation from

1st July 2011 to 31st December 2011 is dealt in §10 from Decree in Law No 225/2011. The price of electricity produced from photovoltaic source in the producer's equipment, installed into operation from 1st July 2011 to 31st December 2011, is determined by direct determination of the fixed price in EUR per megawatt hour of solar power with a total installed capacity of 100 kW, which is located on the roof or on the outer wall of a building, connected with ground by a solid foundation as 259.17 EUR/MWh.

The price of electricity for equipment of a producer, installed into operation from 1st January 2012 to 30th June 2012 is dealt in §11 of the Decree in Law No 184/2011 from 22nd June, amending and supplementing Decree of the Regulatory Office for Network Industries No 225/2011, establishing a price regulation in the electric-power industry, as amended by Decree No 438/2011 from solar energy with a total installed capacity of power producer up to 100 kW, which is located on the roof or the outer wall of a building connected with ground by solid foundation. The price of electricity for the facility of the electricity producer installed into operation from 1st July 2012 to 31st December 2012 is dealt in §11 Decree in Law No 184/2011 from solar energy with a total installed capacity of power producer up to 100 kW, which is located on the roof structure or the outer wall of a building connected with ground by solid foundation.

Table 2. Resulting intervals of cumulative balance for individual situations in 15th year of photovoltaic power plant life time

	15th year of life time	Regarding performance degradation of photovoltaic panels (annual decrease by 1%)
Situation 1	3,812,275 EUR	3,240,433.75 EUR
Situation 2	3,807,864 EUR	3,236,684.40 EUR
Situation 3	3,783,562 EUR	3,216,027.70 EUR
Prediction	2,709,252.67 EUR	2,302,864.77 EUR

The price of electricity for the facility of the electricity producer installed into operation from 1st January 2013 is dealt in §11b Decree in the Law No 184/2011 of solar energy with a total installed capacity of power producer up to 100 kW, which is located on the roof structure or the outer wall of a building connected with ground by solid foundation.

By Monte Carlo method there was made simulation in the photovoltaic plant in chosen Slovakian quarry, which was launched into operation in 2010. The analysis was based on three-year history. Through share of specific production kWh/year during period 2010-2012 and installed capacity photovoltaic power there were obtained values of production, corresponding to 1kWp. Specific production of the 1kWp for individual years was 1,242.936 kWh/year – 2010; 1,219.243 kWh/year – 2011; and 1,241.833 kWh/year - 2012. In the simulation there was considered average value of 1,234.671 kWh/year and range 23.6928 kWh/year. In determining of the distribution of specific production per 1kWp, there was used standard deviation - the integral part of the range.

In applying the Monte Carlo method for the amount of produced energy and inflation, predicted cumulative balance after 15 years of operation will reach a value of at least 3,783,562 EUR (after performance degradation – 3,216,027.7 EUR). This value corresponds to the lower margin of the estimated range from simulations, where there were chosen 10% deviation from the mean value of the energy produced during the first three years of plant´s operation. Compared with the originally predicted yield value in 15th year – 2,709,252.67 EUR (after degradation – 2,302,864.77 EUR), the current pessimistic estimation exceeds expectations by more than 1 million EUR.

Mentioned development of prices of electric energy till 2013 and cumulative balance connects with evaluation of a concrete operated power plant with a negative influence of legislative changes to the economic prognosis of business in energetics. For example, Slovakia is member of double or multiple agreements that also include protection of investments. Simply speaking, such agreements have to protect international investor against later changes of laws, as well as against new taxes, which could threaten his investment. By this way international arbitral procedure has completely clear expectation of success.

In present time there is necessary to invest to photovoltaics, since such source bring real alternative of conventional sources, which stocks are limited and gradually spending. But the legislation of renewable energy sources (RES) in Slovakia was adopted only recently, lacking proper support and also economical evaluation needs still improvement. Mainly it is necessary to assess other characteristics of investment to photovoltaics (e.g., electricity price and production cost). Simulation Monte Carlo presents a further tool for analysis of investment risk with aim to increase quality of decision. This method consists of 5 steps, according which investors can make proper decision, bringing positive results in the future.

Method Monte Carlo was used for simulation in the photovoltaic plant in chosen Slovakian quarry with aim to provide scheme for evaluation in similar conditions. In the simulation there was considered average values, standard deviation - the integral part of the range. Resulting value corresponds to the lower margin of the estimated range from simulations, which was further compared with the originally predicted value and estimated current expectations.

Chapter 4

CASE STUDIES OF RES INVESTMENT IN SLOVAKIA

A. EVALUATION OF INVESTMENT TO PROJECT OF BIOGAS FUEL STATION AND PHOTOVOLTAIC POWER PLANT

Biogas is a renewable energy source, which is produced on the basis of organic waste from the agriculture, food trade industry and households. Furthermore, biogas can be extracted from sludge in the wastewater treatment plants and from landfill sites (Ghazi & Abbaspour, 2011).

In the case of Slovakian investment we considered project of biogas fuel station with installed capacity 300kW, while due to the legislative policy of Slovakia in area of RES support there is not allowed PVP with installed capacity higher than 100 kWp, therefore there would be considered only given installed capacity of PVP. Following tables (Table 3-6) include capacity, cost, revenue and incomes of the projects, separately for both investment projects for 11 year.

Table 3. Capacity of project BFS and PVP

Project performance	BFS	PVP
Middle value of electric capacity (kWhe)	330	100
Number of hours per year	8,000	8,000
Electric energy (kWhe.year^{-1})	2,640,000	105,000
Heat energy (kWht.year^{-1})	1,040,000	-

In spite of similar number of operation hours, we can see BFS with installed capacity 300 kW produces 25-times higher volume of electric energy per year, comparing with 100 kWp in PVP. BFS can be used also for production of heat energy; in PVP case it is not possible.

Meanwhile BFS can calculate also annual revenues from sale of electricity, heat and digestive, PVP provides only possibility to sale electric energy. Project BFS should produce total annual revenues higher then revenues from PVP – mainly about 472,206 EUR.

As for the cost we can state cost during the planned period 11 years are considerable lower for PVP, since there is not rising expense, connected with securing of input raw material or personal costs (for example wages of employees – service of PVP is provided by external company). In PVP there is an also removed expense, connected with consumption of electric energy, since PVP is able to produce energy by itself. Both projects consider also financing form own sources, there is no expense by the way of interest in any project.

Table 4. Revenues from BFS and PVP projects

EUR/year	BFS	PVP
Revenue from electricity sale	392,621	12,507
Revenues from heat sale	24,024	-
Revenues from digestive sale	68,068	-
Together	484,713	12,507

Table 5. Cost for BFS and PVP projects

Costs (EUR)	%	BFS	PVP
Input substrate	2	1,128,648	-
Electric energy consumption	2.5	41,171	-
Project start		5,000	2,300
Repairing, service, maintenance	2	86,337	8,299
Service of cogeneration unit	2	481,881	-
Personal costs	4	157,521	-
Manipulation with biomass	4	48,593	-
Depreciation		1,030,084	-
Interest	0	0	0
Insurance		78,045	16,597
Advisory activity	2.5	77,760	9,959
Overhead, additives, etc.	2.5	10,767	-
Together		3,145,806	37,155

Table 6. Incomes from BFS and PVP projects

Incomes (EUR)	%	BFS	PVP
Sales from electricity sales	2.5	4,901,269	273,850
Sale (saving during 11 years)	2	828,300	-
Using of heat energy	2.5	299,903	-
Together		6,029,471	273,850

Assumed incomes of BFS during 11 years are considerable higher than planned incomes from PVP and they present their sales from electric energy sale, savings from sale during 11 years and using of heat energy. As for BFS incomes present 6,029,471 EUR and for PVP only 273,850 EUR.

Evaluation of economical effectiveness is inseparable part of any investment project. Investor is interesting about way how investment would be evaluated, and at the same time how long it would take to receive invested money again. We will compare investment effectiveness to the biofuel station (BFS) and photovoltaic power plant (PVP). It is calculated according economical results and cash flow from the investment projects. Tables 7 and 8 show comparing of economic results and cash flow from BFS and PVP projects.

Values of the economical result and cash flow in the individual projects are mentioned in the following tables as positive values for both investments. BFS project has more positive assumed economical result, comparing with PVP.

Table 7. Economical results of BFS and PVP projects

Economical result	BFS	PVP
Costs together	3,145,806	37,155
Incomes together	6,029,471	273,850
Profit	2,883,665	236,695
Income tax (19%)	547,896	87,796
Profit after taxes	2,335,769	148,899

Table 8. Cash flow of BFS and PVP projects

Item (EUR)	BFS	PVP
Depreciation	1,030,084	-
Profit (loss)	2,883,000	383,389
Income tax (19%)	547,896	87,796
Cash flow	3,365,853	295,593

Table 9. Payback period comparing

Payback period of invested money	
BFS	PVP
7 years and 214 days	5 year and 73 days

Table 10. Comparing of NPV

NPV (EUR)	
BFS	PVP
745,514.427	226,646.565

Tables 9 and 10 illustrates results from investment effectiveness analysis. As for the static method, we will compare payback period of invested money to BFS and PVP project and net present value (NPV) of the individual projects.

Financial means, invested to the PVP project are returning to investor two years sooner than invested to BFS project.

NPV value for both projects is positive, which means investor is able to create cash flow in necessary level for covering of its invested expenses. Investment in both projects is acceptable.

Higher mentioned evaluation of investment effectiveness to BFS and PVP projects proves that it would be more profitable for investor to invest money to BFS project due to the following: in BFS there is possible to use electric energy, as well as heat energy, but in PVP it is not possible. The only one advantage of PVP project presents its lower invested costs. But BFS project has also other advantages, for example incomes from electric and heat energy sale, incomes from digestive sale, higher revenues and profit. Neither lower payback period of PVP project is decisive for investment. From the view of NPV investment to BFS is expressly more convenient.

Discussion

According resulting data and their analysis we can state that due to the natural conditions and legislative support mainly biomass and solar energy have its perspective future development.

Higher mentioned evaluation of investment effectiveness to concrete projects – BFS and PVP proves that it is more convenient to invest to BFS, mainly due to the possibility to use electric energy, as well as heat energy and it brings higher NPV (Aste et al., 2013).

Suggestion to increase business with RES proves necessity to make gradual accepting of measurements, supporting business with RES in

Slovakia and to remove barriers in this area, political, economic, administrative or legislative ones.

B. Economic Evaluation of Boiler for Biomass Using in Slovakia

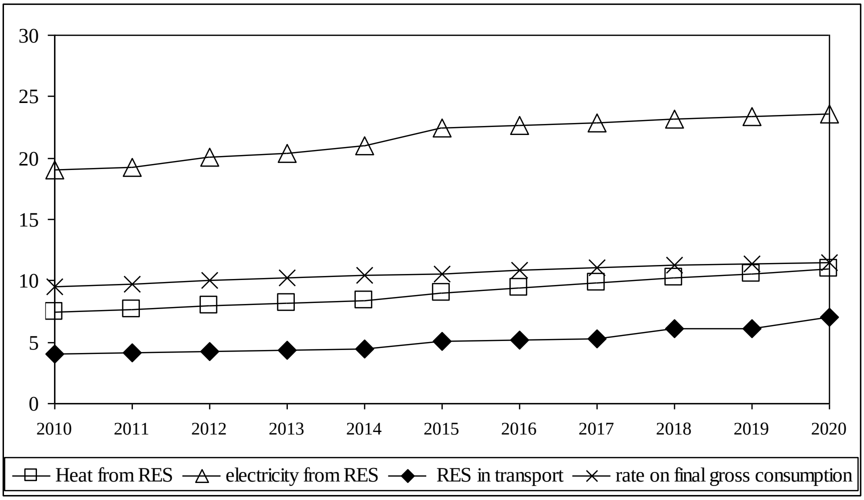
Biomass represents in Slovakia potentially very rich source of clean energy. Biomass was always used as a fuel all over the world, and new technologies allow us to use it more efficiently. In the presented chapter there is analyzed model example for boiler for biomass burning with secondary source of energy, mainly cogeneration unit, orientated mainly to the economic evaluation of the project, with consequent short description of environmental contribution (Badami et al., 2014). Importance of such analysis lies in the using of energy from biomass, that contributes to the increasing of state energetic safety by exploitation of own natural primary sources of energy.

In Slovakia, electrical energy is provided mainly by nuclear and heat power stations, with the remainder being produced in hydroelectric power stations. In this sector renewable energy sources (RES) still represent a minimal share in Slovakia. Nonetheless, the years 2009 and 2010 specifically represented a turning point in legislation promoting RES, with the introduction of both a guaranteed repurchase period for buying electricity produced using the various RES and a ‘fixed’ price. This resulted in greater investor interest in the building of energy sources for the production of heat and electricity including those derived from biomass.

This paper analyses the construction of biomass fired boilers with a secondary source of heat and electricity – a cogeneration unit (CGU) – from a financial viewpoint and based on a case model. The paper is primarily concerned with assessing how economically efficient this kind of project is, while the conclusion refers to the environmental benefits.

Wood materials and products are widely used in many sectors of the economy. They are highly diversified, with some of them having dual uses – they can be further processed (as is the case with biomass) or they can be used as a final product (Ratajczak & Szostak, 2005). Concept of 4th Generation District Heating (4GDH) identifies the future challenges of reaching a future renewable non-fossil heat supply as part of the implementation of overall sustainable energy system and it has an important role to play in future sustainable energy systems - including 100% renewable energy systems Lund et al. (2014). Some studies investigated the benefits of funding and investing in renewable energy projects, which show that number of countries have begun to adopt a more pro-active approach toward renewable energy that will help countries towards sustainability (Bhutto et al., 2014). As for biomass its availability is rather limited in Europe and, hence, it is of crucial importance to determine the optimal biomass-to-energy conversion pathway. Maximizing bio-electricity over other bio fuels turns out to be the best economic and environmental option. Combined with solar and wind energy, about 31% of the electricity production by 2020 could be renewable, i.e., 10 points higher than the target of Directive 2001/77/EC (Sues & Veringa, 2010).

As a member state of the EU, Slovakia is bound by Directive 2009/28/EC on the promotion of the use of energy from renewable sources to increase the share of RES used to 14% of final gross energy consumption and to 10% in transport. The National Action Plan for Energy from RES anticipates that the proportion of RES used in gross energy consumption will in fact be 15.3% (Chudíková et al., 2010). Using of dry biomass significantly reduces the cost of handling and transportation. For example, Haque and Somerville (2013) studied that if biomass is used in a power station as fuel for steam boiler, there is a significant reduction potential of emission.



Source: Tauš et al., 2011.

Figure 1. Rate of energy from RES on total consumption.

Slovakia, similarly as for example Brazil (Hoffmann et al., 2012) has favourable conditions for the cultivation of biomass for energy. In Slovakia biomass in particular has the potential to ensure that these goals are reached, since it is cost effectively and boosts energy security by decreasing the amount of natural gas consumed in heat and electricity production. In accordance with the action plan, Figure 1 illustrates predictions of the proportion of energy produced from RES in relation to total consumption (Chudíková et al., 2010).

As for the economic evaluation of biomass using, number of studies proves for example through so-called net present value that installing a biomass boiler to provide 40% of the annual heat demand is more economical than using a natural gas boiler to provide all the heat at a discount rate of 10% (Chau et al., 2009). Chalikias et al. (2010) created methodology, oriented to simulate space heating of houses and domestic water heating by providing a rough and costless initial estimation of the proposed energy projects with very promising results, relevant to its financial feasibility and environmental sustainability.

Table 11. Production of woody biomass in Slovakia

	thousand t	PJ
Forestry	2,470	23.2
Wood – working industry	1,410	12.3
Communal greenery, wind barriers, stream side overgrows, product	300	2.8
Woody biomass of fruit trees and vine, white planes	208	2

Source: Tauš et al., 2011.

A considerable upsurge in the use of RES to produce heat and electricity has been noted recently, partly due to Act No. 309/2009 Coll. on the promotion of renewable energy sources and high efficiency cogeneration, which came into effect on 1st September 2009. Biomass clearly dominates in the construction of high performance heat sources and wood chips represent the number one source. Biomass has the greatest energy potential of the fuel sources technologically available in Slovakia, but it should be noted that the widely proclaimed levels of forestation in Slovakia, and in other countries, are no reason to make rash use of this renewable resource (Csikósová et al., 2011).

The main source of wood biomass in Slovakia is the forestry industry; timber that is unsuitable for use in the timber-processing industries can be used for this purpose. Other sources include the timber-processing industries themselves, which produce waste during the production process that can be used as a fuel source, and last but not least there are other sources of wood with high potential that can be grown on low-yield agricultural land or on other land without forests as intensive crops. Some of this land is already wooded to varying degrees, as a result of successive wood growth.

Other sources of wood biomass fuel constitute vegetation growing around cities and villages, on riverbanks, as wind barriers, lining roads and found in household waste, or growing under power lines, and driftwood from rivers, etc. In addition to using timber that is not of suitable quality for use in the timber industry to produce energy, it is also possible to use lumber waste (the upper parts of trees, branches and twigs), top wood, timber damaged in natural disasters (uprooted trees, tree roots), pruning waste, etc. (Munnich et al., 2006). Table 11 shows an overview of potential wood biomass sources in Slovakia.

In recent years Slovakia has seen the production of wood fuel slowly increase; notwithstanding this, there has been a marked increase in the production of wood chips, as is illustrated in Table 12. The information shows that there is greater interest in wood chips, which is due to the construction of large facilities for producing heat and electricity. The advantage of "large" boiler systems is that these wood chips are often used on a "fuel-switch basis", where the transition is made from fossil fuels to biomass fuels. In addition, they offer a wide-ranging performance, from 200 kW to 20 MW, and allow for pressures of 0.5 to 28 bar, enabling steam to be created in order to produce electricity, and hot and warm water, in a system where firing and monitoring of combustion is completely automated. These boilers can be used to heat blocks of flats, hospitals, hotels, sports centres and to supply steam, and hot and warm water for various industrial and communal uses.

Table 12. Wood biomass for energetic using produced in forest economy

Year	Wood chips		Fuel wood		Together	
	Thousand t	TJ	Thousand t	TJ	Thousand t	TJ
1990	2	19	368	3,496	370	3,515
2000	5	48	471	4,475	476	4,523
2005	120	140	640	6,080	760	6,220
2008	190	1,805	690	6,555	880	8,360
2009	210	1,995	690	6,555	900	8,550

Source: Tauš et al., 2011.

Analysis of Biomass Using

For the purposes of the biomass using analysis, the case model in question was the construction of RES boilers, specifically wood chip boilers with a cogeneration unit powered by natural gas. We considered the provision of a heat source for the average-sized housing estate or urban district connected to a central heat source with a required heat capacity of 6.6 MW. In order to allow for smooth regulation of performance in summer and during transitional periods and maximum performance in winter, we suggested, given the technologies available, a boiler with a heat capacity of 5 MW and a cogeneration unit as a secondary source of heat, with a capacity of 1.6 MW and a corresponding amount of electricity. The newly built biomass boiler would consist of one wood chip biomass boiler equipped to provide 5 MW of heat. We suggested a warm-water boiler with a maximum temperature of 110°C and a maximum operational temperature of 105°C, given the measurements regarding hot water production during the winter regime:

- boiler output temperature 105°C,
- temperature in two-way pipes 60°C.

In the winter regime we considered heat production simply as a secondary source.

Part of the boiler composed of a buffering accumulator tank with a capacity of 200m^3 to act as a buffer against changes in pressure and temperature within the heating system. For our case model we proposed a medium pressure, hot water, three-pass design boiler of fire tube/tube plate construction, where the combustion gas enters the fire tube from below from the combustion chamber. The boiler must be equipped with a combustion chamber so that the optimum amount of fuel is burnt in relation to the performance of the boiler. The fuel used was wood chips, which are considered to be carbon-neutral in terms of producing so-called greenhouse gasses, particularly carbon dioxide. The wood chip can, therefore, and indeed does, replace natural gas in the production of heat.

The CU was operating on summer, winter and transitional regimes. When on the summer regime, the CU would continually supply the heating system with heat to produce hot water as an end product. Should an insufficient amount collect in the heating system, the CU will kick start the accumulator tank in the biomass boiler. When on the transitional and winter regimes, the CU will heat some of the water returned to the boiler and that will then be mixed under pressure with the water returned by the biomass boiler.

For combined production of electricity and heat, we have selected a technology based on natural gas fired in a cylinder engine. It is essential that the type of cogeneration proposed has a combustion engine providing the most advantageous level of conversion of fuel to electricity (the so-called heating plant module of electricity production 'e', which gives a ratio of between 0.6 and 0.99 of electrical energy and heat energy). The transformation of heat energy from fuel to mechanical energy is ensured by the combustion engine driven in turn by an electrical generator that ensures the production of electrical energy. We propose a gas engine with an electrical generator, serving as a hot water cogeneration unit heating water to 95/75°C and serving as a coolant for the combustion engine.

Within the investment expenditure we included all the financial expenditure spent on investment that has a payback period of longer than one year. Investment expenditure generally includes:

- expenditure on acquiring (purchasing) machinery, equipment, the cost of delivery to the company, installation and drawing up and collating project documentation. If investment was obtained in relation to research and development expenses, then these must also be included as part of capital expenditure,

- expenditure on continued growth of net working capital,
- reduced expenditure on income from the sale of replacement machinery or equipment and associated tax costs relating to the sale.

Investment expenditure on constructing the boiler is 4,332,825 EUR.

Financial revenue consisted mainly of revenue from the sale of products or services, depending on the kind of project. In the case model, income breakdown is illustrated in Table 13. The following facts were taken into consideration:

- cost of producing electricity using a gas engine in EUR (unit price of electricity produced from cogeneration unit fuelled by natural gas – UP = EUR 85.89/MWh pursuant to RONI Decree No. 7/2009 on the regulation of prices in the energy sector, reduced by 50% with the assistance of European funding, including 12% of the value, so that UP = EUR 75.58/MWh),
- heat produced by gas engine in € (unit price = EUR 11.04/GJ),
- heat produced from biomass in € (unit price = EUR 13.68/GJ).

Expenditure during period of operation related to investments, operations or finances.

- *Investment expenditure* – it was either expenditure on completing the construction once the project is operational, or expenditure on expanding production capacity where demand is positive, or it could be expenditure on replacing investment assets that have a shorter life cycle than the project as a whole.

- *Operational expenditure* – it concerned the purchase of raw material, materials and energy, expenditure on services, payroll, and social and health insurance (see Table 13).
- *Financial expenditure* – it referred to interest and credit payments if this kind of financing is adopted.

The model boiler project did not involve additional investment expenditure or financial expenditure, since the project is funded without the need for financing through credit.

Operational expenditure consisted of costs arising from the procurement of materials and goods, payroll, energy costs, services, maintenance costs etc. The greatest expense was energy costs, which almost constitute two thirds of total operational expenditure. The operational expenditure that is illustrated in Table 13 was calculated on the basis of known values, provisional estimates and negotiations. The first year takes into consideration a 2-month trial period, which is reflected in the level of operational costs, given in Table 13 for year 1.

In analysing the efficiency of the project two types of financing were considered:

Table 13. Annual service expenses

Service expenses in EUR	1 year	2-25 year
Material	637.5	1,579.2
Provision of goods	1,126.0	3,002.0
Personal costs	52,808.7	129,454.9
Services	14,140.1	34,960.5
Energy	561,228.9	1,667,905.0
Maintenance	53,739.0	174,671.7
Interest	0.0	0.0
Fee and taxes	0.0	0.0
Other costs	23,406.8	52,907.4
Service expenses total	707,087.0	2,064,480.7

1. type of financing 50% - non-refundable grant,
   50% - own resources.
2. type of financing 100% - own resources.

Financial income from the project consists of revenue generated by electricity production, which was determined as a combination of performance in MWh and a 12% reduction in price due to the non-refundable grant at a rate of 75.58/MWh EUR. Revenue generated through heat production using the gas engine and biomass is similar in both types, since in this case there is no change to the unit price. The result obtained using the true payback period corresponds to the usual returns from energy constructions based on RES using a non-refundable grant. A payback period of 9 years is an acceptable result, since the investment will continue to produce a profit 16 years after payback. The true payback period takes into consideration time and the impact it has on the value of the money the boiler with CGU will generate in the future. Discount factor that was used for its calculation results from the value of the discount factor that characterize real interest rate, stated at the level 5%.

Efficiency Analysis of 1st Financing Type

Type 1st financing consists of:

50% - non-refundable grant	= 2,166,412.50 EUR
50% - own resources	= 2,166,412.50 EUR
Total Investment Expenditure	= 4,332,825.00 EUR

Investment costs (IC) in relation to financing the construction have been calculated using a non-refundable grant accounting for 50% of investment expenditure in construction, since money granted or donated is not part of the recipient's capital assets and thus cannot be depreciated. IC equals 2,166,412.50 EUR (see Table 14).

Table 14. Indexes of economical effectiveness of the project – 1st variant of financing

Effectiveness indexes - 1st variant		Unit
Annual revenue	2,334,297.00	EUR
Annual expenses	2,010,184.90	EUR
Income tax (25y average)	47,393.60	EUR
Irreclaimable financial support	2,166,412.50	EUR
Own sources	2,166,412.50	EUR
Annual CF	276,718.50	EUR
Simple payback period	9.00	year
Real payback period	11.00	year
NPV	1,671,569.60	EUR
IRR	11.40	%

Net present value during considered living period 25 years is positive and according this result we can recommend project for realization. Its volume only confirmed previous declarations, based on the results of payback period. The interrnal rate of revenue is 11.4% that is very positive result. The given variant of project financing had been evaluated from the view of its effectiveness as acceptable and contributing for the investor. Economical effectiveness for the 1st variant of financing is illustrating at Table 15.

Efficiency Analysis of 2nd Financing Type

2nd type of financing consists:

100% - own resources = 4,332,825 EUR
Total Investment Expenditure = 4,332,825 EUR

Table 15. CSF review during life cycle of the project – 1st variant of financing

Unit	Index	Year							
		0	1	3	5	7	9	17	25
EUR	Project income		845,365	2,396,336	2,396,336	2,396,336	2,396,336	2,396,336	2,396,336
EUR	Service expenses		707,087	2,064,484	2,064,484	2,064,484	2,064,484	2,064,484	2,064,484
EUR	Depreciation		59,870	75,289	75,289	75,289	75,289	75,289	75,289
EUR	Investment expenses	2,166,413							
EUR	EBIT		78,408	256,566	256,566	256,566	256,566	256,566	256,566
EUR	Income tax		14,897	48,748	48,748	48,748	48,748	48,748	48,748
EUR	Profit after taxes		63,510	207,819	207,819	207,819	207,819	207,819	207,819
EUR	CF	-2,166,413	123,381	283,108	283,108	283,108	283,108	283,108	283,108
EUR	Cumulative CF	-2,166,413	-2,043,032	-1,476,817	-910,601	-344,386	221,829	2,486,690	4,751,551
EUR	Discount factor	1.00	0.95	0.86	0.78	0.71	0.64	0.44	0.30
EUR	Discounted CF	-2,166,413	117,505	244,559	221,822	201,199	182,494	123,519	83,602
EUR	Cumulative discounted CF	-2,166,413	-2,048,907	-1,547,561	-1,092,826	-680,367	-306,255	873,241	1,671,570

Table 16. Production of boiler in financial meaning financing without irreclaimable financial support

Production of boiler with CGU	Price	1 year	2-25 year	Mj
Production of electricity in gas engine	85.89 EUR/mWh	3,042	12,168	MWh/year
		261,277	1,045,110	EUR/year
Production of heat from gas engine	11.04 EUR/GJ	11,134	44,535	GJ/year
		122,916	491,666	EUR/year
Production of heat from biomass service	13.68 EUR/GJ	36,000	72,000	GJ/year
		492,480	984,960	EUR/year
Income from boiler production with CGU		876,674	2,521,736	EUR/year

Table 17. CF review – 2nd variant of financing

Unit	Index	Year							
		0	1	3	5	7	9	17	25
EUR	Project income		876,718	2,521,749	2,521,749	2,521,749	2,521,749	2,521,749	2,521,749
EUR	Service expenses		707,087	2,064,481	2,064,481	2,064,481	2,064,481	2,064,481	2,064,481
EUR	Depreciation		59,870	75,289	75,289	75,289	75,289	75,289	75,289
EUR	Investment expenses	4,332,825							
EUR	EBIT		109,761	381,979	381,979	381,979	381,979	381,979	381,979
EUR	Income tax		20,855	72,576	72,576	72,576	72,576	72,576	72,576
EUR	Profit after taxes		88,906	309,403	309,403	309,403	309,403	309,403	309,403
EUR	CF	-4,332,825	148,776	384,692	384,692	384,692	384,692	384,692	384,692
EUR	Cumulative CF	-4,332,825	-4,184,049	-3,414,664	-2,645,280	-1,875,895	-337,126	2,740,412	5,048,566
EUR	Discount factor	1.00	0.95	0.86	0.78	0.71	0.64	0.44	0.30
EUR	Discounted CF	-4,332,825	141,692	332,312	301,416	273,394	224,922	152,236	113,601
EUR	Cumulative discounted CF	-4,332,825	-4,191,133	-3,509,894	-2,891,991	-2,331,534	-1,362,093	91,623	864,325

The investment cost was determined by the level of expenditure the investor spent on constructing the biogas boiler, which comes to 4,332,825 EUR.

Financial revenue from the project derives from income generated by electricity production, which was set as a combination of performance in MWh and unit price = EUR 85.89/MWh and income generated by heat production.

Table 16 provides an overview of the output of a boiler with a CGU and the repurchase prices obtained when the project is financed on the basis of its own resources.

In establishing the measures of efficiency of the investment we resulted from the basis of cash flow values before and after discounting; the yearly figures are shown in Table 17.

The simple and true payback period of the project to construct a boiler with CGU financed solely from its own resources is 12-19 years, which is a borderline rate of return. It is a rather long payback period. Given the environmental aspect of the project, it is important to take into account the fact that projects designed to use RES typically have high investment costs and this is a further reason for the need to use non-refundable grants in investment in constructions of this kind.

The economic efficiency of financing projects using one's own resources – type 2 – is illustrated in Table 18 and Figure 2 below.

Table 18. Economical effectiveness during financing of own sources

Effectiveness indexes - 2nd variant		unit
Annual revenue	2,455,947.80	EUR
Annual expenses	2,010,184.90	EUR
Income tax (25y average)	70,507.20	EUR
Own sources	4,332,825.00	EUR
Annual CF	375,255.60	EUR
Simple payback period	12.00	Year
Real payback period	19.00	Year
NPV	864,324.70	EUR
IRR	6.80	%

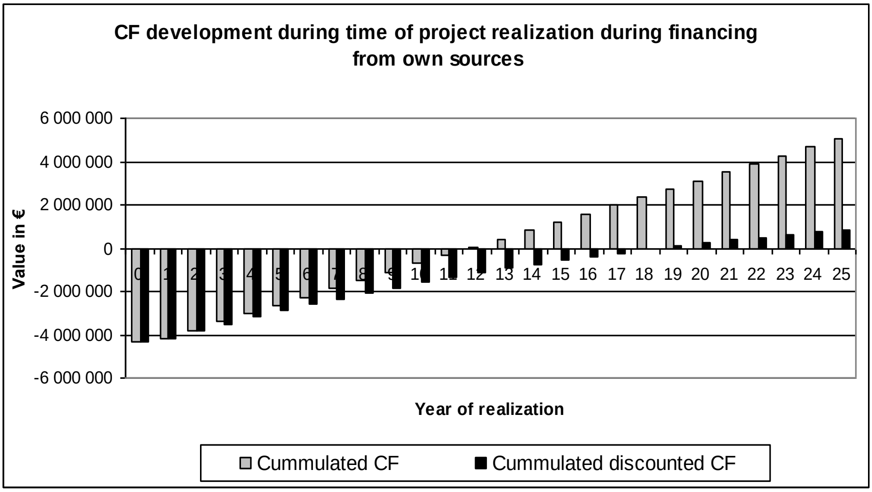


Figure 2. CF development during time of project realization from own sources.

The net present value over a life cycle of 25 years is positive and on this basis we can recommend that the project be realized. The internal rate of revenue is 6.8%, which given the relatively low risks associated with the project is acceptable. A summary of the results of the analysis will enable a particular type of financing to be recommended in view of the investor.

Once the calculations have been made, we can state that from an economical perspective the project is acceptable, the simple payback period T_s is 12 years where no non-refundable grant is used for keeping with the usual parameters for evaluating energy plans, meaning that this finding is favourable in terms of constructing a boiler with CGU with a long life cycle. The findings are shown in Table 19.

This type of project typically has high initial investment costs, and this has a marked impact on the overall efficiency of the project, which tends to be low. Therefore, we recommend that a non-refundable grant be used as it will considerably lower the investment load and shorten the payback period to 9 years.

Table 19. Summary of results

Indexes	Variant 1	Variant 2
Simple payback period	9	12
Real payback period	11	19
Net present value	1,671,570	864,325
Internal rate of revenue	11	7

Discussion

In economic terms, Slovak legislation is very important, particularly Act No. 309/2009 Coll. and subsequent RONI Decree No. 7/2009 that provide for the obligatory repurchase of electricity from co-generation units, fired by natural gas at a fixed price for 15 years and thereby create conditions for reducing market risks in the sale of electrical energy to a minimum. A not inconsequential factor is that in addition to biomass being carbon dioxide neutral, the use of energy produced from biomass helps increase the energy security of the state since it exploits its own natural primary sources of energy. The discount factor used to calculate the results from the value of the discount factor that influences the real interest rate was 5%. The net present value over a 25-year life cycle is positive and so on this basis we can recommend that the project be realized. The amount simply confirms previous statements, based on the results of the payback period. The internal rate of revenue is 11.4%, which is a very positive result. A particular type of project financing can be completely evaluated in terms of whether its efficiency is acceptable and beneficial to the investor.

C. UTILIZATION OF GEOTHERMAL ENERGY IN SLOVAKIA

Higher demand for energy consumption and importance of environmental issues has encouraged researchers and policy makers to consider renewable energies more seriously. Energetic projects, resulting from orientation to energetic effectiveness are contributing to the increasing of energetic safety and decreasing of economy dependence on unstable prices of gas and petroleum during their import. Contribution studies possible ways of utilization of individual types of renewable energies by analyzing of utilization of geothermal energy through characteristics of individual areas of geothermal energy in Slovakia according to intensity of heat flow. Results of analysis prove Slovakia has vast potential of geothermal energy. There is therefore necessary to support business activities, orientated to the energetical saving projects.

Research and science is dealing presently with finding of new clear sources of energy. Slovakia has due to its natural conditions important potential of geothermal energy that is preliminary calculated according present researches to 5.538 MWt. It presents renewable energy source, spread in territory which utilization has importance from the view of economical, as well as ecological. Therefore, interest of the state is to create conditions for rapid using of its potential. Geothermal energy is using in Slovakia in 36 localities with heat useful performance 142.75 MWt of geothermal water. Sources of geothermal energy in Slovakia are presented mainly by geothermal water, utilized in agriculture, heating and recreation.

Energetic projects, resulting from orientation to energetic effectiveness are contributing to the increasing of energetic safety and decreasing of economy dependence on unstable prices of gas and petroleum during their import. Saving of energy for companies and households means lower costs for providing of energetic needs and by this way direct or indirect increasing of competitiveness and quality of inhabitants' life.

Higher demand for energy consumption and importance of environmental issues has encouraged researchers and policy makers to consider renewable energies more seriously. European Union has a leading role in the world due to its strong commitment to increase renewable energy sources as for the energy system change. Success of such long term project requires first of all a stable political framework, well-tailored support system of finances, technical background and administrative, and by this way it can overcome the obstacles existing in distorted energy markets. Regardless their high potential, renewable energy resources are insufficiently exploited in Europe (Csikósová et al., 2012). Geothermal resources are a green energy source that can make a considerable contribution in some countries. For example, Japan has the third ranking geothermal energy potential, and its geothermal electricity production is currently eighth in the world (Jalilinasrabady & Itoi, 2013). Countries must therefore have policies that give legal basis for geothermal to produce electricity. There are different scenarios to assess attractiveness of geothermal investment to attract private investors to participate (Nasution, 2012).

Due to the rapidly increasing percentage of the population living in urban centers, there is a need to focus on the energy demand of these cities and the use of renewable energies instead of fossil fuels. Around 50% of urban population currently lives in areas of medium aquifer thermal energy storage (ATES) suitability, a percentage that will remain constant. Demand for ATES is likely to exceed available subsurface space in a significant part of the urban areas. Countries and regions are identified where regulation and stimulation measures may increase application of ATES technologies and thus help reduce CO_2-emissions. These two preconditions can be combined to identify where in the world ATES potential is present, or will become present as a consequence of climate change (Bloemendal et al., 2015).

Schiel et al. (2016) developed a model to determine the potential per parcel for using shallow geothermal energy and calculated the percentage of the energy demand that could be supplied by geothermal energy. Due to the geothermal energy using there is necessary to determine the requirements and parameters governing the development of shallow geothermal energy in an efficient and safe manner. Luo et al. (2015) mathematically quantified a geothermal heat exchanger system and simulated modeled it to understand heat transfixion and strata deformation taking into account the groundwater seepage and temperature fields, as well as land subsidence.

Ratlamwala and Dincer (2012) focused on a comparative assessment of multi-flash (single to quintuple) geothermal power generating systems integrated with electrolyzes through three definitions of energy and exergy efficiencies. They varied operating parameters such as ambient temperature and geothermal source temperature to investigate their effects on the respective efficiencies of individual and integrated systems and finally studied the effect of increasing the number of flashing steps on the efficiencies.

Other parameters had been studied by Tomaszewska et al. (2014) that calculated energy efficiency and economic analysis, demonstrated that the cost effectiveness of implementing the process in a geothermal system on an industrial scale largely depends on the factors related to its operation, including without limitation the amount of geothermal water extracted, water salinity, the absorption parameters of the wells used to inject water back into the formation, the scale of problems related to the disposal of cooled water, local demand for drinking and household water, etc. Economic efficiency studied also Al-Ali and Dincer (2014) who created a new multigenerational integrated geothermal-solar system to produce electrical power, cooling, space heating, hot water and heat for industrial use. They also conducted parametric study o investigate the effects of operating conditions and environment parameters on the system performance (Al-Ali & Dincer, 2014).

Deep groundwater temperature is necessary for research and use of a geothermal source. Best thermal waters (temperatures from 130°C to 160°C) for the purpose are located in the spa, which presents other area of research of geothermal resource utilization (Stojković et al., 2013).

Economic Evaluation of Geothermal Energy Using

Due to the summarization of characteristics for individual areas of geothermal energy in Slovakia there had been used classification of geothermal activity according intensity of heat flow (see Table 20).

Classification of geothermal energy is made also by complex of country space. Among spatially largest collectors of geothermal water in Slovakia belong triasic dolomite and limestone complexs in internal part of Western Carpathian. Springs of geothermal waters originate from these carbonates. Second place belongs from the view of space belong to neogene sand and plastics, third place belongs to andesite and pyroplastics.

From the view of litologic development of flysch and klippen area there are practically no geothermal water in the area. Such water bed are extended to 25 respectively 26 limited geothermal areas. Geothermal activity is giving to the areas according value of heat flow intensity (see Table 21).

According to world trend geothermal water had been divided to three groups:

1. High-temperature waters with surface temperature over 150°C (reservoir water over 180°C),
2. Mediate temperature waters with surface temperature 100-150°C (reservoir water 130-180°C),
3. Low temperature waters with surface temperature less than 100°C (reservoir water under 130°C).

Table 20. Classification of geothermal activity according intensity of heat flow

Value of heat flow intensity ($mW.m^{-3}$)	Geothermal activity
< 10	Very marginal
10-20	Marginal
20-30	Rather marginal
30-40	Very low
40-50	Low
50-60	Rather low
60-70	Average
70-80	Rather increased
80-90	Increased
90-100	Very increased
100-110	Rather high
110-120	High
> 120	Very high

Source: Franko et al., 1995.

Table 21. Classification of limited geothermal areas according value of heat flow intensity

Value of heat flow ($m.W.m^{-3}$)	Limited areas
120-100	Beša – Čičarovce
110-80	Basin Košice
100-90	Middle Slovakian neovulcanite (south east territory)
100-70	Middle Slovakian neovulcanite (north west territory)
90-100	Levice block (depression Dubnice)
90-70	Central depression
80-70	Ridge Humenné, firt fault Hornostrhohársko-Trenšská, basin Hornonitrianská, depression Komjatice
80-60	Basin Levoča (west part), Basin levoča (north part)
70-60	Bight Trnava, Piešťany, Basin Trenčín, Ilava, Bánovce, Turiec, Rimava, Peripheral block Komárno
70-45	Vienna shell
approximately 60	Basin Žilina, shell Skorušiny, basin Liptov, block Komárno

Source: Tometz and Dugáček, 2010.

Table 22. Review of classification of geothermal energy sources according temperature of water in underground stocks

Author Temperature	Muffler Cataldi (1978)	Hochstein (1990)	Benderitter Cormy (1990)	Mavrickij et al. (1997)	Haenel et al. (1988)
Low	to 90	to 125	to 100	to 70	to 150
Middle	90-150	125-225	100-200	70-100	
High	over 150	over 225	over 200	over 100	over 150

Sources of geothermal energy were classified according criteria, regarding their physical and chemical characteristics or geological processes, connecting with their origin. According to type of temperature regimes in the frame of Earth they are divided by various authors. Table 22 illustrates review of classification according to various authors during geothermal energy classification by temperature.

Potential of geothermal water is calculated according to temperature regime of earth crust, which influenced among deep 1, 5-40 m mainly by intensity of solar radiation in various annual periods. With growing depth this influence is decreased. Temperature of ground in depth H can be expressed by following equation:

$$t_H = t_V + (H+) \times h_t^{-1} \tag{5}$$

Where: t_V = medium temperature of air in the area (K)
H = depth (m)
h = depth of layer of fixed annual temperatures (m)
gt = geothermic level (m.K-1)
tH = temperature of ground in depth H (m)

Majority of data that were available for geothermal potential determination had been obtained from not successful experimental boreholes during finding of earth gas and oil.

Geothermal energy has in Slovakia vast potential similarly as water energy and it presents approximately 21.456 TJ annually. Slovakia has very good conditions for development and using of this RES (Pavolová et al., 2011). Performance of heat from geothermal waters is around yet 70 MW.m-3. Geothermal gradient of Slovakian sources achieves averagely 37 K.km-1, which presents more than worldwide average 30 K.km-1. There are 26 localities in Slovakia with sources of geothermal waters, with temperature 25 – 150°C. The temperature of water is proper for cascade using during households heating, as well as for using in agriculture and industry. Total energetic thermal potential is around 5,538 MWt. At 40% using of the potential there would be produced 2,200 MWt of thermal energy. In present time there is used only 5.4% of identifying technically useful potential of geothermal energy, mainly in area of heat. Technically useful potential for production of electricity presents only 0.06 TWh per year. Present using of the potential is only installation of performance 44 kW in two small cogeneration units, burning gas from the geothermal source in city Komárno with annual production 0.0035 TWh. Further potential from this RES using presents project in Košice Basin with electrical performance 5 MW and expected annual electricity production 0, 04 TWh, but this project had been not realized due to extremely high cost of geological research and mining. These are basic limiting conditions for further using of the potential.

Total potential of energy from renewable energy source, which is possible to change to other forms of energy per one year and its´ volume, is given by natural conditions. As for its characteristics it is unchangeable from the short term and middle term view. Technically useful potential, which can be used during establishment of available technology, is limited by administrative, legislative and environmental obstacles.

Table 23. Potential of thermal energy from geothermal waters in Slovakia (MWt), regenerated and without regeneration

Regenerated			Without regeneration		
Probable	Verified	Predicted	Probable	Verified	Predicted
321	147	85	4,511	29	445
Total potential of useful geothermal energy 5,538 MWt					

Division of various types of potential according volume of produced energy in form of heat and electricity is illustrated transparently in Table 23.

From the Table 24 we can see that value of available potential is in present time using only by 20%, which present value of economic potential that presents approximately only 36% from the total available potential of renewable energy sources in Slovakia. Position of present legislation against renewable energy sources, expresses last data in table, which means value of market potential that corresponds approximately to 12% from available potential at present prices of technologies, repurchase prices of energy and support tools for using of renewable energy sources. When considering that geothermal energy and biomass have generally highest energetic potential and they contribute generally to production of heat energy, it is not amazing that heat potential is higher than electric. For all sources there is available potential for electricity production 17.5% from total available potential, while market potential of electricity is 12.3% from total market potential.

While economic potential of heat presents 36.9% from available potential, for electric energy it presents only 27.6%. This trend is also approved by figures from market potential, which is 13.1% from available potential of heat, while for electricity it is only 8.9%. This can be explained by problematic realization of photovoltaic systems and wind power plants at higher measure. Extension of individual types of geothermal waters in limited areas is mentioned in Table 25.

Table 24. Potential of geothermal energy, compared with other RES in Slovakia, in TJ (2012)

Source	Technically available potential	Present using	Available potential	Economic potential	Market potential
Geothermal energy	22,680	1,224	21,456	8,424	4,355
Wind energy	2,178	0	2,178	505	150
Solar energy	18,720	25	18,695	4,460	1,270
Small water power plants	3,722	727	2,995	749	299
Biomass	40,452	12,683	27,770	11,868	2,932
Total	87,754	14,659	73,094	26,006	9,006

Table 25. Ranking of limited geothermal areas according temperature in depth 1000 m

Temperature in 1000 m (ºC)	Limited areas
> 65	Beša – Čičarovce, Levice block (depression Dubnice)
65-45	Basin Košice
60-40	Middle Slovakian neovulcanite (south east territory), Middle Slovakian neovulcanite (north west territory), depression Komjatice
50-45	Ridge Humenné, central depression
50-40	Komárno margin block, rift fault Hornostrhánsko and Trenčská
50-35	Vienna block, basin Trnava, Hornonitrianská, Piešťanská, Turiec, Komárno margin block
45-30	Basin Bánovce, Liptov, Levoča, block Levoča – west, south and north part
40-30	Block Skorušiny
35-30	Basin Trenčín, Ilava, Žilina
40-20	Komárno high block

Source: www.teko.sk.

After deduction of average annual air temperature in Slovakia 7°C from temperature in depth 1,000 m remaining temperature corresponds approximately with the average geothermal gradient. Geothermal waters can be divided to basic types from the view of chemical structure creation:

- Relict sea waters,
- Highly mineralized geothermal waters,
- Petrogenic geothermal waters with total mineralization to 5 g per liter,
- Geothermal waters of mixed genesis with complete chemical structure (www.teko.sk).

Geothermal water with temperature 15-90°C is from the view of energy very convenient source for heat pumps, but basic disadvantage is very high investment cost for its obtaining (drill hole to the depth to several km), high level of corrosion and its availability at the place of appearance. Convenient solution would be using of geothermal water with high temperature first of all for obtaining of heat directly in heat converters "water-water" and consequently during its cooling to 15-25°C, as a source for heat pumps (Tometz & Dugáček, 2010). Type of geothermal water according to temperature is illustrated by Table 26.

Geothermal sources present such part of geothermal energy of solid, liquid or gas phase of earth crust that can be economically mined and utilized by present available technologies for energetic, industrial, agricultural, balneo technical, and recreation - rehabilitation purposes. The source of the energy is recent heat of Earth, heat that is loosening during radioactive ground destruction and during movement of lithospheric plates, which is accompanied by volcanic activity and earthquake. From this view geothermal energy is considering as renewable energy source. (RES, Publication to project financing from EHP mechanism, Norwegian financial mechanism and state budget of Slovakia).

Table 26. Depths of water beds of geothermal water in relation to their surface temperature

Type of geothermal waters	Limited areas	Depths water beds (m)
High temperature (under 15°C)	Rift Humenné	5,000-6,000
	Beša Čičarovce	3,500-5,000
	Basin Ždiar	5,000-6,000
	Vienna block	5,000-7,000
Middle temperature (100-150°C)	Beša – Čičarovce	2,500-3,000
	Basin Košice	2,500-3,000
	Central depression of Dunaj block	3,000-4,000
	Rift Humenné, block Levoča	4,000-6,000
	Basin Žilina, Ilava, Trenčín	5,000-6,000
	Trnava and Piešťany bight	4,000-5,000
	Vienna block	4,000-6,000
Low temperature (over 100°C)	Komárno high block	100-3,500
	Central depression of Dunaj block	1,000-3,000
	Basin Bánovce	100-3,500
	Trnava and Piešťany bight	1,000-4,000
	Middle Slovakia neovulcanite NW+SE	1,000-4,000
	Basin Hornonitrianská	1,500-2,500
	Turiec basin	1,000-3,000
	Basin Žilina	1,000-5,000
	Depression Skorušina	100-25,000
	Basin Liptov	1,000-4,000
	Block Levoča (west and south part)	500-4,000
	Rift fault Horná Nitra	500-600
	Basin Rimava	150-1,500
	Basin Trenčín and Ilava	1,000-5,000
	Block Levoča (north part)	1,000-2,000
	Komárno margin block	1,000-2,500
	Vienna block	2,000-4,000
	Komjatice depression	2,000-3,000
	Levoča block	1,500-4,000
	Beša – Čičarovce	1,000-2,500
	Basin Košice	1,000-2,500

Source: Tometz and Dugáček, 2010.

In Slovakia there is used following division of geothermal sources of geothermal energy:

- low temperature – with temperature 20-100°C,
- middle temperature – with temperature 100 - 150°C,
- high temperature – with temperature over 150°C (Čulková & Teplická, 2008).

Sources of geothermal energy are generally appearing in four main forms: hydrothermal system, geo compressed zones, dry heat of ground (hot dry rock) and magmatic sources. Available geothermal sources are in places where there is relatively slight earth crust, or where it is invaded by tectonic movements and volcanic activity during 10 million years also with its volcanic reflections and recent volcanic activity (Duleba & Lisoňová, 2009).

From total volume of energy that is annually consumed in Slovakia, almost half is falling on industry, almost fifth to households, next fifth to providing of agricultural production and services and residual to the transport. Average household needs probably 60% of energy due to the heat supplement, around 30% for heat water supplement and 10% for operation of appliances in the households. When considering family or community as economic unit, there is natural to deal with the way how to decrease energy cost from short term as well as from the long term view. Using of geothermal waters in Slovakia is illustrated by Figures 3 and 4.

Geothermal water is not always heating to other, secondary water that is supplied to heating systems. In case of swimming pools and spas, there is direct using of geothermal water, which means that geothermal water is filling to pools directly from drill hole. Majority of localities with using of geothermal water is in Trnava County.

Except of heating in system there is possible also to prepare heat service water for habitation and steam is used for technological purposes of hospitals. By this installation there is possible to provide heat for habitation and to improve the living environment in the city, where there is not used any more coal. For example, one of the localities, providing heat for whole habitation and hospital with policlinic, is in Galanta.

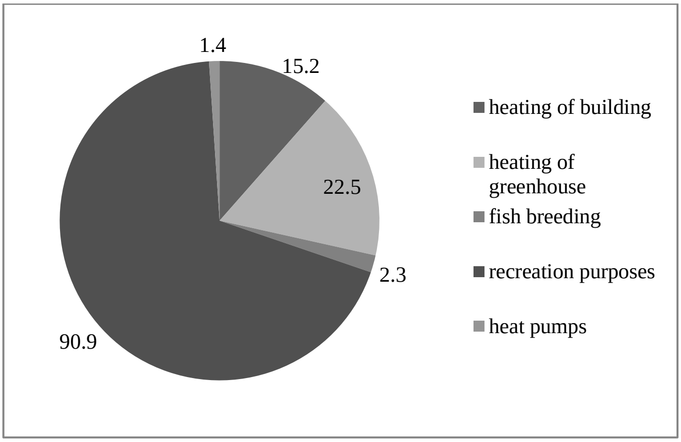


Figure 3. Using of geothermal water in Slovakia according installed performance (MW).

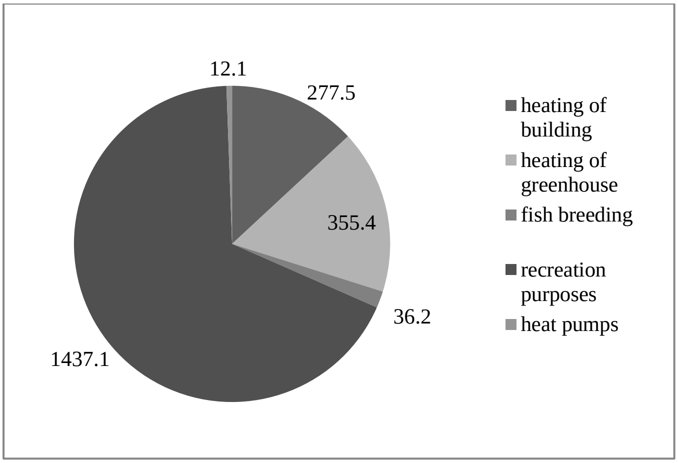


Figure 4. Using of geothermal water in Slovakia according annual consumption of energy (TJ per year).

From the view of providing of decreased energetic demand, presenting one of the main goals of energetic policy in Slovakia, there is necessary to follow up possibilities how to support energetic projects together with regarding their personal, program and financial sustainability (Hakelová et al., 2013).

As for the financial situation following, there is necessary to orientate to support of business activities financing, orientated to the energetically saving measurements, for example finding of a effective way of financing.

In present time there is possible to use for financing of energetic projects various operation programs in the frame of structural funds, various specialized donations, financed from state budget, or international programs and funds.

Geothermal energy is used through its bearers – geothermal waters and steams. Most known external and good visible reflection of this energy means volcanic activity, connected with seismic territories – most active zones in earth crust. Second good visible manifestation of geothermal energy means springs of steam and hot waters, which are also connected to these zones.

Using of geothermal energy has several advantages:

- It presents a domestic source,
- It is rather cheaper than fossil fuels,
- It decreases danger of the living environment threating by reduction of transport, elaboration and using of fossil fuels (accidents during construction, service of gas and gas products stocks, stock economy, emissions,
- It enables managing of energy prices,
- Service of geothermal energy is secure with minimal impact to living environment and soil occupation.

Discussion

One of the priorities of state policy is support of business, orientated to increasing of energetic effectiveness, production and consumption of energy. By this way business is more and more orientated rather to environmental appeal, as for example quality of the air, climatic changes and management of sources with opportunity for regional development through investing to regions and communities, opportunity for job, decreasing of production cost, growth of competition advantages, etc.

But this goal is not possible to achieve without a necessary financial mechanism, supporting effective and environmental business with energetic sources. Energetic projects that result from orientation to energetic effectiveness, contribute to increasing of energetic safety and they decrease dependence on unstable prices of gas and oil during import.

As for the companies, services and households, saving of energy means lower costs for providing of energetic needs and by this way direct or indirect increasing of competitiveness, as well as quality of inhabitants' life.

D. Evaluation of Energetic Efficiency of Public Building

New direction of energetic efficiency deals especially with buildings in public sector. Buildings are greatest consumer of energy that is used not only for providing of the needs of buildings users with the goal to create conditions of heat comfort, but also hygienic conditions as well as improving of life's quality.

Greatest potential of rationalization of energy consumption lies in buildings, mainly in their heat and technical characteristics, determining need of heat/coolness, or during preparation of heat and coolness supplement. This potential is similar when we compare it with Europe, where big amount of final energy in buildings is estimated about 50% (Dylewski & Adamczyk, 2012). Energetic efficiency presents way to better competition, since it decreases service costs. It can be done except of others also through the thermostat using during off-peaks hours in school building and replacement of artificial lighting with more efficient ones (Kwong et al., 2013) But problem presents saving measurements with economical return more than 5 years, since development of market conditions and economical sustainability is difficult to predict in long term. A trend of energy saving is particularly noticeable in the industry as it provides the opportunity to increase economic efficiency (Vilamová & Piecha, 2016).

Energetic consumption in buildings presents all over the world approximately 40%. Lauko (2009) mentions public buildings in Slovakia consume 12 - 14% that is:

- approximately 20 - 25 TJ/year (from 350 PJ/year)
- approximately 300 mil EUR/year.

According to the first action plan of energetic efficiency for 2008-2010, buildings saved almost 498 TJ of energy. During quantification of energy savings there were used two methods: upside down – evaluation of savings through obligatory indicators in individual sectors of national economy and bottom-up – detail evaluation of individual projects, where we saved 3.7 TJ of energy and middle term goal of savings had been achieved.

As for the financing, existing institutions have been unable to create new sources of funding and governments turned to the private sector (Freitas et al., 2007). Public buildings were financed mainly from structural funds, where in the frame of operation program: Basic infrastructure 178 buildings obtained non-recurring financial contribution. Schools and health institutions prevailed from reconstructed buildings, since they achieved significant decreasing of energy consumption (Šebejová, 2011).

Prices of energy are permanently growing, there is necessary to think about possible savings. Saving measurements that deal with significant renovation of building could save money, paid for energy, and they influence living environment positively, but on the other hand they increase comfort. Basic saving measurements in the frame of significant renovation belong:

- Windows exchanges,
- Heating of building construction,
- Choice of heat sources, way of heating, possibility to use renewable energy sources (RES),
- Managed ventilation,
- Proper regulation of heating (Tauš et al., 2011).

During renovation of building there is necessary to begin with energetic audit that evaluates building from the view of energy consumption and it enables to obtain information about what measurements to realize in the concrete case and where to save the most (www.economy.gov.sk).

Subject of Searching – School Building

School of building is evaluated subject existing in north-east part of Slovakia. It is building 38 years old (built in 1975). It consists from two pavilions with three floors. It is constructed from concrete panels; the roof is plane, covered by asphalt. It is connected to the public electric and telecommunication net.

Supplement of heat to central heating is provided by a supplier through heat medium – water in closed circle with compelled circulation, by the way of circulated pumps, installed in heat source with automatic regulation of resulting heat medium. Heating periods begin 1st September, and it ends 31st May. The schedule of heating is adapted to the school's service. Heating medium presents cast iron radiators and thermostatic valves, enabling to regulate demanded temperature.

Decreasing of heat necessity must regard different measurements that are different in case of new or renovated building. Basically it means providing of demands on heat protection of the individual building constructions. In existing building there is necessary to achieve decreasing of heat necessity for heating mainly by change of heating and technical characteristics of such building elements (Straka et al., 2016).

Heating and technical characteristics of building construction are subjected to norm STN 73-0540-2, determined by heating protection of building with aim to provide demanded state of internal environment. There is evaluated index of heat transfer U (W/m^2K) and demanded and recommended value. This value gives what volume of heat (in W/m^2) transfers through building part during heat difference 1K. In case temperature of the air is equal in the internal and external surface of construction, there is any transfer (Sternová, 2010).

According to energetic evaluation of building by Elaut BauMont ltd., Snina building has shortages as for its technical state that influences mainly consumption of heat energy.

Building does not meet also acceptable values, determined by norm and it causes great heat loss. Evaluation of construction according energetic evaluation of building according to recommended values is as follows:

- *The external wall* with surface 1,083.16 m^2, index of heat transfer – 1272 W/m^2K, highest allowed value of the index according norm – 0.46 W/m^2K, recommended value – 0.32 W/m^2K, which means it does not meet present requirements. Heat loss due to the transfer through construction presents 327% of total heat loss.
- *Roof surface* - 644.10 m^2, index of heat transfer – 1099 W/m^2K, highest allowed value of the index for such type of construction – 0.30 W/m^2K, recommended value – 0.20 W/m^2K, therefore it does not meet present requirements. Heat loss presents 16.8% from total heat loss.
- *The ceiling over not heated basement* with surface 644.10 m^2, index of heat transfer – 1,868 W/m^2K, highest allowed norm value – 0.35 W/m^2K, recommended value – 0.25 W/m^2K, it does not meet present requirements. Heat loss presents 14.3% from total heat loss.
- *Wooden double Windows* with surface 540 m^2, their index of heat transfer is 2800 W/m^2K, highest allowed nor value – 1.7 W/m^2K, recommended value – 1.4 W/m^2K, Windows do not meet present requirements as well. Heat loss is 359% from total heat loss.
- *External doors* with the surface 3.2 m^2, index of heat transfer – 2,500 W/m^2K, highest allowed norm value – 1.7 W/m^2K, recommended value – 1.4 W/m^2K and heat loss is 04% from total heat loss (Sternová, 2012).

Due to the composition of energetic balance we result from invoices from previous three years that provide idea about energy consumption, as well as costs on building (see Table 27).

Electric energy is consumed for lighting and service of various facilities (computers, video, data projectors, copying machine, fridge, cooker, beverage machine, etc.) that consume energy.

Table 27. Heat consumption and costs during 2013-2015

Year	Heat	Costs	Heat	Fix part (input)	Costs on fix part	Total
	(kWh)	(EUR)	(EUR/kWh)	(kW)	(EUR)	(EUR/kWh)
2013	181,735.56	15,746.07	0.0866	30.30	6,014.11	0.1197
2014	160,064.00	15,278.34	0.0955	30.30	5,808.96	0.1317
2015	146,390.00	16,844.03	0.1151	34.29	6,936.36	0.1624

Source: Kwong et al., 2013.

Average consumption of heat energy in 2013-2015 presents 162,729.85 kWh, consumption of electric energy presents 9,959.33 kWh, which is together 172,689.18 kWh, from which results that energy from heating presents 94% from total energy consumption and to electric energy belongs approximately 6% (see Table 28).

Table 28. Consumption of electric energy during 2013-2015

Year	Electric energy	Costs	Electric energy
	(kWh)	(EUR)	(EUR/kWh)
2013	9,935	2,661.93	0.2679
2014	9,984	2,700.18	0.2705
2015	9,959	2,961.71	0.2974

Source: Kwong et al., 2013.

The Suggestion of Measurements for Energy Consumption Decreasing

In comparing with EU countries energetic severity of buildings in Slovakia is higher; approximately 60% energy is consumed on heating. Most heat fades through walls, therefore there is possible to achieve lower energy consumption at older buildings by proper measurements.

During calculation of savings we result from average consumption and price of heat (see Table 29).

Table 29. Average heat consumption during 2013-2015

Average	Heat (kWh)	Costs (EUR)	Total (EUR/kWh)
	162,729.85	26,434.72	0.16

Source: Kwong et al., 2013.

From the esthetical, as well as the energetic view we suggest changing windows and making heating of roof and walls.

Input costs of measurement realization, mentioned in Table 30 present total costs of material with work, according calculation of Elaut BauMont ltd., Snina providing complex services.

Assumed percentage saving of energy (see Table 31), according energetic evaluation of building by mentioned company will be considered during calculation of individual measurements savings according real consumption in evaluated building.

Table 30. Input investment costs

Windows change (540 m^2)	EUR
Plastic window single – sash 1,500/1,500 mm (240 pieces)	37,800.00
Plastic window board (360 m)	5,604.34
Work and supplement (main and helping building production)	27,441.30
Together	70,845.64
Heating of walls (1,083.16m^2)	
Polystyrene EPS-F 100 mm	38,912.00
Work and supplement (main and helping building production)	27,670.85
Together	66,582.85
Roof heating (644.10 m^2)	
Polystyrene EPS 150 S hr. 60 mm	6,170.19
Work and supplement (main and helping building production)	25,160.38
Together	31,330.57

Source: Kwong et al., 2013.

Table 31. Calculated heat necessity

Measurement	Before measurement realization	After measurement realization	Percentage change – saving
	(kWh/year)	(kWh/year)	(%)
Windows change	337,420.58	262,277.02	22.27
Heating of walls	337,420.58	239,804.81	28.93
Roof heating	337,420.58	279,417.98	17.19

Table 32. Contribution of suggested measurement – change of windows

	m^2	Costs (EUR)
Wooden windows – Exchange for plastic one	540	70,845.64
Together	540	70,845.64
Evaluation of energy savings	Unit	Evaluation
Assumed energy saving (22.27%)	kWh/year	36,239.94
Price of energy	EUR/kWh	0.16
Costs saving on energy	EUR/year	5,799.78
Simple payback period	Year	12.2

Table 33. Contribution of suggested measurement – building heating

	m^2	Costs (EUR)
Wall heating	1,083.16	66,582.85
Together	1,083.16	66,582.85
Evaluation of energy savings	Unit	Evaluation
Assumed energy saving (28, 93%)	kWh/year	47,077.75
Price of energy in 2012	EUR/kWh	0.16
Costs saving on energy	EUR/year	7,533.90
Simple payback period	Year	8.8

Table 34. Contribution of suggested measurement – roof heating

	m^2	Costs (EUR)
Roof heating	644.10	31,330.57
Together	644.10	31,330.57
Evaluation of energy savings	Unit	Evaluation
Assumed energy saving (17, 19%)	kWh/year	27,973.26
Price of energy in 2012	EUR/kWh	0.16
Costs saving on energy	EUR/year	4,475.40
Simple payback period	Year	7.0

Infiltration is very important factor, influencing wastage of energy and it is caused by old windows and doors. Some windows in the building are not possible to open; other ones are fixed by nails due to the security. Therefore, there is vast fade of energy "through the window". Table 32 shows possible costs saving and payback period.

Important assumption for achievement of lowest consumption of heat is qualitative heat isolation of building construction – wall, roof, ceiling, and flooring. Building heating through suggested measurement could bring costs saving as well (see Table 33).

The best way is to start to make heating beginning with the roof. The roof is protecting against negative influences of weather and heat fade. There is existing simple physical principle of warmer air ascending up, and by this way heat is fading mainly through the roof. Contribution of measurement for the roof heating is providing by Table 34.

Saving measurement saves except others money, paid for energy, as well as they increase comfort, and they influence a positively the living environment.

Energy Saving Projects – Economic Evaluation

The energetic saving in buildings is achieved by combination of various measurements, in which rate among price/saving is very important factor during decision. Some measurements are rather expensive but at the same time, not very effective ones. From the individual measurements we constructed two projects, every one of them contents calculation of energetic and economical savings (see Table 35).

Permanent growth of energy prices leads to looking for such solutions that would enable to achieve energy savings with lowest realization costs. Any owner of the building has interest to invest to the energetical saving projects without return of invested money.

Quality of habitation is influenced mostly by windows. They define not only quality of the air, but they influence also lightning of the room and volume of payment on energy. In first project we change only windows, since they are considerably used and great volume of heat is fading through them. This project demands investment 70,845.64 EUR and it would bring annual costs saving 5,799.78 EUR (see Table 36). Saving of total energy consumption at windows change depends also on the rate of glass covered the surface to the rest of the building surface, as well as orientation of windows and quality of original windows in comparing with new windows characteristics. Windows presents in new building and reconstruction also esthetical element and except of energy and heat savings they provide also protection against noise.

Table 35. Energy saving projects 1

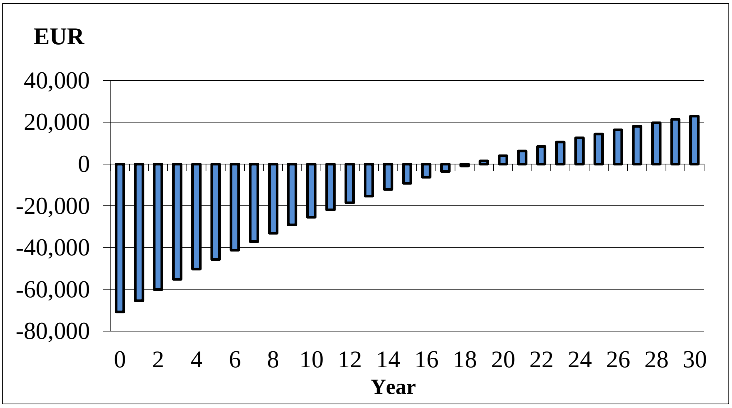
Measurement	Energy saving (kWh/year)	Costs on realization (EUR)	Costs savings (EUR/year)	Simple payback period (years)
Windows change	36,239.94	70,845.64	5,799.78	12.2

Table 36. Economic evaluation – variant 1

Evaluation - variant 1	
Input investment	70,845.64 EUR
Costs saving	5,799.78 EUR
Simple payback period	12.2 year
Real payback period	18.4 year
Net present value (NPV)	22,962.82 EUR
Internal rate of revenue (IRR)	8.6%

During calculation we considered discount rate 6% and annual rate of energy prices growth 1.5% p. a., defined by processes of economical evaluation of energetic systems in buildings and in accord with studies of potential for energy savings in buildings.

Simple payback period is 12 years and 78 days; real payback period is 18 years and 144 days. Time prolongs real payback period against simple one about 6 years (see Figure 5). Net present value is positive, which means project is acceptable. Internal rate of revenue – 8.6% is higher than discount rate 6%, it is more than presently offered rate from banks.



Source: JMP software processing.

Figure 5. Cumulated discounted cash flow – project 1.

Table 37. Change of investment costs – project 1

Change of investment costs (EUR)		NPV (EUR)	IRR (%)	Real payback period (year)
- 40%	42,507.38	51,308.08	14.9	9.2
- 30%	49,591.95	44,216.51	12.7	11.2
- 20%	56,676.51	37,131.95	11.1	13.4
- 10%	63,761.08	30,047.38	9.7	15.7
0%	70,845.64	22,962.82	8.6	18.4
10%	77,930.20	15,878.26	7.7	21.4
20%	85,014.77	8,793.69	6.9	24.8
30%	92,099.33	1,709.16	6.2	28.9
40%	99,183.90	-5,375.44	5.5	x

As we can see at Figure 5 with cumulated discounted cash flow, suggested measurement would be profitable only after a 18th year of investment realization.

Table 38. Energy saving project 2

Measurements	Energy savings	Costs of realization	Costs savings	Simple payback period
	kWh/year	EUR	EUR/year	years
Windows change	36,239.94	70,845.64	5,799.78	12.2
Heating of walls	47,077.75	66,582.85	7,533.90	8.8
Roof heating	27,973.26	31,330.57	4,475.40	7.0
Together	11, 290.95	168,759.06	17,809.07	9.5

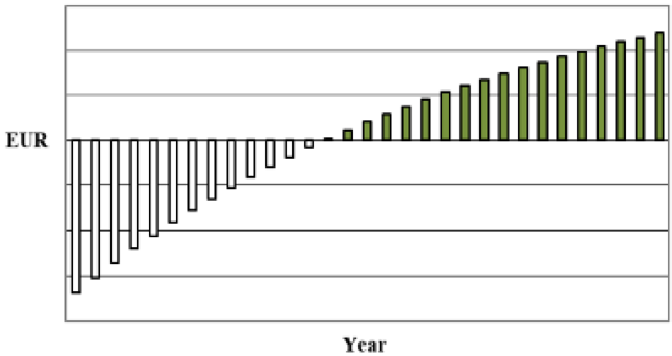
Table 39. Economic evaluation – variant 2

Evaluation - variant 2	
Input investment	168,759.06 EUR
Costs savings	17,809.07 EUR
Simple payback period	9.5 year
Real payback period	12.8 year
Net present value (NPV)	119,293.50 EUR
Internal rate of revenue (IRR)	11.4%

We will look at the influence of investment costs change, their increasing or decreasing to other economic factors, concretely to the net present value, internal rate of revenue and real payback period (see Table 37).

In case we consider a living cycle of the project 30 years, payback period is more than half of living cycle, but in spite of this there is still a rather long time of profit creation till the end of living cycle. Sensibility analysis proves that also during investment costs increasing about 30% net present value would remain the positive and internal rate of revenue would be higher than discount rate. But on the other hand real payback period is increasing, during 30% increasing of investment costs it is yet to the maximal period of living cycle. This is illustrating also at other economical indexes, net present value and internal rate of revenue meet required criteria, but their values are at the level of their acceptability.

In second project we made except of the windows change also heating of walls and roofs. This project demands higher investment, but on the other hand it would bring the higher annual saving of costs. Heat quality of wall is given by necessary temperatures of building spaces with aim to provide energy savings as well as heating comfort. Increased input costs for measurements realization would return by the way of lower operation costs from saved energy.



Source: JMP software processing.

Figure 6. Cumulated discounted cash flow – project 2.

Table 40. Projects comparing through present value index

Project	Investment costs	Cash incomes	Present value	NPV	Index PV
1	70,845.64	217,716.09	93,808.46	22,962.82	1.32
2	168,759.06	668,529.00	288,052.56	119,293.50	1.71

During combination of building heating together with windows change there is possible to achieve in buildings, constructed till 1983 decreasing of heat energy consumption about more than 50% (see Table 38). At buildings, constructed after 1983, it is approximately 30%.

At this project there is achieved higher energy saving and costs, and in case we consider input costs 168,759.06 EUR and annual saving 17,809.07 EUR, simple payback period presents 9.5 years, mainly 9 years and 182 days (see Table 39).

Real payback period, regarding time is longer more than 3 years; mainly it is 12 years and 292 days. Net present value is positive; therefore, also in this case the project is acceptable. The internal rate of revenue is 12.8% that presents higher profitability then from common investment projects.

Figure 6 shows that suggested measurement of project 2 would be profitable before 13th year of investment realization.

According index PV project is acceptable in case its value is over 1 (see Table 40). Projects are acceptable according to NPV, they have positive NPV, and they are acceptable as well according index PV, its value in both cases is over 1. From the view of both criteria project 2 is better, it’s NPV (119,293.50 EUR) as well as index PV (1.71) is higher than project 1.

During the project financing from own sources, increasing of input costs about 60% (see Table 41) would bring still positive net present value as well as higher internal rate of revenue over discount rate (in project 1 it was half, which means 30% increasing), real payback period during such increasing would achieve almost maximal period of living cycle that is not profitable for project acceptance.

From the view of real payback period project is advantageous in case payback period is shorter than living cycle of the project. The shorter is payback period, the better. Project 2 achieves payback period 12.8 years, in comparing with project 2 it is shorter period about 5.6 years, in case we regard the living cycle of the project – 30 years, we can decide it is positive situation.

At evaluation of energetically effective suggestions or measurements there are important also factors, necessary to regard with aim to provide sufficient information for the building owner about suitability to invest to suggested measurements. Payback period of invested money is important as well by the way of savings from decreased energy consumption. During searching of possibilities to decrease energy consumption in school building there is question of financing of savings measurements. We will analyse the chosen project according financing with aim to find out optimal variant and we will show possible scenario of development of public building renovation.

Table 41. Change of investment costs – project 2

Change of investment costs		NPV (EUR)	IRR	Real payback period (year)
- 75%	42,189.77	245,862.79	43.7%	2.6
- 60%	67,503.62	220,548.94	27.9%	4.3
- 45%	92,817.48	195,23508	20.6%	6.2
- 30%	118,131.34	169,921.22	16.3%	8.2
- 15%	143,445.20	144,607.36	13.5%	10.4
0%	168,759.06	119,293.50	11.4%	12.8
15%	194,072.92	93,979.64	9.8%	15.5
30%	219,386.78	68,665.78	8.5%	18.6
45%	244,700.64	43,351.92	7.5%	22.2
60%	270,014.50	18,038.06	6.6%	26.4
75%	295,328.36	-92,929.23	5.8%	X

Selection of Optimal Variant

During evaluation of projects there is necessary to find out optimal solution that is convenient for the investor/owner of building not only from technical view, but also from economical view that means from the view of input investment and operation costs. This can influence considerably single decision.

During calculation we considered with financing from own sources. Choice of the optimal variant had been made by the way of basic variant. First of all, we have chosen criteria, according which we would compare individual projects and choice proper suggestion. Consequently, we constructed decision matrix.

During calculation of indexes, mentioned in Table 42 we resulted from average heat consumption during period of three years and prices of heat in 2013. Average costs of heating during mentioned period present 26,434.72 EUR.

From the view of economical evaluation, we calculated a net present value that was positive in both cases (see Table 43), which means both projects are acceptable; the higher value is achieved in the complex renovation of building. We add to the individual values points without weight significance and also percentage proximity to basic variant.

Table 42. Chosen criteria of decision

Criteria		Project 1	Project 2
Decreasing of operation costs	EUR/year	5,799.8	109,631.1
Investment costs	EUR	70,845.6	168,759.1
Real payback period	Year	18.4	12.8
Net present value	EUR	22,962.8	119,293.5
Index PV – profitability	-	1.3	1.7
Volume of savings	kWh	36,239.94	111.290.95

Table 43. Point evaluation of projects suggestion without weight

Criteria	Project 1	Project 2	Basic variant
Decreasing of operation costs	5.3	100	100
Investment costs	100	41.9	100
Real payback period	69.6	100	100
Net present value	19.2	100	100
Index PV – profitability	77.2	100	100
Volume of savings	32.6	100	100
Together	303.9	541.9	600
Order	2	1	
Percentage proximity to basic variant	50.65%	90.32%	

Project 2 is the optimal variant, in which we made complex renovation of building; this variant shows better evaluation against project 2, as well as better percentage proximity to basic variant. We add weight significance to the individual criteria, determined according binary comparison of criteria (see Table 44).

Table 44. Evaluation of projects suggestion with weight using

Criteria	Project 1	Project 2	Basic variant	Weight
Decreasing of operation costs	1.2	23.0	23	0.23
Investment costs	6.0	2.5	6	0.06
Real payback period	16.0	24.0	24	0.24
Net present value	3.5	18.0	18	0.18
Index PV – profitability	4.6	6.0	6	0.06
Volume of savings	7.5	23.0	6	0.23
Together	38.8	96.5	100	1
Order	2	1		
Percentage proximity to basic variant	38.8%	96.5%		

In case of evaluation with weight again the 2nd project is the optimal variant that shows better preferences. Such solution should also help to observe principles of sustainable environmental development (Khouri et al., 2016). Moreover, enterprises have to deal with the question of internationalization because it is one of the possibilities how to face the competitive environment (Kubíčková & Procházková, 2014).

Discussion

From results it is obvious that building constructions are important factor that influences total energy necessity for heating. During change of heat protection of building we can assume decreasing of heat necessity and determination of possible savings of costs on energy.

According assumed realization of measurements we achieved decreasing of energy consumption, as well as costs on energy. In first project, where there were realized partial measurements, connecting windows change, since windows are very used and do not fill their function; we achieved decreasing of heat cost about 22% against average costs. In second project, in which there were realized complex measurements by the way of building heating, concretely heating of the wall, roof and windows change, we achieved energy saving and also costs on energy about 67%.

According mentioned assumption it is documented profitability of investment depends also on the way of reconstruction – partially or complexly. With aim to save money there is made only partial renovation of building, for example windows change, or heating of only one side of building, or only roof heating, but by this way investment are made more times, and therefore there are increasing for example cost on leasing of staging, etc. Complex renovation is from the view of costs more demanded, but there is immediately achieved total costs savings, and by this way payback period is shortening.

E. ALTERNATIVE SUPPORT OF FINANCING BUSINESS WITH ENERGETIC SOURCES

One of the priorities of cohesion policy during 2007-2013 is supporting of the project orientated to the increasing of energetic effectiveness, production and consumption of energy from renewable sources. Energetic saving measurements are not possible to realize without necessary financial support mechanism and more over business with energetic sources is considerably financial sophisticated, therefore classical ways of firms financing are not sufficient. Solution for such situation lies in using of alternative ways of financing that use tools of financial engineering.

Support of financing of business orientated to the increasing of energetic effectiveness, production and consumption of energy from renewable energy sources is one of the priorities of cohesive policy during 2007-2013. Cohesive policy directs environmental appeals by the way of energetic projects, for example quality of atmosphere, climatic changes and sources management, and directs them to the possibilities for regional development by the way that regions and cities will be more attractive for investment, work, production cost decreasing, growth of regional competition convenience and export of regional ecological innovation.

Business with energetic sources is orientated to the energetic low – budget measurements – energetic projects that are not possible to realize without necessary financial support mechanism. It is necessary to use individual operation programs for removing of such financial limits in the frame of structural funds, as well as existing tools, for example Environmental Fund or various special donations financed from the state budget. Planned creation of Fund for energetic effectiveness presents long term financing of chosen projects support. The Fund is financed primary without demand to the state budget and it is institution that would support public and business sphere. Projects that fulfill demands of energetic effectiveness can be financed also by the way of donation for removing of equipment, by the support of concrete projects, by premium refund of interest from the credits for example financial mechanism of European Economy Society or Norwegian financial mechanism.

Further solving of projects financing, orientated to the energetic effectiveness is also creation of innovative financial support mechanism and programs, that secure financing of the whole process, for example sale and development of energetic services, scheme of white certificates, PPP Projects (Public Private Partnership) and various other existing alternative possibilities of financing, as well as tolling, bot to boot, project financing or financing by third party (Mihaliková et al., 2008).

Financing of Business with Energetic Sources

During choosing of proper method for financing of business it is necessary to know not only effectiveness of used energetic source, but also whole economic situation or business activity with the given energetic source.

Priority is choice of criteria for evaluation of project economy. Success of an energetic project is then comparable with measure of chosen criteria filling. Criteria for evaluation of business with energetic sources economy and its concrete project are orientated to the general economic criteria and investment and consumer's criteria.

The first group of criteria evaluates exclusively economical or financial elements of the project. They are therefore decisive for providing of financial sources for project realization. The second group is created by criteria that result from the project results that are defined by businessmen. Such criteria are achieved output energy price, measure of the economic load decreasing, etc. (Čulková & Teplická, 2008).

Criteria that we choose for evaluation of the concrete project should result from both mentioned groups. Financial and economic structure of the project must be suggested with goal to fill criteria of businessman and general economic criteria.

Basic economic criteria are profitability of input financial tools, or ability of project self-financing. Profitability means ability to create financial tools necessary for covering of payments for used financial sources. Payback period of leasing or credit influences also profitability of input tools. In case of financing from own sources of the investor there is necessary to optimize payback period of the project. Profitability of input financial tools influence ability of the investor to realize other projects. Then ability of the project self-financing can be defined as running ability of the project to create financial sources minimal to the level necessary for covering of every invested cost.

Projects from the area of energetic effectiveness and using of renewable energy sources are specified by certain specification that must be regarding. First of all, projects orientated to the using of renewable energy sources have in Slovakia only limited number of installation that is not sufficient with regard to their potential. It is caused by lack of knowledge during their preparation, implementation, but also during own service. But from the technical point of view there are Technologies that are known enough and they are verified. In spite of declared state support, existence of domestic and foreign support programs in practice we meet them only rarely. Funds from European Union can also help to progress with energetic sources business.

Mentioned reality causes that such projects raise reluctance of businessmen to deal with them. Since there is not possible to apply standard methods of financing, their realization has become domain of specialized banks and institutions.

Available Alternative Financing in Slovakia

In Slovak capita market alternative financing of business with energetic sources offers several banks as well as some specialized institution. During choice of a proper way of financing it is necessary to consider following:

- type of chosen energetic sources,
- structure of financing – rate of own and foreign sources,
- structure and way of income realization,
- SWOT analysis,
- economy of whole project (www.economy.gov.sk).

Financing by Third Party

The third party will cover cost for project realization, that are consequently paid by financial flow or savings that are generated by the projects. Financing by third party can be used for projects of renewable energy sources. During application of financing by third party in such projects, orientated to the energetic effectiveness and renewable energy sources there are important any differences. Financial flow can be generated by produced energy sale and saving can rise for example by cost decreasing for fuel during change of fuel basis.

Financing by third party can help to remove some barrier, since Energy Service Company that realize such projects, can provide also technological know – how, or they can help to deal with distribution and transfer societies.

The example of the penetration to the market with renewable energy sources by third party is from Spain, where there has been connected integrated Access with state goal achieving in area of energetic effectiveness and renewable energy sources including donation for the projects.

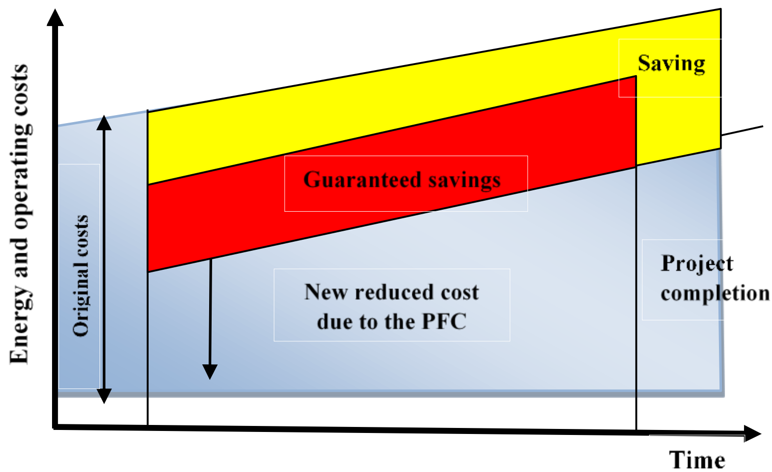
One of the methods of third party financing is also system Energy Performance Contracting and Public Private Partnership. But system PPP is not very used during energetic saving measurements (www.economy.gov.sk).

Energy Performance Contracting (EPC) – Financing from the Savings

EPC method is financing based on the savings. It means that savings achieved from heat and electric energy, during cooling or service cost, finance modernization of heat source, heating, air conditioning, technologies managing and they are results of mentioned savings. Principle of such method is saving effect, brought by modernization or reconstruction. Service cost is decreasing after investment (saving) and there is created space for gradual payment of employed investment. Length of financing is stated according level of achieved savings and it is similar as during the energetic contract, that is approximately 20 years. Convenience of financing by EPC method is providing of the full guarantee of the firm, that offers such possibility instead of achieving of energy savings, agreed by the contract, and such savings presents source of financial tools for covering of investment necessary for project realization. Cost of the service firm, that provides such type of financial service are endowed from provable savings of energy expenditures.

Most valuable contributions of the projects, financed through savings are as follows:

- modernization of energetic system,
- decreasing of the cost for energy consumption,
- increasing of the reliability,
- decreasing of living environment pollution,
- minimizing of investment risk.



Source: Lauko, 2009.

Figure 7. Process of costs.

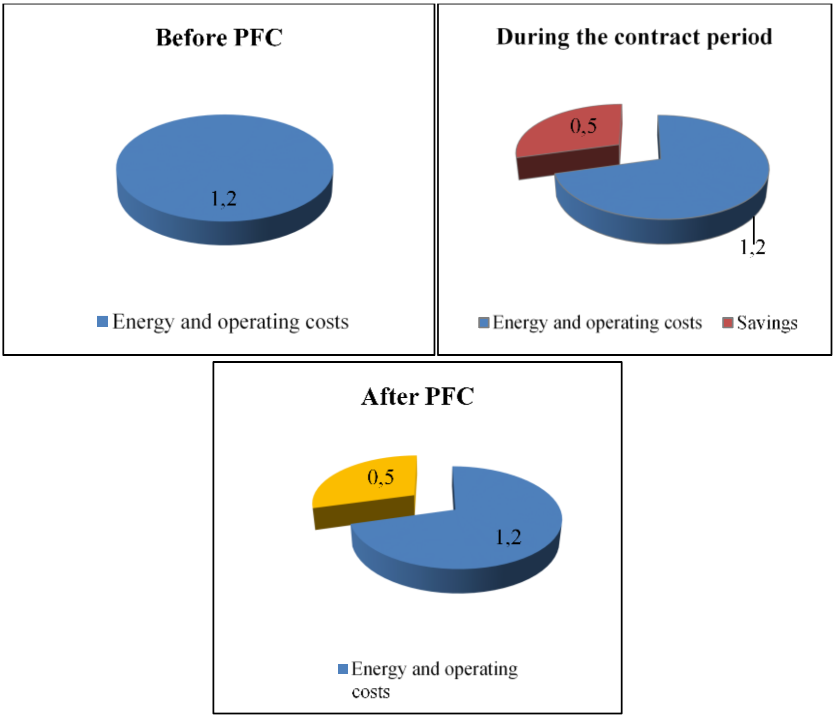


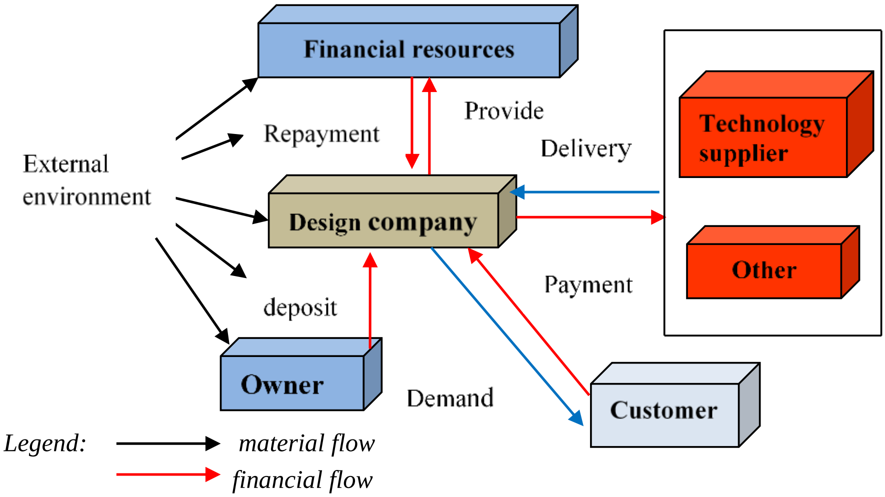
Figure 8. Project cost during individual period.

From the beginning of saving period till the end of the project every realized measurement is financed by the savings. Such ways of financing is offered by the bank, that guarantee savings. Guaranty of the savings means, that in case the saving will not be achieved, bank will cover to fail of the saving in volume of actual prices that means it will cover economical loss. Economical result of the project is then clearly predictable. In practice real energy savings are higher than guaranteed ones (www.economy.gov.sk). Mentioned illustrates also Figure 8, where we can see more exactly difference between cost before project contracting, during the contract and after contract.

Project Financing

Presents in the world approved a tool for investment financing by long – term bank credit. A carrier of the project and applicant about credit is purpose based a company that does not have financial history. The basis of company evaluation will be future revenues of prepared investment. Financing is based on the projection of financial indexes during demanded period that will reflect payback period and living cycle of the investment. Credit is secured by individual project that means by its revenues and assets. The basic scheme of the project financing is at the Figure 9.

The project financing is based on the property take – over from rising project. Strategic partners enter to the company service, secures financing of its modernization with following service. By its own eventual participation in company client will secure maximal control over the service and economy of such company that is secured production and energy supply for a client through modernized work. At the industrial plants financial modernization of energetic economy is realized by outsourcing. During such financing client will decide to set apart work, to sale it or to invest it by the way of same rate in new rising company.



Source: Lauko, 2009.

Figure 9. Project financing.

Project preparation has multidisciplinary character and it includes technical and technological, economic and financial, environmental, organizational and legal area of analysis.

The bank creates specialized teams for preparation of such financing that are orientated always to the concrete credit case. According situation external specialists can participate in such team.

The proper project must obtain demanded economical and financial indexes. Such indexes must be proved and verified by economical and financial model. The basis of the model is calculation of standard criteria for evaluation of investment activities (NPV – net present value, IRR – internal rate of revenue, PBP – payback period), to which bank add financial indexes and risk factors. Achieving of expected parameters of the project is necessary to secure by contract relationships. Identified risks are sharing by individual project participants according their task in the project.

Technical analysis of the project results from the energetic audit, technical and economic study, or feasibility study. Generally, it consists also on stating of environmental impacts of the project. Organization scheme of the project represents relationships between individual participants. Its proper configuration is basis of long – term natural running of the project and it is created generally before individual project preparation.

Legal analysis includes evaluation/suggestion/of decision agreements for securing of project revenues and elimination of connected risks. Complexity of agreement relationships is given by a legal frame, specified for concrete area (energetic legislative). Assumptions for long – term defensibility of the project are long – term contracts, with clearly defined conditions and sanctions.

Project financing has lower demands for securing and through project financing there is possible realization of bigger project. But it has disadvantage, since it is proper only for project over 1 mil. EUR, it has complicated preparation and high cost.

BOT/BOOT

Next alternative source of financing is BOOT system that includes establishing of single purpose company, that will act as an investor and operator till whole investment cost will be paid and energetic economy could be given to the using of a real customer. As every other company also such company is capitalized by the rate of its own capital – by shares - and rate of foreign capital – credits. Important fact for capital obtaining is: will of the supply firm and real customer to invest its own capital. Other investors to the own capital can be found among commercial investors.

It is necessary that potential investors would be contacted yet in preparation phase of the project, that it could be achieved optimal structure of financing and that it could be secured that claims and directions of financial partners would be included in the project from the beginning, since by this way there will be removed protraction of the project. Single Purpose Company is rising formally after payment of every cost connected with investment. Basic idea of this concept is that payments for provided services have to be used for covering of credits as well as for dividend payment and own investment capital. Then energetic economy will be taken over by real local customer (www.economy.gov.sk).

There are other possibilities for financing of business with energetic sources, so called market supporting mechanism, where belongs following:

Fixed Ransom Prices from Renewable Energy Sources

Prices are stated by URSO according to law No 658/2004 about regulation in net branches annually. Fixed ransom prices result from market prices of Technologies and payment period of investment – 12 years. There is defined exact electricity production from combined production of energy, production in steam – gas cycle and a flame turbine, production in condensation taking turbine. Distribution of produced electric energy is defined according to used fuel. Change of the fixed electricity price between years that is produced in combined energy production is not only according to average core inflation, but it regards also changes of fuel prices. During drawings of donation there is percentage division of fixed price retrenchment. Categories of fixed prices for energy, produced from renewable energy sources and combined energy production are actualized every year and they are published at the internet and at the competent places.

Business with Emissions – Mechanism of Flexibility

That country or company, that achieve lower emissions, then Kyoto protocol, can this difference (saved emissions – “emission allowance”) sale, and other country, or company, can by them and to fill by this way its reduction goal. Such business is installed in EU – Direction about business with emissions in every member state. This way of financing is limited on the societies, included in National allocation plan that is part of National Register of Emission Quota of Slovakia. Register is controlled by the administrator of the register that is Dexia bank Slovakia, Joint Stock Company. The Ministry of Living Environment in Slovakia is central institution of state administration in business with emissions (www.economy.gov.sk).

Present Possibilities of Alternative Financing of Business with Energetic Sources in Slovakia

In present time there are possibilities of financing support of business with energetic sources such as leasing, credit or financial tools obtained on the capital market, but these are not sufficient. Also in case of grant sources using or other commercial sources of financing, where there is PPP or EPC there is a problem in area of not ability of the banks or complex administration processes. Structural funds, that are in present time very often used, can be a part of operation program for financing of expenditures to the business activity, that includes contributions for support of the financial engineering tools, mainly for small and medium enterprises, as for example risk capital funds, guaranty funds and borrowing funds, or funds for development of the cities. The Ministry of Economy in Slovakia as Managing Institution for operation program Competitiveness and economic Growth separated part from the operation program for competition and economic growth as reserve for continuing of indirect state support. But also in this area there is a problem that forces using of alternative financing possibilities. The biggest problem of functioning with euro funds is for some enterprises inflexibility of whole system that means, that yet smallest change in the project must be agreed in National Agency for development of small and medium firms.

When we compare higher mentioned possibilities of financing support, then in case of the financing model BOT/BOOT with regard to the transaction cost, connected with rising of single purpose company and with regard to the administrative severity, it is proper mainly for the bigger project, with volume of investment over 2.5 mil. EUR. Due to the uncertainty, that is typical for eastern European countries, recommended rate of own capital should achieve 50% of total investment cost. The rate of own capital in this volume enables Access to the sources providing long – term credits.

In case of financial support through project financing with regard to the analysis extend, that is necessary to perform for preparation, given way is defined for realization of the projects with high investment cost, long – term profitability and regulated prices of the inputs or outputs. Such projects generally secure basic functions of the society – supply with energy, water, waste liquidation, construction of communication as well as living environment protection. They are connected with activities realization that presents public interest. Following illustration shows project financing in concrete conditions for its realization (Lauko, 2009).

Project Financing Provided by Tatra Bank

Tatra Bank offers project financing for construction and service of Renewable energy sources, as well as combined energy production. A type of projects for which bank provides project financing are as follows:

- Small water plants.
- Equipment for elaboration and burning of biomass.
- Equipment for production and burning of biogas.
- Photovoltaic parks.
- Wind parks.

Combined energy production:

- Steam gas cycle.
- Burning engines.

Structure of financing that bank demands during providing of demanded financial tools must content rate of own sources at the input to the project in connection to the parameter and type of the project, rate of combination with EU funds, that are possible for financing of the irreclaimable financial grant, for financing of PAYE during construction and possibility to finance part of own sources after building up time of the project. Demanded documentation and information are following:

- Business aim that includes basic information about project, purpose and goal of the project, description of total investment cost of the project, time limit of its realization.
- Technical parameters of the project (capacity and efficiency of the equipment, demands for service and maintenance, way of its providing).
- Stating of the investor or other participants (projecting, expert guarantee, supplier of technology, building, raw material, product customer, provider of mezzanine financing), reference of the subjects, mainly those, that are very difficult to replace.
- Description of the locality, property relationships to the parts of the project (mainly to the plot where there will be project realized), description of available infrastructure, etc.
- Description of market environment for raw material and products.
- Project economy (estimated volume of sale, prices, cost for raw material, description of service cost and reserve), projection of

cash flow, revenue and cost of the project in the planned period of the credit.

- SWOT analysis, identification of the risk and its managing.
- Expected structure of financing (rate of own sources, other source – mezzanine, irreclaimable grant, donation, etc.).
- Application for credit with description of volume and payback period of the credit, distribution of the credit repayment, aim of credit using and offered credit securing.
- Actual extract from the commercial register of the client.
- Contact to the credit applicant.
- Prospective further information in connection to the type and project character (www.economy.gov.sk).

Discussion

Business finances demand obtaining of the capital for covering of supplier and client relationships, material and property purchase, etc. In present time there are existing many ways of finances obtaining for the business. It is necessary to decide properly what way of the finances will be the best. Proper decision about firm's financing choice belong among most serious and difficult decisions of the firm, that will influence future development of the firm, therefore decision must have much attention. Risk of the foreign sources financing is connected with possibility, that interest will not be paid (for creditors) and in case of its securing it present threat for the firm's existence. Other risks are connected with uncertainty of the clients, suppliers and with cost of possible liquidation. The firm must decide proper most convenient way of financing and to state criteria that will be decisive factor during choice of the firm's financing. In case when the firm will choose a bad way of financing, it can influence badly financial situation on the market in the future. Individual ways of alternative financing of the business with energetic sources that are available in condition of Slovak Republic are using tools of financial engineering and they mention present functioning of the whole system. It is necessary to know, that suggestion and securing of project financing, that means finding of best and cheapest way of financing is necessary assumption of successful realization of business with energetic sources. Nevertheless, that described methods, providing to the firms various financing support. But there is still necessary to state and evaluate, if given business activity will generate such cash flow in a long – term period that will secure sufficient profitability of evaluated project. Especially due to the fact, that individual banks are not willing to provide common ways of financing for new ways of business with energetic sources, businessmen must access to the alternative support more consistently and with higher confidence. The massive turn out of the project with renewable energy sources or energetic savings will create conditions for extending of their commercial financing.

Glossary

Renewable Energy Sources (RES) – renewable energy is energy from sources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time.

Investment – investment is time, energy, or matter spent in the hope of future benefits actualized within a specified date or time frame.

Return on investment – return on investment (ROI) is the ratio between the net profit and cost of investment resulting from an investment of some resources. A high ROI means the investment's gains compare favorably to its cost.

Biomass – biomass is an industry term for getting energy by burning wood, and other organic matter. Burning biomass releases carbon emissions, but has been classed as a renewable energy source in the EU and UN legal frameworks, because plant stocks can be replaced with new growth.

Geothermal energy – geothermal energy is thermal energy generated and stored in the earth. Thermal energy is the energy that determines the temperature of matter. The geothermal energy of the earth's crust originates from the original formation of the planet and from radioactive decay of materials.

Photovoltaics (**PV**) – is the conversion of light into electricity using semiconducting materials that exhibit the photovoltaic effect, a phenomenon studied in physics, photochemistry, and electrochemistry.

Photovoltaic power plant – photovoltaic power station, also known as a **solar park**, is a large-scale photovoltaic system (PV system) designed for the supply of merchant power into the electricity grid.

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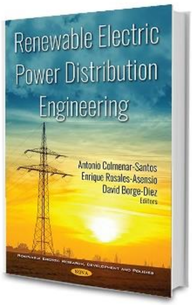

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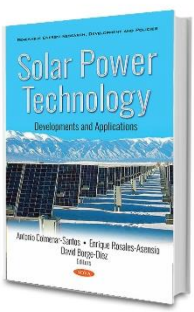

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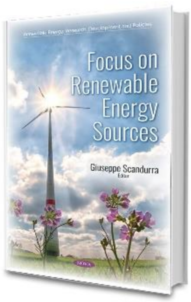

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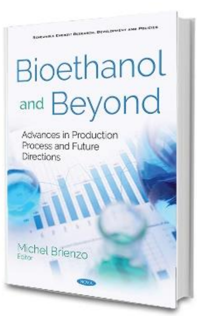

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Book Description: *Bioethanol and Beyond: Advances in Production Process and Future Directions* discusses the advances in the production process of bioethanol, ranging from first to fourth generation bioethanol.

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