Študentská vedecká aktivita

Environmental and Financial Consequences of Heating System Change

Using example of dormitory No. 4 MBU

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Abstract

This work deals with alternatives of heating systems, their environmental and economic consequences. Five main factors are taken into account; firstly, capacity and efficiency of heating boilers, secondly, fuel price and availability and, finally, environmental impact of different fuel types. Calculations are made on the crucial decision making aspects concerning the heating system change; investment return and enviromentally-wise, emissions. The work promotes usage of renewable recourses and implementing of responsible thinking into our lives. The calculations of savings are made on an example of the dormitory No.4 MBU and further analysis and evaluation are presented.

Key words: Heating system, heating fuels, biomass, CO2 emission reduction,

Introduction

One of the most important current environmental issues causing worldwide concern is global warming. This results from growing concentrations of greenhouse gas emissions in the atmosphere. CO_2 accounts for approximately 72% of the global man made emissions contributing to the greenhouse effect and CO_2 emissions are growing. The significance of this has been internationally acknowledged by the Rio de Janeiro Convention and the Kyoto agreement which oblige all countries to reduce their CO_2 emissions by between 8 and 20 percent by 2012 compared with the level of emissions in 1990. Later even more: in United Nations Framework Convention on Climate Change goals were even higher by 2020. Slovakia is required to reduce its CO_2 emissions by 20-30 percent by 2020. Many other European countries have higher targets.

In Slovakia heating and hot water supply consumes at least 35 percent of the state's primary energy resources. Most of the neighbor countries have a similar level of energy consumption for heating as Slovakia, compared to Poland and the Czech Republic (approximately 30 percent), in Finland where it is 23 percent, in Denmark (28 percent), and in the USA, where it is 33 percent.[1] Therefore this area of concern becomes the attention center and discussion topic of many subjects.

Recent years have witnessed a fundamental change in the way governments approach energy-related environmental issues. Promoting sustainable development and combating climate change have become integral aspects of energy planning, analysis and policy making in many countries, including Slovakia.

This work will focus on the heating system change at dormitory No.4 of Matej Bel University. It will compare already existing offer with different possibilities and provide calculations of costs and possible financial and environmental savings, in addition it will provide potential ways of financing the change.

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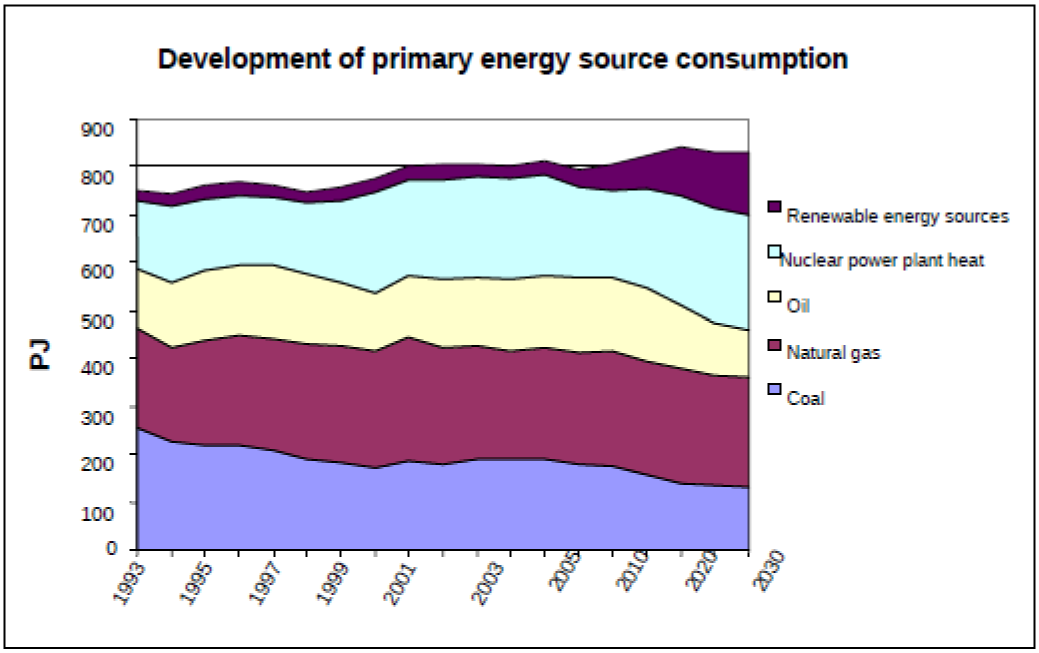
[1] From IEA Statistics "Emissions from fuel combustion"; http://www.iea.org/co2highlights/co2highlights.pdf

Table of Contents

Current situation

General situation in usage of energy sources in Slovakia is very diverse. We may distinguish between 5 main energy sources which are used:

- Coal
- Natural gas
- Oil
- Nuclear power plant heat
- Renewable energy sources



[2]

Several of these sources are used primarily also for heating purposes. Coal is used for creating electricity but it is also directly used for heating. One of the purposes of natural gas is heating up buildings and warming up water. Renewable energy sources are represented nowadays mainly by wood logs but the future promises more economic and environmentally friendly alternatives.

Coal is one of the major energy sources not only for Slovakia, but also for EU and the world in overall. Its burning is used for creating electricity which is a significant life

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[2] Energy Policy of the Slovak Republic; RESOLUTION OF THE GOVERNMENT OF THE SR No. 29

standard of our times. Coal creates about 29% of world's energy sources. In 2006, about 39% of world's electricity was produced by burning coal and in EU it was 67%. Currently in Slovakia, extracted coal represents a 79% share on the energy source spectrum[3]. Overall population awareness of environmental issues caused that in last decade, there has begun a rapid deflection from use of coal mainly because of its emission problems. Energy policy of Slovakia is nowadays aimed at more sustainable sources of energy and it is already possible to see that coal is not the way that will be chosen for the future.

Natural gas represents about 21% of energy sources in the world and its use is constantly growing not only in the world but also in Slovakia. It represents the new alternative for the relatively environmentally harmful coal since it is mentioned as a "green" energy source. Natural gas is in households used especially for heating and creating hot water. The main problem with natural gas is its constantly growing price in Slovakia because of the existing monopoly. This represents a significant barrier in further use of this energy source. Compared to other fossil fuels (coal and oil), gas is the cleanest source but it still represents a major health and environmental hazard because of its methane content (93 – 98%) and therefore, it significantly adds to the global emissions of greenhouse gases. Methane is 20 times more efficient greenhouse gas than carbon dioxide which means that it catches 20 times more solar radiation than CO_2. Other hazard represents natural devastation caused by extraction and with methane escapes[4].

Electricity is mainly noted as a secondary energy sources used for heating up households. It has relatively high price and therefore it is not suitable for heating big premises. In smaller households it is usually used as a backup heating source or as a tempering heating to keep a steady level of temperature.

Renewable energy sources are the way of every theoretical future analysis and policy. Its constantly growing usage in the world is creating a pressure on every government to make it a steady part of future policy. In heating, it is mainly represented by, so called, biomass (wood pellets, brickets and chips). This new trend is only arriving to Slovakia but it already creates a significant heating share on the market. As a part of

[3] http://www.energia.sk/tema/uhlie/uhlie/0512/
[4] http://www.platforma.ekofond.sk/moderne-vyucovanie/teoria/49-zemny-plyn

environmental policy, governments provide various subsidies to buying these green and renewable alternatives which makes using biomass even more interesting even from the economic point of view.

Current situation in the chosen premises

At the dormitory heating is supplied by 3 natural gas boilers at capacity of 430 kW each. System is outdated (about 20 years old) and needs a complete reconstruction which would update all the components to the modern norms and regulations. Heating was provided for 2 buildings; one has been dormitory No 4 of Matej Bel University and other was dormitory of Sports grammar school. Recently this premise has been disconnected from the heating network and therefore there is a drastic decrease of the need for such a high performance of boilers. After the disconnection the average yearly consumption was about 130 000 m^3. Yearly gas expenditures were calculated to be about 70 500€ (these numbers will be further used in calculations).

Current offer

Need to change the system forced the authorities to carry out an energy audit and request price offer of renewing the system. Offer done by an external company contained 3 condensing boilers (2x 370 + 1x 170 kW) at total of 69 500€. Offer further contains many other technical components change which in this work will not be taken into account (isolation, installation, hydraulic system upgrade and so on) and it will be considered as a necessary cost for any type of heating systems change.

Choosing heating system

Key element of a heating system is a boiler (stove), which transfers combusted heat energy to a system usually carried by water. There are many different types of them comparing principle of operation, used fuel sizes. The main types are classified by fuel.

When choosing a system, not only price has to be taken in account, the main selection parameters should be:

Boiler capacity;

Boiler efficiency;

Combustion and environmental impact;

Fuel availability and price;

Some others (as warranty or after sale service);

Boiler capacity

As we could see in the offer, the heating system will be supplied with only 910 kW (with comparison of 1290 kW before). To satisfy this need of capacity natural gas is not the only possible way of heating, modern technologies allow us to use biomass boilers at the same capability. Thus we can assume that the crucial decision making factor should not be based on the capacity only.

Boiler efficiency

Energy efficiency is the ratio between the useful output of an energy conversion of the boiler and the input, in energy terms. In other words it is boiler high efficiency the actual fuel combustion energy is transferred in to system with a minimum waste. The efficiency of the heating appliance is an important factor when determining the cost of a given amount of heat. In general, the efficiency is determined by measuring how well an appliance turns fuel into useful heat. (The condition of the heat distribution or delivery system also affects the overall system efficiency.) Many types of space heating appliances must meet minimum standards for efficiency developed by the Slovak

Department of Energy of Ministry of Economy of SR. Modern boilers exceed 90% efficiency, which in most cases way over required values.

The offered project contains Viessmann Vitocrossal 200 boilers with standard efficiency up to 97%[5], which is quite high for gas burned boiler and it is really close to electric heater efficiency. That efficiency cannot be reached by biomass boilers, various producers offer boilers with capacity up to 950 kW with standard efficiency about 92%. (will be taken into account in calculations).

Fuel availability and price

Gas and electricity are nowadays the most commonly used heating sources and therefore their availability is quite high. Electricity has been spread to even the furthest part of the country and its use is then only restricted to its price. Unfortunately, price of electricity is relatively high although there aren't any promises of significant future increases. Electricity is thus not suitable for heating of big areas or buildings since it creates enormous financial need.

Gas availability is also very high but the necessity of pipeline infrastructure restricts its use. Simply said, gas is not available for every inhabitant of Slovakia because he may not have been connected to the network. Availability of gas is also strongly connected to suppliers. Slovakia is not able to extract enough natural gas that would be provided and it is dependent on foreign gas providers such as Russia. This brings several hazards connected with political situation and general relations with this country. Slovakia has already experienced gas shortages when there was a political tension between Ukraine and Russia. This event represents an example of how problematic could be the question of future gas supplies and availability. Price of gas has been steadily increasing in last decade. Taking into account the limited supply of natural gas sources we may assume further increase of prices and, consequently, decreasing demand and suitability for heating of large premises.

Biomass used for heating is quite diverse. Wood pellets, brickets and chips may be produced from various sources, such as, wood, grass, weed, hay, sorted communal trash, animal manure. This creates a very big supply of potential sources and thus

[5] http://www.hevac.ltd.uk/boilers/vitorossal-200-type-cm2

provides almost infinite supply and renewability. Availability is connected with regular supplies that are necessary. It is important to find a regular and trustworthy biomass provider which still may be difficult in Slovakia. Price is relatively low but delivery costs have to be taken into account which may significantly increase the final price. On the other hand government and various private sector entities provide diverse subsidies to the use of biomass which lowers the price and makes biomass more desirable.

Price calculations

Given the information from the current situation of the dormitory, we may assume that yearly gas consumption has been about 130 000 m^3 and average yearly expenditures have been about 70 500€. Current offer contains 3 Viessmann Vitocrossal 200 boilers with total capacity of 910 kW for 69 500€. From our research we found that various biomass boilers with capacity up to 950 kW cost usually up to 73 000€.

We calculated that the regular boiler that has been working in the dormitory used 130 000 m^3 of gas to create 1094,3 MWh of energy.[6] This will be the main criteria that we will have meet in further calculations. We will assume that the energy need of dormitory is about 1094,3 MWh. The offered condensing boiler has higher efficiency compared to the old one (up to 97%) and thus it need less amount of natural gas to create the same amount of energy. We calculated that this amount equals to about 113 430 m^3. Given the information from the current situation of the dormitory we are also able to calculate the average price of m^3 of gas that is being used. This price equals to about 0,54 € per m^3. From this we are able to calculate the new total yearly expenditures if the offered project is accepted. The dormitory would pay about 61 252,20 € which already represents yearly savings of about 10 000 €.

The heating efficiency of wood pellets is lower than that of condensing boiler but it still represents 92% which is quite high, especially when compared to the system that is in use now. To create 1094,3 MWh of energy dormitory would need about 243 940 kg of wood pellets. Prices of certain suppliers of pellets vary but their average is 194 € per ton

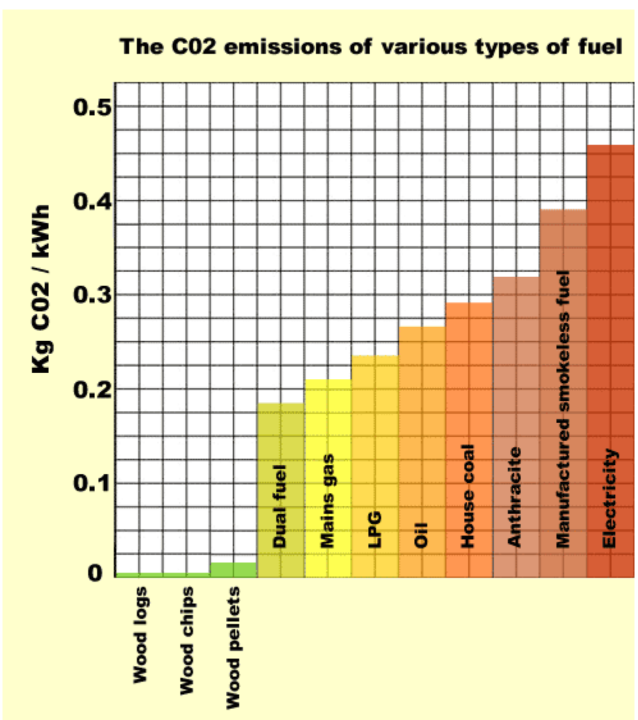
[6] Conversion calculator; http://vytapeni.tzb-info.cz/tabulky-a-vypocty/269-porovnani-nakladu-na-vytapeni-podle-druhu-paliva

of pellets.[7] This creates total price of the pellet consumption and it is about 47 324,36 €. Further, pellets require regular supplies into the silo. Optimum delivery amount per truck represents 17t of pellets which gives us total of 15 deliveries per year. If we assume that our supplier is about 80 km far then the price per supply delivery equals 250 €. The final yearly dormitory expenditure when wood pellets are chosen then should equal to pellet consumption price plus the delivery costs which gives us approximatelly 51 074 €.

Environmental impact of different fuel types

If a house or other property is equipped with an old, inefficient boiler or natural gas furnace more than 15 years old, heating system is producing significant carbon dioxide emissions that contribute to the greenhouse gas effect which scientists say is causing an increase in global temperature (the reason to update). Even newer, more efficient heating systems produce some CO2. Soot emissions from wood burning stoves are another possible contributor to the warming effect. Main goal choosing right heating system is to find an impact of it to environment.

Below you can see the CO2 emissions of various types of fuel used for heating.[8]



[7] BIOMASA association; http://biomasa.sk/images/stories/biomasa/cenniky/Cennik_pelety_zima_11-12_nov_klienti.pdf

[8] http://www.stovesonline.co.uk/fuel-co2-emissions.html

As you can see, wood logs, wood pallets and wood chips come out way ahead of the other fuels because of their low CO2 emissions. Actual CO2 emissions of wood combustion is quite close to natural gas (about 0.18-0.2 kg CO2/kWh), but combustion if it does not add to total emission of carbon dioxide as long as the burned mass don't exceed the renewed production. Then it can be said that CO2 emissions of actual burning is equal to zero, only CO2 emission can be added for transporting and preparing it to consumption. Therefore emissions for wood pellets are a bit higher that wood logs or chips.

An additional consideration, though, is such air pollutant emissions caused in producing the energy used to manufacture pellets. A recognized problem is the emission of fine (particulate matter) to the air, especially in urban areas that have a high concentration of pellet heating systems or coal or oil heating systems in close proximity. So-called black carbon has emerged as the second highest contributing factor to global warming, behind only carbon dioxide, according to climate scientists. Black carbon is described as soot particulates from the burning of fuels, especially in developing countries that depend on wood stoves for heating and cooking. When the black carbon matter settles into areas such as the Arctic, it can darken the snow and ice, and reduce the amount of sunlight reflected, increasing ice melting. This emissions of older pellet stoves and boilers can be problematic in close quarters, especially in comparison to natural gas (or renewable biogas), though on large installations electrostatic precipitators, cyclonic separators, or bag particle filters can control particulates when properly maintained and operated.

Electricity seems like a clean energy source, but most electricity in Slovakia is generated by burning coal, which emits sulfur dioxide, nitrous oxides, particulates, and greenhouse gases. Some electricity is generated from natural gas, which burns cleaner, but at least half of the energy is lost in converting it to electricity and delivering it to consumers. On the other hand, electricity is used to run heat pumps, which have the benefit of producing more energy than they consume. An electric heat pump system can balance out the efficiency losses at the power plant by using the electricity to draw energy from the outside environment.[9]

Calculation of emission

Just looking at the graph it is pretty clear what emissions would be when using different types of fuels. Main idea of this part of work is to show the possibility of savings in CO_2 emissions.

From calculations before it comes out that total capacity energy needed from boiler is 1094.3 MWh, this number will be used in calculations of CO_2 emissions.

Counting yearly emissions when using gas we will use known number of gas emissions (0.23 kg CO_2/kWh)[10]. Where after computation of yearly consumption of 130000 m^3, which comes to 1094.3 MWh(1094300 kWh) it is equal 251689 kg CO_2 (251.7 tons).

If we look at the emissions of wood burning boiler we will not see big difference of real emissions (0.18 kg CO_2/kWh), it comes to annual sum of 197 tons. If there was no reproduction taken in account the average emissions would rise twice to 0.39 kg CO_2/kWh.[11] In that case we can see that annual emission would be 426 tons that is half as much as heating with gas. But here again we have to mention that sustainably sourced wood fuel has a relatively effect on CO_2 level in atmosphere. This because for every tree that is burnt another takes its place and by simply growing absorbs the CO_2 that was released by burning the first tree – simple. Obviously some CO_2 is produced as a result of the processing and transport of the fuel. There we can count emissions for measurable CO_2, for wood logs emissions for transportation and actual preparation is minimal, most of the times are shown as 0 kg CO_2/kWh12 because it is commonly viewed as bio fuel. However in our case we would look for more automated system of heating which is easy to maintain fuel has to be more processed (that means more emissions of production). Pellet boilers are automated and can bring comfort the same as gas heaters, only one but, need storage and constant delivery. Production of pellets combusts based on 130 kWh/ton

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[9] Department of energy; http://www.energysavers.gov/your_home/

[10] http://www.engineeringtoolbox.com/co2-emission-fuels-d_1085.html

[11] A special report of the World Energy Council July 2004; http://www.worldenergy.org/documents/lca2.pdf

[12] http://www.engineeringtoolbox.com/co2-emission-fuels-d_1085.html

manufacture, 15 kg CO2/MWh plus 1 kg CO2/MWh for transport or total of 0.016 kg CO2/kWh.13

Annual emission with above given number would be only 17 tons. And of course not forgetting about delivery emissions: 15 deliveries with large delivery trucks would do their part to emissions of CO2. Using truck route as we used before (about 80 km) we can see that total annual delivery would be 2400 km (counting for return trip too). Using standard diesel fuel emission is 0.036 kg CO2/ton-km[14]. Taking in account delivery size of 17 tons every delivery, 15 deliveries for 80 km we can count that total annual emission would be 785 kg CO2. As we can see, with a production process, with a delivery to site total CO2 emissions would not exceed 18 tons, which with comparison of gas heating is 14 times lower.

Economic evaluation of projects

Data used in calculations

Input data for economic analysis are obtained as follows:

- The saving measures of the projects are estimated based on the results of similar implemented projects;
- Information from internet publications

Further calculating economic measures, is necessary to determine other additional input data – the time of evaluation, the discount rate, price trends.

- **Discount rate**

When evaluating the funds received or issued in the future, there is a need to transfer them into present value. The discount rate is the aid, which lets us do that. It is a form of expression of value of annual interest rate change and other factors. Chosen discount rate is 4.8%.

- **Time evaluation**

Time evaluation is generally determined based on the life of the asset. The arrangements of building character (windows, doors, insulation), the depreciation period of 20 years, for other is 4-12 years, so for comparison we use 15 years.

[13] Dr. Geaoff Hogan of the Biomass Energy center; http://biomassmagazine.com/articles/5819/betting-on-biomass

[14] Volvo truck corporation; http://www.silvertipdesign.com/BR(Imperial)/

- **Price development**

During the operation of the assets prices of fuels can be affected by inflation and could vary significantly. The assessment is that we consider constant prices and inflation is not taken into account.

Economic **outcome values** are simple return period of investment, discounted investment return period and net present value of project.

Method of evaluation of investment

Revenues or just **cash-flow** (CF) is couted taking in account savings on energy and costs in a given year. CF in our case is set from financial savings of energy costs, savings from other activities (for example wage costs, or lowering other costs) and depreciation (amortization) of new assets, after completing all the energy saving works, which are considered at current price level, discount rate 4.8% of the theoretical implementation of first year.

To evaluate projectecs we have chosen these basic indicators of economic efficiency of energy saving measures:

- **Simple return period of invetment**

$SRP = I_0 / CF$ where I_0 = costs of investment, CF = annual CF (savings with depreciations)

- **Real return period of investment** - counted using discounted CF of the project (discounted cash flow)

$RRP = (I_0 - \sum CF_{t-1}) / CF_t$

- **Net present value - NPV**

$NPV = \sum_{t=1}^{n} \frac{CFt}{(1+r)^t} - I_0$, where: CF_t = *CF of project in the year* t

r = discount rate, t = period of evaluation (1-20 years)

- **internal rate of return - IRR**

For $I_0 - \sum_{t=1}^{n} \frac{CFt}{(1+r)^t} = 0$ stands: $IRR = r$

Economic evaluation of proposed solutions

The results of the economic evaluation are in the following table:

a) Option of gas usage

					Depreciations		20	12	6	4	
	Disc. factor		CF	Sum $CF/(1+r)^i$	Disc. rate= 4,8 %		0,05	0,083333	0,166667	0,25	Total
Period	r	0,048	27022,5		I0	NPV	**259241**	**38071**	**12566**	**622,6**	**310 500,00**
1	$(1+r)^{1}$	1,05	44169,39	44169,39		-266330,61	12962,03	3172,58	2094,32	155,64	18384,57
2	$(1+r)^{2}$	1,10	42988,41	87157,80		-223342,20	12962,03	3172,58	2094,32	155,64	18384,57
3	$(1+r)^{3}$	1,15	41861,52	129019,32		-181480,68	12962,03	3172,58	2094,32	155,64	18384,57
4	$(1+r)^{4}$	1,21	40786,24	169805,56		-140694,44	12962,03	3172,58	2094,32	155,64	18384,57
5	$(1+r)^{5}$	1,26	39604,57	209410,13		-101089,87	12962,03	3172,58	2094,32	0,00	18228,93
6	$(1+r)^{6}$	1,32	38625,53	248035,66		-62464,34	12962,03	3172,58	2094,32	0,00	18228,93
7	$(1+r)^{7}$	1,39	35597,01	283632,67		-26867,33	12962,03	3172,58	0,00	0,00	16134,61
8	$(1+r)^{8}$	1,46	34705,60	318338,27		7838,27	12962,03	3172,58	0,00	0,00	16134,61
9	$(1+r)^{9}$	1,52	33855,02	352193,30		41693,30	12962,03	3172,58	0,00	0,00	16134,61
10	$(1+r)^{10}$	1,60	33043,40	385236,70	310500,00	74736,70	12962,03	3172,58	0,00	0,00	16134,61
11	$(1+r)^{11}$	1,67	32268,95	417505,65		107005,65	12962,03	3172,58	0,00	0,00	16134,61
12	$(1+r)^{12}$	1,76	31529,98	449035,63		138535,63	12962,03	3172,58	0,00	0,00	16134,61
13	$(1+r)^{13}$	1,84	27652,27	476687,90		166187,90	12962,03	0,00	0,00	0,00	12962,03
14	$(1+r)^{14}$	1,93	26979,43	503667,33		193167,33	12962,03	0,00	0,00	0,00	12962,03
15	$(1+r)^{15}$	2,02	**26337,42**	**530004,75**		**219504,75**	12962,03	0,00	0,00	0,00	12962,03
16	$(1+r)^{16}$	2,12	25724,80	555729,55		245229,55	12962,03	0,00	0,00	0,00	12962,03
17	$(1+r)^{17}$	2,22	25140,25	580869,80		270369,80	12962,03	0,00	0,00	0,00	12962,03
18	$(1+r)^{18}$	2,33	24582,47	605452,26		294952,26	12962,03	0,00	0,00	0,00	12962,03
19	$(1+r)^{19}$	2,44	24050,23	629502,50		319002,50	12962,03	0,00	0,00	0,00	12962,03
20	$(1+r)^{20}$	2,55	23542,38	653044,87		342544,87	12962,03	0,00	0,00	0,00	12962,03

b) Option of biomass usage

					Depreciations		20	12	6	4	
	Disc. factor		CF	Sum CF/(1+r)^i	Disc. rate= 4,8 %		0,05	0,083333	0,166667	0,25	Total
Period	r	0,048	37022,5		I0	NPV	**259241**	**38071**	**12566**	**622,6**	**310 500,00**
1	$(1+r)^1$	1,05	53711,38	53711,38		-256788,62	12962,03	3172,58	2094,32	155,64	18384,57
2	$(1+r)^2$	1,10	52093,36	105804,74		-204695,26	12962,03	3172,58	2094,32	155,64	18384,57
3	$(1+r)^3$	1,15	50549,44	156354,18		-154145,82	12962,03	3172,58	2094,32	155,64	18384,57
4	$(1+r)^4$	1,21	49076,24	205430,42		-105069,58	12962,03	3172,58	2094,32	155,64	18384,57
5	$(1+r)^5$	1,26	47514,88	252945,30		-57554,70	12962,03	3172,58	2094,32	0,00	18228,93
6	$(1+r)^6$	1,32	46173,54	299118,84		-11381,16	12962,03	3172,58	2094,32	0,00	18228,93
7	$(1+r)^7$	1,39	42799,31	341918,15		31418,15	12962,03	3172,58	0,00	0,00	16134,61
8	$(1+r)^8$	1,46	41578,03	383496,18		72996,18	12962,03	3172,58	0,00	0,00	16134,61
9	$(1+r)^9$	1,52	40412,68	423908,85		113408,85	12962,03	3172,58	0,00	0,00	16134,61
10	$(1+r)^{10}$	1,60	39300,70	463209,56	310500,00	152709,56	12962,03	3172,58	0,00	0,00	16134,61
11	$(1+r)^{11}$	1,67	38239,66	501449,22		190949,22	12962,03	3172,58	0,00	0,00	16134,61
12	$(1+r)^{12}$	1,76	37227,22	538676,44		228176,44	12962,03	3172,58	0,00	0,00	16134,61
13	$(1+r)^{13}$	1,84	33088,57	571765,00		261265,00	12962,03	0,00	0,00	0,00	12962,03
14	$(1+r)^{14}$	1,93	32166,74	603931,75		293431,75	12962,03	0,00	0,00	0,00	12962,03
15	$(1+r)^{15}$	2,02	**31287,14**	**635218,88**		**324718,88**	12962,03	0,00	0,00	0,00	12962,03
16	$(1+r)^{16}$	2,12	30447,82	665666,70		355166,70	12962,03	0,00	0,00	0,00	12962,03
17	$(1+r)^{17}$	2,22	29646,94	695313,65		384813,65	12962,03	0,00	0,00	0,00	12962,03
18	$(1+r)^{18}$	2,33	28882,75	724196,39		413696,39	12962,03	0,00	0,00	0,00	12962,03
19	$(1+r)^{19}$	2,44	28153,56	752349,95		441849,95	12962,03	0,00	0,00	0,00	12962,03
20	$(1+r)^{20}$	2,55	27457,76	779807,71		469307,71	12962,03	0,00	0,00	0,00	12962,03

Comparison of evaluations:

Overall evaluation		**Gas**	**Biomass**
I_0	EUR	310500	310500
CF	EUR	27022,5	37022,5
r	%	4,8	4,8
SRP	years	7	5,8
RRP	years	8,1	6,3
NPV	EUR	219504,8	324718,9
IRR	%	3,53	8,34

When comparing the evaluations of gas and biomass usage it is clearly visible that the biomass fuel is more efficient and the investment is realistic. When the calculations of gas option were done some of the measures and values were taken from similar projects (rathen than estimated) in order to get as accurate results as possible.

Knowing from previous price calculations of biomass usage, the cash flow was adjusted accordingly (adding 10 000 EUR that were saved by using the biomass) and estimating the same price of the project since the prices of boilers are equal, the new biomass option evaluation was calculated.

As is observable in the comparison table, return period of the investment is shorter with the biomass option (simple and real return period). From the time perspective, 15 years were chosen as the sample on which the net present value was to be calculated. Biomass fuel again proved to be a better choice when the net present value climbed to 324 718,9 EUR compared to 219 504,8 EUR of the gas. Finally, internal rate of return supports the environmentally friendly choice; IRR of biomass was estimated to be 8,34% in the period of 15 years and IRR of gas was 3,53%.

Solar collectors

Solar panels and collectors for solar energy are becoming more and more widespread. The today trend is the use of alternative energy sources. Solar energy is one of the best ways of obtaining energy since its creation and use does not create any harmful waste.

Solar energy can also be used for the central heating and warming up hot water. In covering all the consumption however, we cannot calculate only with solar energy because the area of solar collectors would have to be so large that the cost of their purchase would be excessive and without the effect of return.

Depending on the type of solar collector and the intensity of sunlight it has been calculated that the collectors are able to produce annually from 300 to 1200 kW/m^2; sober estimate is calculated with the performance of 350 kW/m^2. It is up to the owner of the facility to choose how will be the energy used.[15]

There are several advantages to the use of solar power. Solar collectors provide greater independence from monopoly suppliers of energy and high reliability. They require almost no maintenance and last for decades. It may also be easy to install more solar panels in the future to the existing system. No pollution is created and another advantage is the price of constant heat regardless of the evolution of market prices of other energy sources. Electric providers are even willing to buy the produced electricity from the collectors which creates a potential for higher possible future returns. The last advantage of the use of solar collectors is that various government agencies and also private companies provide numerous grants and subsidies to the purchase of this technology which may not significantly decrease the initial investment costs but it definitely makes the system a little bit more desirable.[16]

[15] http://www.profisolar.sk/vsetko-o-solarnych-systemoch

[16] http://www.jmktn.sk/solarne-systemy

Conclusion

As we have proved, conditions and frameworks for biomass are very favorable in Europe as well as in Slovakia. This is due to positive legal frameworks and policies with regard to the use of bioenergy along with the good conditions regarding sources and well-developed infrastructure.

It was shown that environmentally friendly choices can be also financially and economically desirable. Thanks to the various grants and subsidies it is relatively easier to withstand the initial investment costs which are the biggest challenge that needs to be overcome when obtaining new modern environmentally friendly systems.

The main problem that is faced is that Slovak people are dependent on comfort and simplicity which is given by natural gas heating systems. Unfortunately, there is still lack of information that is provided regardless the alternative possibilities of heating and energy sources. We believe that sooner or later people will have to face the question of economic independence and environmental responsibility. The future promises that the authorities such as government agencies and even European Union itself will have to take actions and force legislation related to energy efficiency that will have to be implemented in order to sustain functional and living environment which would support further life. Why to wait? People should make decisions before the conditions and situation make them act without any other possibility.

This work has proven that CO_2 emissions can be lowered and sustainability preserved with as little as choosing the right fuel for heating system. The expenses show that environmentally responsible systems can be and are competitive at the market. Furthermore, advancing technologies allow us to benefit from implementing them into our lives.

New environmental projects have more possibilities of financing than simple reconstruction or upgrade of the existing systems that use nonrenewable energy sources. However, in our work's example the emission saving is too low to be taken into account as a really decisive factor but every, even the slightest, change has to be counted.

The first step that needs to be taken is always the hardest but once it has been done, it serves as an inspiration for the whole community. There is a high and positive believe that students who would live and study in the environmentally friendly premises will keep this idea and promote it further more throughout their lives.

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