# D 5.02.2

# Cost benefit calculation for biomass heating system

EU CONCERTO Project (6FP) Sustainable Management Systems

## Content

## Index of Figures and Charts

## Abbreviations, symbols and indices

| Abbreviation | Description |
|---|---|
| € | Euro |
| $CO_2$ | Carbon dioxide |
| FP6 | 6th EU Framework Program for Research and Technological Development |
| kg | kilogram |
| kW | kilowatt |
| kWh | Kilowatt hour |
| $m^3$ | Cubic metre |
| MJ | Mega joule |
| PLN | Polish Zloty |
| SEMS | Sustainable Management Energy System |

# 1 Current situation in Slubice

The community of Slubice is part of the Sustainable Energy Management Systems (SEMS) project, which has been implemented under the joint support of the 6th EU Framework Program for Research and Technological Development (FP6). One of the main goals of SEMS is the implementation of energy efficiency and renewable energy systems. The community of Slubice plans the implementation of a wood pellet heating in combination with a heat pump for hot water production in a primary school in Kunowice to replace the existing coal heating, which is to be considered the most common form of heating throughout Poland.

This report shows the current output and emissions by the use of coal heating in comparison to the alternative of a $CO_2$-neutral wood-pellet heating. It will be shown how the community can sustainably profit from the investment.

## 1.1 Coal/firewood heating

The primary school of Kunowice is now being heated by a solid fuel heating, which mainly uses coal in blocks and has an output capacity of 40kW[1]. Since it is a multi-fuel stove it can also utilize firewood. The heating is being used for warm water production and to heat up the building itself. The annual consumption of coal equals 12[2] metric tons and in addition to that 15 m³[3] of firewood. The raw materials produce approx. 120.000 kWh[4] of thermal energy each year. The annual costs for raw materials can be summed up to approx. € 2.620[5].

[1] Expert talk: Waldemar Buchta(Energy Change Manager community of Slubice), 30.01.2012
[2] C.f. ibid.
[3] C.f. ibid.
[4] C.f. Ibid.
[5] C.f. Ibid.

### 1.2 Wood pellet heating as an alternative

As an alternative to the existing coal heating it is planned to install a wood pellet heating for the primary school as well as a heat pump for hot water production. The investment cost of the wood pellet heating is approx. € 2.900[6], while the heat pump amounts to a total of approx. €1.400[7]. The new installed heating will consume around 25 metric tons of wood pellets per year at an expense of approx. 4.000 €[8] while producing 120.000 kWh of thermal energy.

## 2 Financial situation

### 2.1 Economic guidelines/ assumptions

To calculate the economic effects of the planned heating system there are guidelines to be considered. The calculations are based on an equity ratio of 100% with no credit facilities, which means interest payments are unaccounted. The costs are based on the actual investment for biomass heating systems in Poland. Furthermore both systems need a replacement investment after 10 years at the expense of the value mentioned in the following assumptions:

**General assumptions**

| | |
|---|---|
| Annual heat demand: | ~ 120.000 kWh |
| Currency exchange rate: | 1 € ≙ 4,2055 PLN (10.02.12)[9] |
| Gross expense ratio: | 2,5%[10] |
| Rate of inflation in Poland: | 2,83[11] |
| Planned economic life: | 20 years[12] |

[6] Expert talk: Waldemar Buchta (Energy Change Manager community of Slubice), 30.01.2012
[7] C.f. ibid.
[8] C.f. ibid.
[9] http://www.finanzen.net/devisen/euro-zloty-kurs, 10.02.12 10.05am
[10] Assumption IfaS
[11] http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/, 27.01.2012 11.35am
[12] http://www.bundesfinanzministerium.de, 10.02.2012 9.03am

**Coal/firewood heating system assumptions**

| | |
|---|---|
| Coal price: | 800,00 PLN/metric ton[13] |
| Inflation on coal price: | 5%[14] |
| Inflation on coal price – no subsidies (see chapter 2.2) | 10%[15] |
| Firewood price: | 220,00 PLN/m³[16] |
| Inflation o firewood: | 5%[17] |
| Capital required for coal/firewood replacement investment: | € 5.000,00[18] |

**Wood pellet heating system assumptions**

| | |
|---|---|
| Wood pellet price: | 700,00 PLN/metric ton[19] |
| Inflation in wood pellet: | 5%[20] |
| Capital required for wood pellet replacement investment: | € 500,00[21] |

[13] Expert talk: Waldemar Buchta (Energy Change Manager community of Slubice), 30.01.2012
[14] Assumption IfaS
[15] Assumption IfaS
[16] Expert talk: Waldemar Buchta (Energy Change Manager community of Slubice), 30.01.2012
[17] Assumption IfaS
[18] Assumption IfaS
[19] Expert talk: Waldemar Buchta (Energy Change Manager community of Slubice), 30.01.2012
[20] Assumption IfaS
[21] Assumption IfaS

## 2.2 Financial comparison

The framework of the following cost comparisons considers two scenarios on the inflation of coal: **Scenario 1** follows a constant rate of inflation on coal, firewood and wood pellets of the in chapter 2.1 mentioned 5%. **Scenario 2** commits to the current discussion whether to still subsidize coal beyond the year 2014 throughout Europe. Some experts consider an inflation on coal of 10% after 2014, while the inflation of firewood and wood pellets remains steady at 5%.

**Scenario 1**

*Figure 2.1* shows the costs for the coal/firewood heating system for the school in Kunowice as it now exists in comparison to the alternative of a wood pellet heating over the next 30 years. The annual costs for the wood pellet heating are not significantly exceeding the costs of the coal/firewood heating. Nevertheless the costs for coal in this scenario will constantly be located below the costs for wood pellets over the next 25 years.

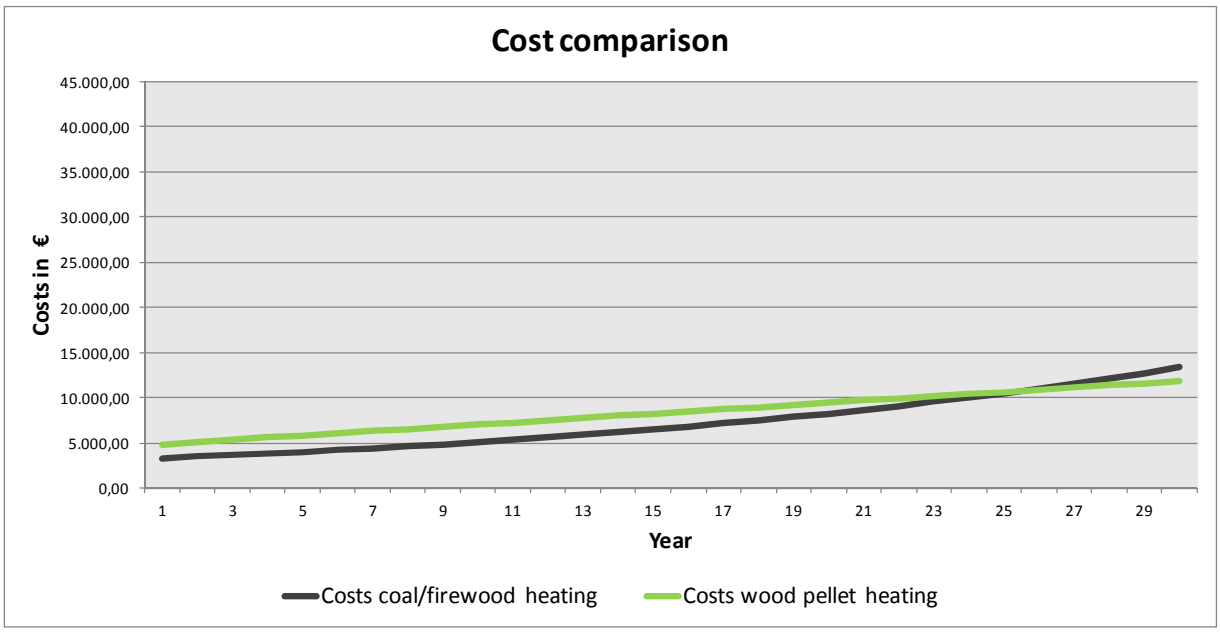


**Figure 2.1: Cost comparison coal/firewood heating – wood pellet heating (5% coal price inflation)**

### Scenario 2

*Figure 2.2* shows the cost comparison based on the inflation of 10% on coal, while wood pellets and firewood remain steady at 5%. The situation in *figure 2.2* is now inverted compared to *figure 2.1*. The coal price will be lower than the price for wood pellets over the next 5 to 7 years, but then exceeds the price for wood pellets in year 10. After year 10 the annual costs for the coal and firewood heating rapidly increase while the costs for the wood pellet heating system rise on a considerably lower level.

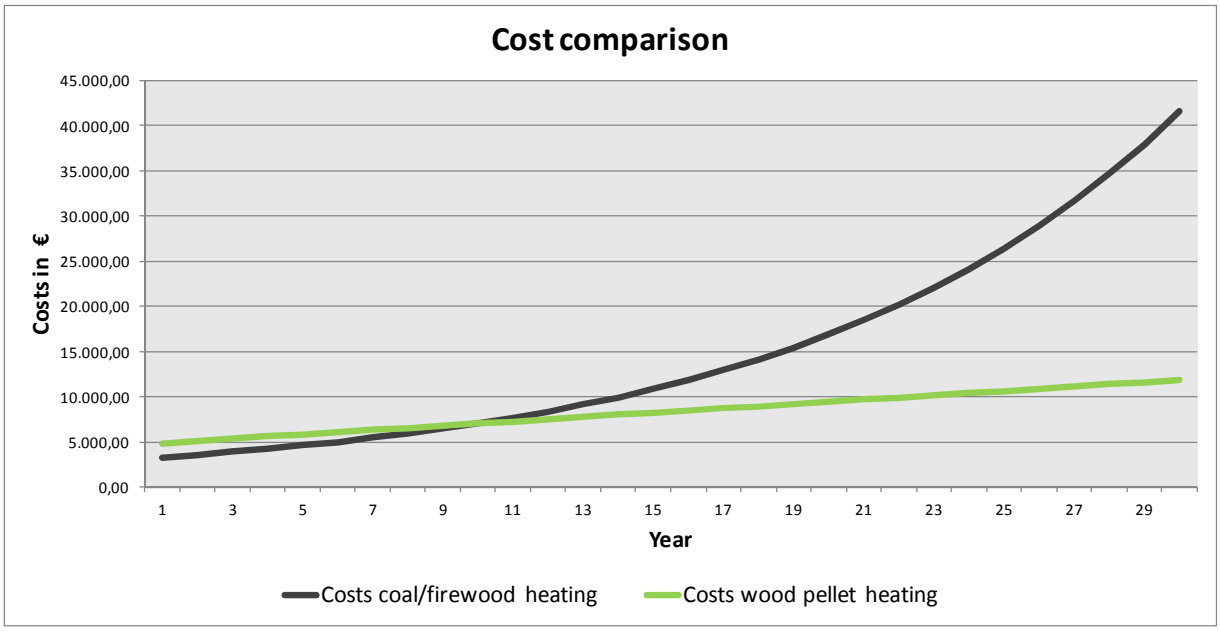


**Figure 2.2: Cost comparison coal/firewood heating – wood pellet heating (10% coal price inflation)**

## 3 $CO_2$-emission comparison

The following figures conduce to calculate the ecological effects of both heating systems. The values for the raw materials are based on their immediate annual $CO_2$-emission when they are burned up, i.e. the upstream chains like the raw material production is unaccounted.

**Situation with a solid fuel burning chamber**

| | | Heat value/ kWh | MJ | $CO_2$ Emission/kg per MJ | Total $CO_2$-Emission/kg |
|---|---|---|---|---|---|
| Consumption coal in metric tons: | 12,64 | 88.501 | 318.604 | 1,980000 | 25.033 |
| Consumption Firewood in m³: | 15,00 | 31.500 | 113.400 | 0,004240 | 481 |
| | | | | Total: | 25.514 |
| **Situation with wood pellet heating** | | | | | |
| Consumption Wood pellets/ metric tons: | 25,00 | 120.000 | 432.000 | 0,010000 | 4.320 |
| | | | | Total: | 4.320 |

**Chart 3.1: Detailed annual $CO_2$- emission comparison**[22]

*Chart 3.1* compares the $CO_2$ –Emissions of the existing coal/firewood heating and the planned wood pellet heating. Due to annually 12 metric tons of burned coal, the $CO_2$ – balance shows a broad walkover for wood pellets, which are considered to be nearly $CO_2$-neutral (only 0,01 kg $CO_2$ per MJ). That means the tree, the wood pellets are made of, gathered nearly the same amount of $CO_2$ that is later emitted by burning up the wood pellets. Furthermore every tree is replaced by a new one, which can be seen as a circular flow. For a better illustration Figure *3.1* compares the potential of the investment in a new heating system graphically.

[22] Based on Ecoinvent Database v 2.2

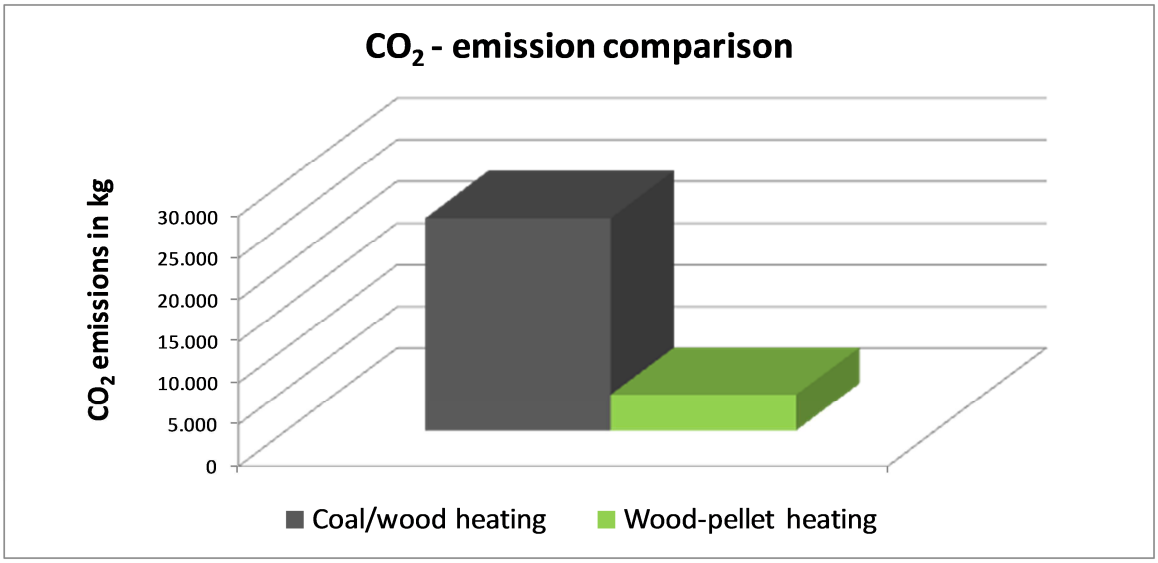


Figure 3.1: Graphic illustration of $CO_2$ –emissions

## 4 Conclusion

As this report illustrated there are two ways to argument for a new investment in a wood pellet heating system. First of all a wood pellet heating is not only the more sustainable way to heat and second there is always a higher inflation in fossil fuels than there is on renewable energies, like wood pellets. It is safe to say that the current coal/firewood heating is an extreme emitter of $CO_2$ to our environment and its utilized raw materials are partially not endless, like wood, which always can be reforested. In comparison to firewood wood pellets have another big advantage: they are made from saw mill waste and are considered to be a by-product, that doesn't need any trees to be cut down just for the purpose of wood pellet production. The wood pellets needed for the operation of the heating can be purchased from a local retailer and the supply of services will be done by local craftsmen. This way additional value is created in the region, as illustrated in the following *figure 4.1*:

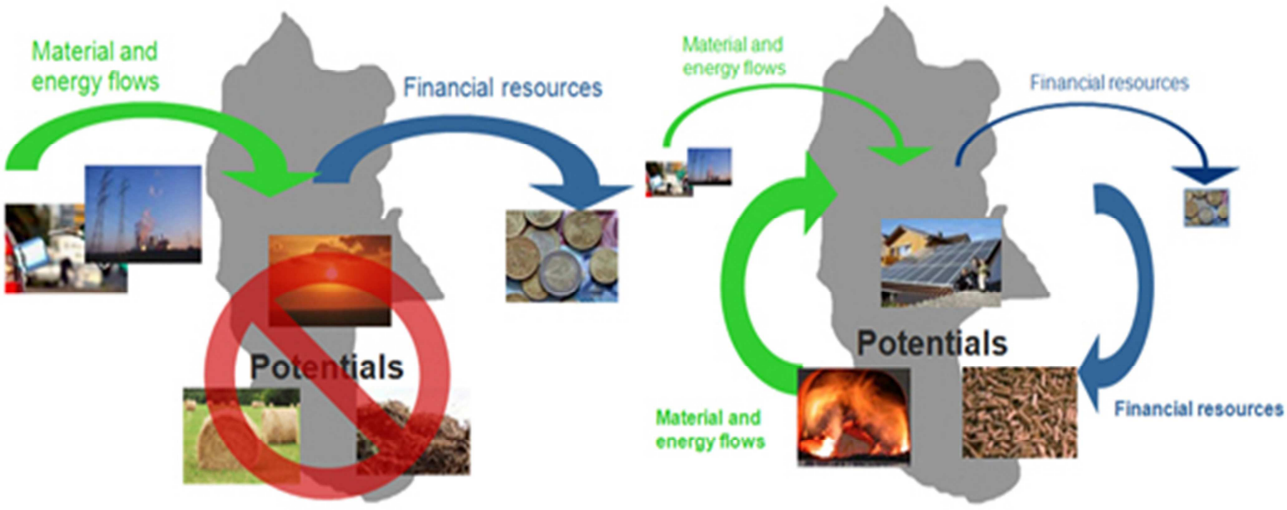


**Figure 4.1: Region without (left) and with (right) optimized material flow management**

*Figure 4.1* shows the current situation in the community of Slubice (left) and the situation after applying regional material flow management (right). In almost every region the situation as illustrated on the left can occur. The regions are not capable of using their own potentials but instead they are buying material and energy flows (e.g. heating oil, gas or food) from abroad. The financial resources are not bond in the region and through the use of fossil fuels $CO_2$-emissions are generated, which has a direct impact on the environment. Material flow management helps to recognize regional potentials and to activate them. The financial resources are not, or at most small parts, flowing abroad anymore. This way, additional regional value is created.