REGIONAL ENERGY CENTRE, O. P. S.,
VSETÍNSKÁ 78, 757 01 VALAŠSKÉ MEZIŘÍČÍ, CZECH REPUBLIC

PROJECT INNOREF SUB-PROJECT BRIE

FEASIBILITY STUDY

IMPLEMENTATION OF AN ENERGY SUPPLY SYSTEM AT MUNICIPALITY LEVEL WITH BIOMASS

Authors: Ing. Libor Lenža, Ing. Naděžda Lenžová, Ing. Jana Švarcová, Ing. Radim Pištělák, Ing. Čestmír Berka

Project manager: Ing. Libor Lenža

Content

Opening remark

The following feasibility study deals with basic problems of projects planning and implementing. Here we are talking about projects especially aimed at energy biomass use in the regional and municipality level. Regarding the character of the study some initial parameters cannot be determined with a sufficient accuracy. That was the reason why the methods of analytic models and case studies were used during this study elaboration.

The study is intended for all persons interested, investors, instructed representatives of municipalities, officials, mayors and so on. In the case of particular investment project implementing (project for energy biomass use) it is necessary to subcontract all documents elaboration providing the feasibility of the intention together with its economic and other benefits.

1. Basic characteristics of the region and its localization

The area of the Hranicko region can be found in the eastern part of the Czech Republic, east of the town of Olomouc. Regarding the **administrative distribution**, Hranicko is the easternmost part of the Olomouc region, former Přerov division. There are 31 municipalities in the region; two of them are towns' by-law (Hranice and Potštát).

The region is lying along the significant river Bečva. The Hranicko region is mostly a rural area with the only large town, Hranice. Hranice is a natural attraction zone and an economic area of the whole region. Most of the industrial production is located just in Hranice or in its outside industrial zones. Other parts of the region are mainly aimed at agriculture and small local farms.

The altitude of Hranice moves between 240 up to 280 meters above see level. There is the European watershed of 3 rivers in the altitude of 310 meters above see level between Hranice and Bělotín. There is an upland with the highest point of Maleník (479 meters above see level) south-west of Hranice. Northern and north-eastern parts of the region lay in the Oderské uplands. The highest points of the region are in the north (594 meters above see level near Kovářov). The lowest parts of the region (except the Hranice abyss) are in the western part near Jezernice, at the water level of the river Bečva (235 meters above se level).

Picture no. 1 – Localization of the Hranicko region.

Basic geographic and demographic information:

Population:	about 34 744
Area:	325, 37 km^2
Demographic density:	107 inhabitants/km^2
Arable land:	16 589 ha
Forests:	7 239 ha

Picture no. 2 – Map of the Hranicko region. Source: http://www.machovsky.cz

Regarding the **transportation** questions, the fast highway R47 is crossing the region from east to west. The towns of Ostrava and Olomouc are connected then from east and west. Other important artery of traffic joins the fast highway in Hranice from the south (regions of Vsetín and Valašské Meziříčí). Hranice is also a significant transfer node of railway service of an interregional importance.

The whole **natural character of the region** can be seen on the satellite map (picture no. 3). The majority of agricultural land is evident completed by a share of forests. Thus the structure of land and its utilization together with the industry of the region are the important attributes of the source potential of energy biomass use. The analysis of land structure was made because of this reason. Its conclusions are summarized in the chart no. 1.

One half of the region is cultured as an **arable land** for production of food or technical crops (also for energy crop production but only in the minimal extensions). The largest areas of arable land are in the south-eastern and eastern parts of the region.

Forests and forest lands can be found north and south-west of Hranice. There the continuous spaces are formed. Some smaller isles of forests are also in other parts of the region. **Permanent greens** form approx. 12 % of the area and are mostly used for the extensive beef-raising.

Picture no. 3 – Satellite map of the Hranicko region. Source: www.mapy.cz

The rates in the chart no. 1 can be compared with the satellite map of the region (picture no. 3).

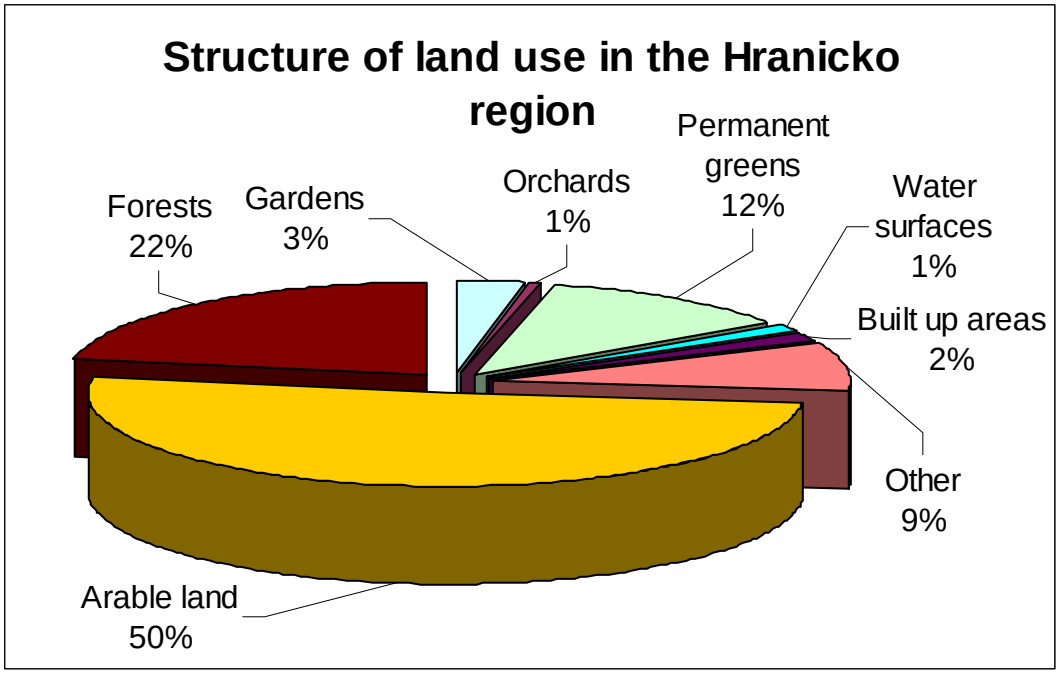


Chart no. 1 – Structure of land use in the Hranicko region. Source: ČSÚ

Regarding the biomass for energy use the region has a **particular advantage**. **Natural conditions and character of land use** creates the potential of a sources mix for agroenergetic production (biomass from forests, agricultural production, agroenergetic production of biomass and so on). The transportation availability must be also mentioned as an important advantage.

2. Social, demographic and economic situation of the region

Other aspects to be considered while the analysis are the demographic and economic situations of the region, social situation of inhabitants, economic potential and development potential. **The population of the region** is around 34 750 inhabitants with a slightly majority of women. The statistic is listed in the chart no. 2.

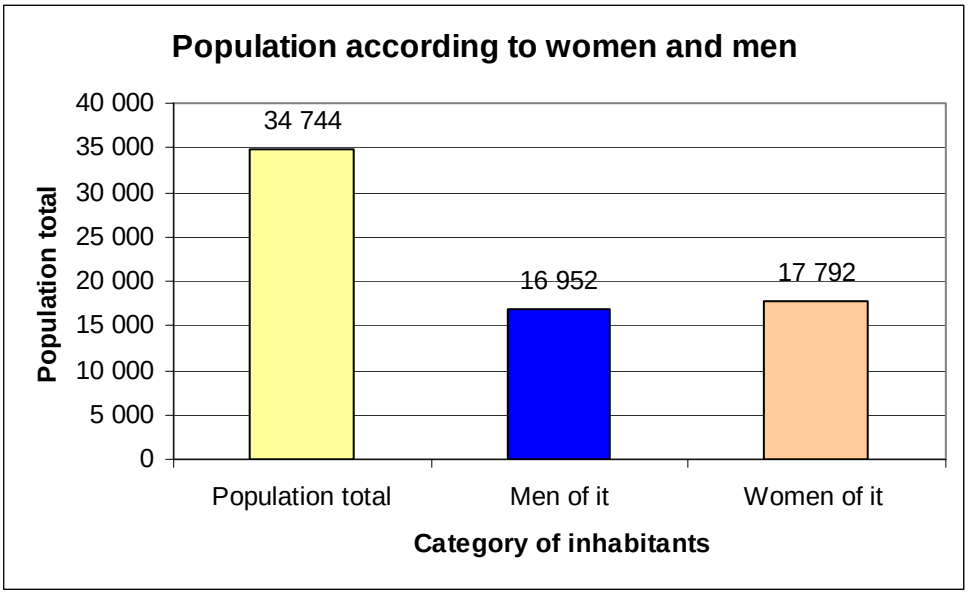


Chart no. 2 – Population of the Hranicko region and its structure according to the gender. Source: ČSÚ

Demographic evolution or **population growth or decrease** is also, among others, the important indicator of developing potential of the region. In the Hranicko region the decrease of population can be noticed. The decrease is caused not only due to the natural decrease of population but especially due to its migration. The progress in time is shown on the chart no. 3. If we define the town of Hranice as the largest urban unit in the region, the statistic shows higher decrease of population in Hranice and a slight growth of population in the rest of the region, in the neighbouring municipalities. This tendency is evident since 1999. In the last years the growth of population in rural areas is stagnating again or starts to decrease.

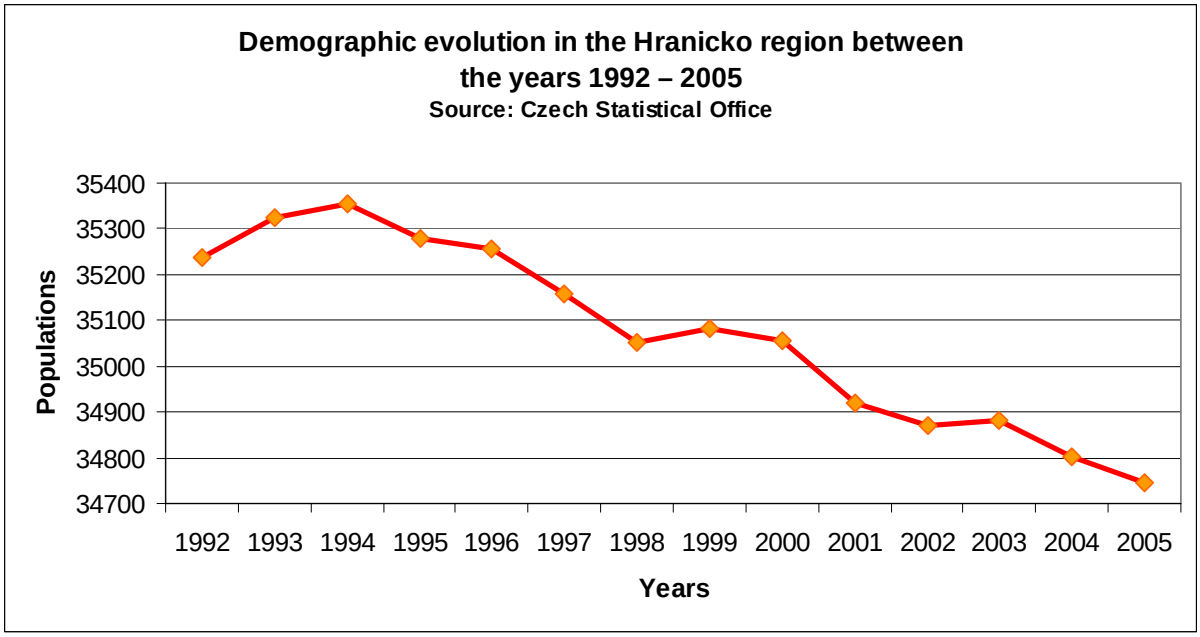


Chart no. 3 – Demographic evolution in the Hranicko region. Source: ČSÚ

These movements are related to the attractivity of the region regarding job opportunities, economic power, quality of life and basic tendencies of the last years (moving towards the regions of economic activity).

Age structure of the population shown on the chart no. 4 is also very important. Two-thirds of the population are people between 15-59 years, 18 % are people over 60 and 16 % people under 14 years. The population will grow slightly older but there also exists the potential of younger age group.

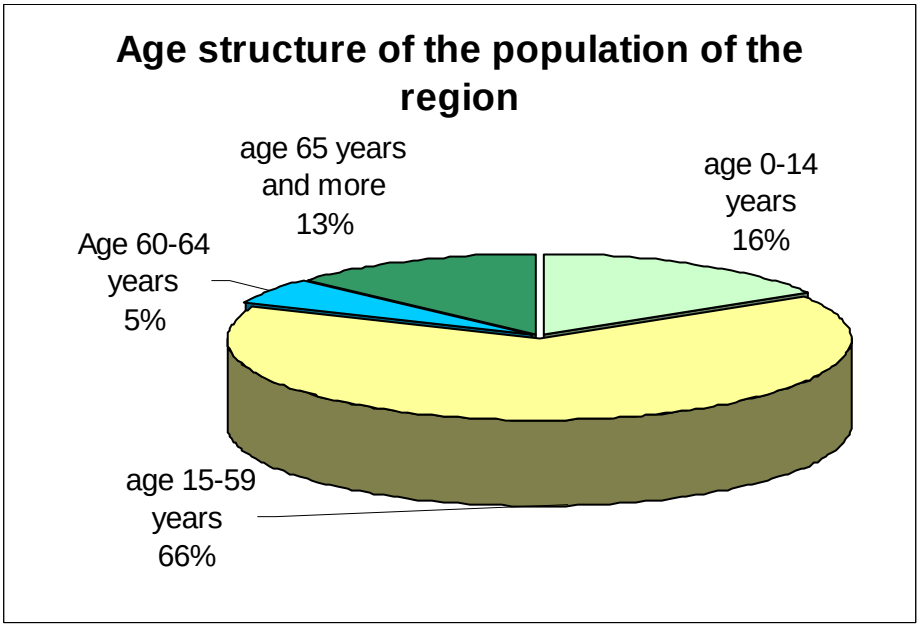


Chart no. 4 – Age structure of the population of the Hranicko region. Source: ČSÚ

The average unemployment rate in the region makes approx. 8,6 %[1] of economic active inhabitants.

The initial demographic situation is not in conflict with the intention of energy biomass use in the region. It can on the contrary create new job opportunities (of lower qualification) and the total competitive advantage of the local economy can be pushed up.

3. Basic information about the project

Proposed aspects' examinations of energy biomass use and its increase were elaborated within the larger project that was implemented on the area of the Hranicko region in the years 2005 – 2007.

It was the project *Innovation and Resource Efficiency as Driving Force for a Sustainable Growth*, known under the abbreviation INNOREF, supported by the initiative INTERREG IIIC of the European Union. It is aimed at principles of sustainable development, thus the participatory processes among the participants, initiation of economic and social developments regarding the quality of the environment. The common website of the project can be found on: http://www.innoref.net/.

The sub-project BRIE (Biomass Resource use, Innovation and Efficiency) is one of the eight sub-projects. Its aim was to establish the basic presumptions for creation of close bio-energy cycle within the region. This cycle becomes a part of optimal use of available renewable energy sources. The project encourages agriculture and forestry in the production of energy biomass. This fact helps to create i.a. also the suitable conditions for new working places creation in the field of renewable energy sources and its utilization.

The analysis of existing situation in the field of energies use, efficiency and the suggestion of the possible and optimal development with the sequence of regional potential use is one of the important parts.

The sub-project tries in practise to initiate and support the functional association (partnership, consortium) of all subjects (firms, agricultural or forest companies, public, housing sector and so on) supporting the mutual collaboration and barter, then the economic growth in the region stimulated by cultivation, transformation and use of biomass.

Educational activities, educational training and transfer of know-how are very important parts of the sub-project as well.

4. Municipalities in the region – characteristics, problems, energetic questions´ solution

The structure of land use of the region can be seen in the chart no. 1. The Hranicko region is oriented especially on the agricultural production (except the town of Hranice, which is the industry centre of the region). Nearly half of the area is an arable land. Forests occupy around 1/5 of the region.

In the geographic view the region can be divided into one part, slightly hilly with the intensive agricultural production (esp. the south, south-east, east and a percentage of northern

[1] Source: ČSÚ

part of the region). On the other hand, the second part is hilly (south-west of Hranice – Valšovice, then the Potštát and Střítež areas north of Hranice). The neighbourhood of Hranice is industrialized.

Particular residential and municipal units are not very large at all. They can be divided into 3 basic groups (except of Hranice). Villages, township villages and towns with the population over 1 000 inhabitants belong to the first group. The second group is formed by villages with population between 500 – 1 000 inhabitants. Villages with population up to 500 inhabitants belong to the third group. Smaller villages have no strong power to enforce and implement larger investment activities.

Municipality	Population	Municipality	Population
		Rakov	390
Hranice	19 525	Milenov	388
Hustopeče nad Bečvou	1 749	Paršovice	372
Bělotín	1 613	Teplice nad Bečvou	343
Potštát	1 200	Malhotice	336
Všechovice	854	Hrabůvka	320
Střítež nad Ludinou	843	Špičky	277
Opatovice	788	Polom	272
Černotín	748	Milotice nad Bečvou	241
Skalička	556	Klokočí	233
Ústí	549	Rouské	224
Partutovice	485	Zámrsky	198
Jindřichov	473	Horní Těšice	155
Olšovec	454	Provodovice	148
Horní Újezd	438	Radíkov	137
Býškovice	392	Dolní Těšice	43

Table no. 1 – Population in particular villages, December 31st 2005. Source: ČSÚ

The area used for biomass production forms approx. 85 % of the total. This is after calculation of permanent greens and gardens. Most of the production is not intended for energy use. However the potential for larger waste biomass use and its transformation into the form for energy use exists in the region.

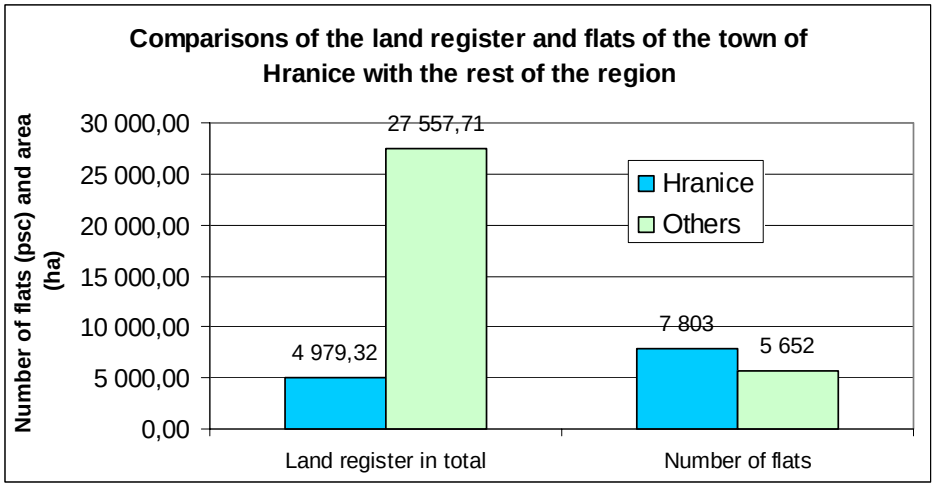


Chart no. 1 – Comparison of the land register of the town of Hranice with the rest of the region. Then the chart shows the number of flats under the same structure (Hranice and the rest of the region). Source: ČSÚ

The town of Hranice forms the most important **residential unit**. 58 % of flats of the whole region are just in Hranice. The dominance in the number of flats is not very marked. There the possibility of biomass use in local systems in smaller villages is offering. Its consumption will refer to the production possibilities of the region.

Most of villages face the **problem of high energy requirements** of buildings in their ownership, thus high operating costs. Some municipalities (e.g. Střítež nad Ludinou) already went to the change of fossil fuels for biomass, incl. **local bio-energy cycle** creation. Within the cycle the local (municipal) biomass sources are used (forests, areas, surroundings, ways and rivers servicing …), transformed (chipping machine) and used for heating in municipal buildings. Energy saving actions are being (if possible) implemented within those buildings as well.

Only one municipality -Potštát of the whole region (31 municipalities) **is not connected to the gas distribution system**. To conduct the gas distribution system to the region of Potštát would be very financially demanding. There is no anticipation of this step in the near future. Furthermore the also exist some smaller areas without the gas distribution system (e.g. Valšovice belonging to Hranice). Just those are areas that are already using biomass for heating on the higher level. Those areas are also suitable for further energy biomass extension and utilization.

All municipalities of the region are connected to the distribution networks of electricity.

5. Possibilities of biomass use – biomass-based kinds of fuels

While the analyses of energy biomass use in the Hranicko region those were the initial factors:

- geographic and climatic conditions of the region
- size and character of agricultural areas and its use
- agricultural production
- way of forests management
- other factors

The region shows a particular **duality in the way of land use** – agricultural land (arable land) and forests. This also is its advantage because of the **diversification of primary sources of biomass for energy use.** The mentioned biomass is coming from the agroenergetic production or agricultural waste on one hand. On the other hand the wood mass for energy use (timber production or waste) or forest crops (timber harvesting or servicing) are other sources of biomass.

Except of those two kinds of biomass there also **exists a potential of waste biomass** in the region (public areas, parks, gardens servicing, ways and rivers servicing). Even if those areas are not very large, waste biomass can be an important local source for energy use (usually combined with other sources – see the example in Střítež nad Ludinou).

The source duality makes the **diversification** in time and **territory** possible. Single smaller regions do not compete in term of biomass sources. For example, one region uses wood mass of forests, other uses agricultural waste, the third one aims at its combination or at agroenergetic production.

The analysis shows that it is **possible to use efficiently** the following kinds of fuels on the biomass-based in the Hranicko region:

- lump wood
- wood chips
- pellets (wood-based)
- agro pellets (plants-based, event. vegetable waste)
- bio-gas (waste after livestock production, event. plants cultivation with the high potential of bio-gas production – e.g. maize – silage)

Technologies used for transformation, but also consumption of energy biomass in the particular region are dependent on kinds of biomass produced – biomass produced in the primary agricultural or forester sector, waste produced from imported raw materials.

If the existing transformation technologies are limited in regard the available production of primary raw materials, transportation costs, actual value of classical fuels and cost of labour the following systems are realistic and economic in the Hranicko region:

- wood waste chipping
- lump wood preparation
- bio-gas production
- pelletizing (in limited rate)

Limitation of the production potential of the region can be overcame by raw material import – purposeful import of raw materials for pellets production or import of materials for other commodity production or transformation (e.g. agricultural production import for its further transformation in the region).

Information about the biomass transformation into usable fuel is available in another study that was also elaborated within the sub-project BRIE (chapter 17 – source 2). While manufacturing capacities planning it is very important to analyse the stability of production potential very carefully, then its availability, possibilities of economy advances (step change in price of alternate commodities), exercisable production and so on.

After these aspects examination it is obvious that it will be more preferable in the Hranicko region (despite of some advantages) to build capacities that will be smaller and thereby also financially undemanding. These will not be dependent on raw materials imports and will be able to transform raw materials efficiently from the economic available area.

Possibilities of biomass consumption were analysed the same way, through the methods of simple **combustion**. The same limitations and factors operate in the field of biomass consumption (mentioned above in context of biomass transformation). Limited production potential, questionable economy of raw material transportation on greater distances and others belong among the limiting factors. In the phase of **slow development of the regional market with biomass for energy us**e, the **small regional systems** are going to be more efficient and strategically preferable than large bio energy centres. Regional systems can help effectively in the municipalities not only in the public sector. Large bio energy centres are capital-and-operational intensive. Its building would probably take the essential part of sources from the region and would exclude by this step small and effective bio energy systems of local character from the regional market.

6. Bio fuel sources and its availability

Very important factor of regional market of biomass development is the bio fuels sources availability within the whole cycle: production – transformation – consumption, regarding the quantitative, qualitative and time point of view.

The primary sources analysis for bio fuels production in the Hranicko region was aimed at land use. Thanks to the analysis we were able to quantify the production, waste percentage, quantity of biomass produced. The parts of production used for non energy purposes (foodstuff, technical crops, industry materials …) were excluded from the following calculations.

Theoretic values for energy biomass were calculated. The values faced with the given areas extension. There is an overview in the following table.

Land	Area (ha)	Energy biomass production per ha (t)	Energy biomass production (t)	Reduction of utility (seasonal character, year-on-year fluctuation)	Energy biomass production after reduction (t)	Potential in GJ
Gardens	1011,25	0,2	202,25	0,4	81	849
Orchards	185,41	0,7	129,79	0,4	52	545
Permanent greens	3777,46	1,5	5 666,19	0,3	1 700	22 098
Arable land	16588,85	2,1	34 836,59	0,3	10 451	141 088
Forests	7238,75	1,2	8 686,50	0,4	3 475	36 483
Others	2772,08	0,6	1 663,25	0,4	665	6 986
Total			**51 184,56**		**16 424**	**208 050**

Table no. 2 – Potential reduction of energy biomass sources

Production values of energy biomass result from expert surveys of workability for particular types of land. Standard values of energy content in given kinds of biomass were used for biomass potential expression in GJ.

Table no. 2 shows **theoretically usable biomass potential** in the Hranicko region. Now the reduction of the values must be calculated in order to get the potential that is available. Values after reduction taking into account many factors restraining efficient biomass use are stated in the table no. 3 (last column). Among the factors can be included above all:

- technical inaccessibility of areas (hardly reachable forests, ravines…)
- lack of proper machinery
- other way of biomass use
- lack of interest in future usage (lack of economic motivation, ignorance, lack of information)
- geotechnical reasons (tendency to leave the remaining biomass in the fields because of improving the soil quality) and others

The **economic efficient usage** is the most important factor besides the above mentioned ones. Costs for harvesting, collection, storage and other necessary operations of the potentially usable biomass are higher than its sales price (or usable energy content).

Land	Potential in GJ	Coefficient of reduction	Usable production (GJ)
Gardens	849	0,8	680
Orchards	545	0,8	436
Permanent greens	22 098	0,89	19 667
Arable land	141 088	0,2	28 218
Forests	3 6483	0,7	25 538
Others	6 986	0,65	4 541
Total	**208 050**		**79 080**

Table no. 3 – Reduction of theoretic potential of biomass for energy use.

In the following chart (chart no. 6) there is the comparison of original values before reduction with the final values. The results express very substantial **disproportion between existing (theoretical) potential and its usable part**. We have to point out that this rate is not fixed in time. It can change due to price of classical fuels progress, awareness raising, necessary machinery existence, consumer's capacities and other factors.

Moreover the mentioned values are according to the practise lower because of the low interest in the products transformation. There is another problem – plurality of land owners or farming subjects. Then the organising of central harvesting and purchase of raw biomass, areas decentralization (many smaller areas in the region increases transportation and labour costs disproportionable) are questionable as well. **The real values in nowadays practise are going to be even lower.**

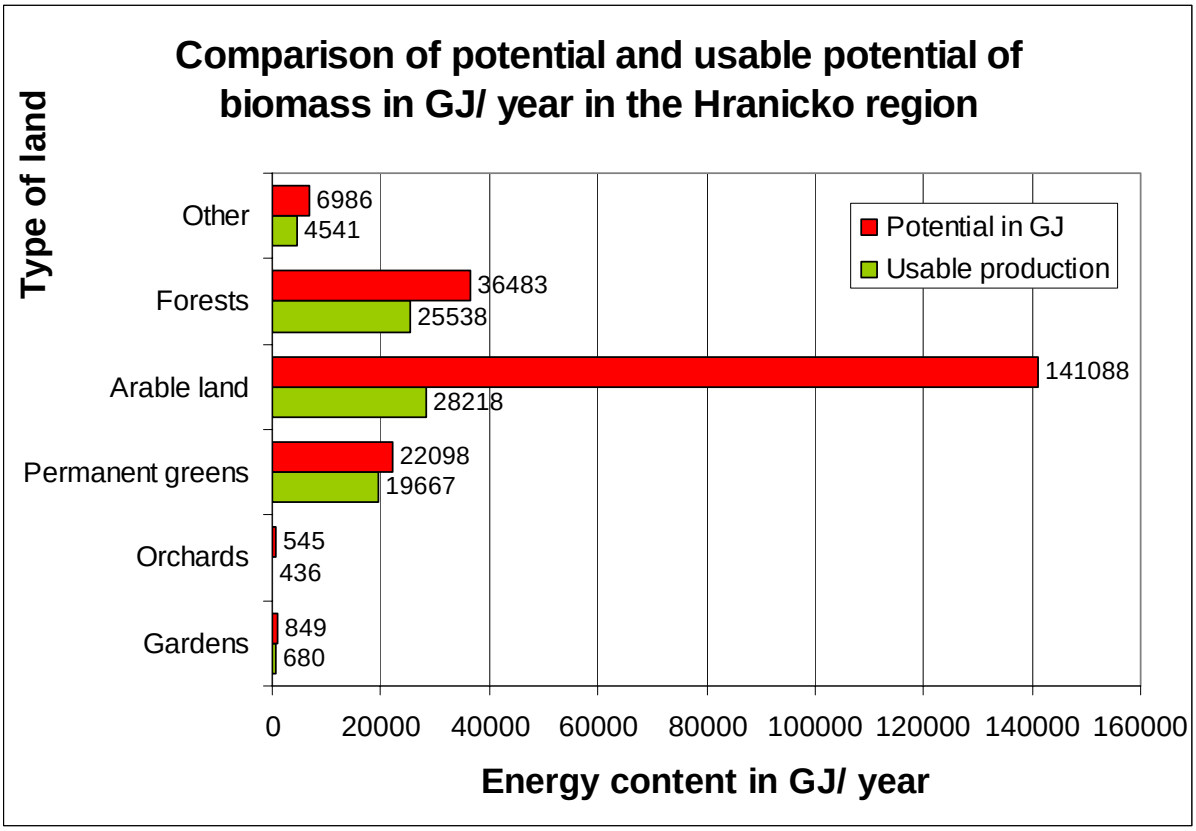


Chart no. 2 – Comparison of potential and its usable parts from the regional biomass production. Introduced in the land use structure. Source: ČSÚ, REC, o. p. s.

Possibilities of energy biomass use increase from existing sources are available. It is important to create specific presumptions and implement some activities for their usage.

For example:

- analysis of spatial and time arrangements of sources within the region (incl. proximal regions)
- mapping and quantification of technical and economical requirements in the case of particular project intentions
- central coordination of procedures with the significant support of subjects engaged in regional market of energy biomass development
- formation of sufficient consumption potential based on the partnership of public and commercial sectors
- efficient use of grants and dotations (esp. the investment ones)
- energy requirements of buildings and technologies reduction
- creation of energy biomass reserve resources (e.g. agroenergetic production, use of line produce areas – along ways, water flows and so on)
- others

7. Market analysis

The regional economy is based on the same principles as the national economy. Those principles are the market formation where the offer meets the demand. The mutual interaction forms the particular price.

Together with the basic thesis also the principle of subagents has its place here. That means that people consume such estates and services that cover their needs while the lowest spending. We will not deal with the economic of imperfect markets on the offer or demand side but with the **aspects of contemporary market with bio fuels in the region** and with the factors influencing them.

One of the problems of current market with bio fuels in the Czech Republic in general is the **price turbulence** of bio fuels incl. rapid changes, acceptable offer fluctuations in time and sometimes also temporary or permanent lack of fuels (this can be caused by several facts: local disposable biomass sources exhaustion, transportation costs increase, convenience of bio fuels export (esp. pellets) and so on).

These and other factors are the reasons why smaller producers and agricultural farms dealing with energy biomass and its consumption wait and anticipate the future development. They wait for big producers, what way they will choose (which commodities, crops, procedures …). Big producers are significantly stronger. There does not exist the force for limitation of foodstuff production nowadays. The production is replaced by technical crops production incl. oil bearing plants that are used for liquid bio fuels production in large volumes.

The mentioned conclusions cannot be applied in general. There exist some companies cultivating and using energy biomass nowadays. Those are mainly single companies producing the primary raw material, transforming and consuming by their own (e.g. the biogas station in Jindřichov, kettle for corn in Skalička and similar ones.)

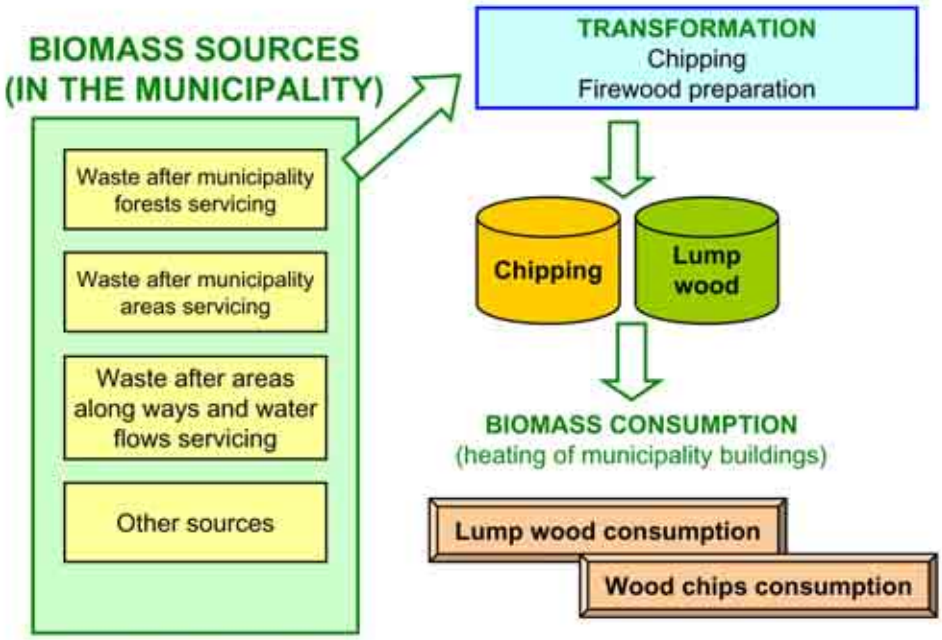
On the current market with bio fuels the **wood mass** of different origin **dominates** (when energy expression). This tendency grows strong with the increase in price of classical fuels

and energies. Also **among people the wood mass is the absolutely majority renewable source of energy**. The subjects farming in forests and enabling self-production (thinning, air-raid species removing …), mining companies (waste after timber production), wood manufacturers and other subjects using wood as an industrial material can act as sources of firewood (of different forms).

In the recent years the **specialized companies trading in firewood** in the form of cleft timber are rising. Prices are usually higher than those from the above mentioned subjects, but on the other hand the wood is wholly prepared (and usually dried already) to be used without any other modifications. In the first semester of 2007 the prices moved depending on the kind and quality of wood from c. 18 EUR per stacked cubic meter and more.

Other important factors restraining the development of market with bio fuels are **consumers' doubts about the lack of given kind of fuel** in the future and fear of rapid change of its price. Another argument is also the "dependence" on limited number of suppliers of given kind of fuel. All the above mentioned arguments are basically subjective. The effect of "personal experience" has been applied here, when the supply of natural gas, electricity, coal is regarding the subjective point of view "sure". On the other hand the supply of biomass is less confidential in the long term.

The reality can be totally different in the future. Classical fuels distribution can be interrupted because of different reasons or its price will reach a very high level. Then the well-balanced regional energy system based on biomass can be a certain temporary solution. Demand increasing by steps in the case of problems with classical sources constitutes the troubles. Regard to these questions there is plenty of work to be done in the field of education, energy requirements of buildings reduction (thus primary fuels need reduction), awareness and consultancy.



Picture no. 1 – Scheme of the closed bio-energy cycle in Střítež nad Ludinou. Source: REC, o. p .s.

At the beginning of functional regional market with biomass creation it is convenient to start with so called **closed bio-energy systems**. It is the case when the only subject (or several subjects related to each other) provides the production of energy biomass, its transformation but also its consumption. If the system is proposed well (the annual biomass consumption corresponds with a particular reserve of its production and manufacturing capacity) then the **system is sustainable in the long term, is economically efficient and perspective**. The example of such a system is the already mentioned system in Střítež nad Ludinou. Its chart is shown below.

The **price development of bio fuels** is an important circumstance as well. It is applied in the Western Europe that despite of price level and energies increase the price of bio fuels is lower than the price of classical noble fuels (electricity, natural gas, furnace oil). This status is accepted also in the Czech Republic. Competitors are thus solid fossil fuels (coal) whose price is lower – see the next chapter.

It can be rightly anticipated that the **price of bio fuels** will change in time depending on the price of classical and most usable fuels and energies (natural gas and electricity). It also can be supposed that the price level of bio fuels will be lower compared to the mentioned classical fuels. Regarding its regional sources the price pressure (political, economic ones) will not influence them as significantly as the strategic fossil fuels (pure oil, natural gas). Those are the clear reasons for efficient use of regional available and long-term sustainable biomass sources.

8. Economic aspects of biomass use

The basic economic aspects of energy biomass use were already examined in the previous study (see chapter 14 – source 1). This material does not deal with any particular investment project where the particular economic parameters could be analyzed. We only will aim at chosen problems regarding the economy questions of energy biomass use in general.

It is obvious that most consumers **prefer the fuel or energy of the lowest costs that is possible**. The question is what this price is: price of fuel purchase, specific price per one unit of fuel, specific price for the heating season.

Some conclusions regarding **price of bio and fossil fuels comparisons** can be misguided. If we will look at the actual prices in the view of the specific price per unit of the energy contained in the fuel (so the heating power), the following table can be compiled.

Kind of fuel	Price per kg (EUR/t)	Heating power (GJ/t)	Price per MJ of heating power (EUR/GJ)
Whitewood (pine)	34,5	13	2,7
Hardwood (leafy)	39,7	13	3,1
Black coal	125,9	26	4,8
Brown coal	79,3	14	5,7
Agro pellets	86,2	14,5	5,9
Wood chips	75,9	12	6,3
Coke	170,7	27	6,3
White pellets (wood)	124,1	17	7,3

Table no. 4 – Overview of specific prices of chosen bio fuels and solid fossil fuels in EU/GJ of heating power.

If we consider another parameter that is very important - **efficiency of equipment** where the fuel is combusted, then the order of fuels and their specific price changes on behalf of bio fuels. Values in the table result from the average kettles efficiency (average of older types – majority and modern types of higher efficiency). The lowest prices of lump wood stayed, then the order in the table as well but the order at the end of the table changed. The specific price per GJ is due to the high efficiency of new kettles for pellets combustion under the specific price in the case of brown coal and coke.

Kind of fuel	Price per GJ of heating power (EUR/GJ)	Source efficiency	Price per GJ reduced efficiency of the source (EUR/GJ)
Whitewood (pine)	2,7	0,8	3,3
Hardwood (leafy)	3,0	0,8	3,8
Black coal	4,8	0,7	6,9
Agro pellets	5,9	0,85	7,0
Wood chips	6,3	0,9	7,0
White pellets (wood)	7,3	0,9	8,1
Brown coal	5,7	0,65	8,7
Coke	6,3	0,7	9,0

Table no. 5 - Overview of specific prices of chosen bio fuels and solid fossil fuels in EUR/GJ of heating power regarding the kettle efficiency.

Because every intention and project of energy biomass use is different and deals with different input values and other elements, economy benefits cannot be quantified exactly. But the benefits can be demonstrated in the general model. It shows the economic benefits for investor or for the company as well. The **model** was derived form the already implemented intentions for biomass use in the buildings of compared size.

Regarding the subject of this study the model results form the **smaller public building with the annual heat consumption of 250 GJ**. Only three basic energy sources were chosen:

- brown coal
- natural gas
- biomass (lump wood)

In the following chart there are **annual costs for fuel comparison** in the case of three above mentioned fuels. It is obvious that use of lump wood is nowadays – on conditions of its sufficient amount, storage possibilities, low humidity (20 %) the most cost-effective. The price is in practise influenced by the factor of self-production. People harvest, modify and transport the wood by their own (without own labour costs calculating). Then the price is even lower. On the other hand the system (lump wood) requires high level of labour input and service.

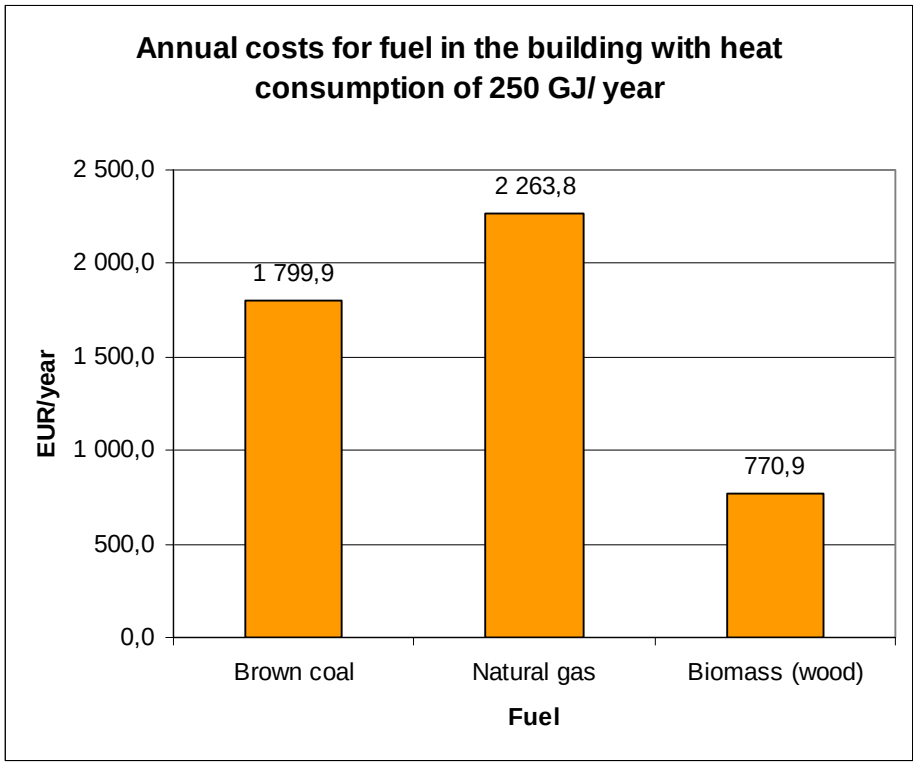


Chart no. 3 – Annual costs for fuel compared at three fuel sources. Source: REC, o. p. s.

The important aspects influencing the energy consumption are the **energy requirements of the heated building**. Through the energy saving actions the consumption of the building can be reduced by several tens of percent (regarding the initial level).

Values in the chart no. 7 change in time according to the actual prices of particular fuels and energies. Prices of fuels and energies have the tendency in the long term to grow with temporary price swings copying the economy and policy circumstances, current offer and demand and other factors.

8.1 Employment impacts

Economic benefits of well designed and implemented energy system that produces, transforms or consumes biomass go along with positive impacts on the level of employment in the region.

We will compare two areas (both of the size c. 4 000 units for housing and public structures with the total required output of 40 MW). One of them will use biomass as a source of energy, the other natural gas instead. According to the survey of the Austrian association for biomass, the system of the local source of biomass creates **15times more working places** in the given region than the system based on natural gas. The number is only a route-identification but the benefits in the area of employment are obvious.

Particular benefits expressed in the number of new employees in the case of regional bio energy system implementation cannot be stated generally. It can be quantified in the case of particular project implementation.

9. Environmental impacts

Environmental benefits of energy biomass use have several levels. At the well done design and implementation the **positive effects arise** - not only at the ecologic combustion (thanks to the CO_2 and pollutants reduction) but also at the biomass production itself. Controlled production of energy crops in the region adequately (no large areas of monocultures but production mixture of wood waste for energy use, agroenergetic production, waste after agricultural production and so no) diversifies the land use, its production capability, kind's varieties, increases of the retentive ability of landscape and others. Each plant has different requirements. So the large areas cultivation of particular monocultures can evoke opposite reactions and influence the environment negatively.

Let us come back to the model mentioned in the previous chapter. We will analyse emission impacts of particular options for chosen pollutants and CO_2. The following tables and charts present the results.

Pollutant	Brown coal (kg/year)	Natural gas (kg/year)	Wood (kg/year)
Solid substances	316,73	0,14	300,50
SO_2	537,59	0,00	24,04
NO_x	82,41	11,14	72,12
CO	1 236,15	2,23	24,04
C_xH_y	244,48	0,45	21,40
CO_2	46 306	13 795	24 687

Table no. 6 – Overview of calculated values of chosen pollutants and CO_2 production. Model - building with heat requirements of 250 GJ. Source: REC, o. p. s.

Results of the table no. 6 are diagrammatized in the following charts no. 8 and no.9.

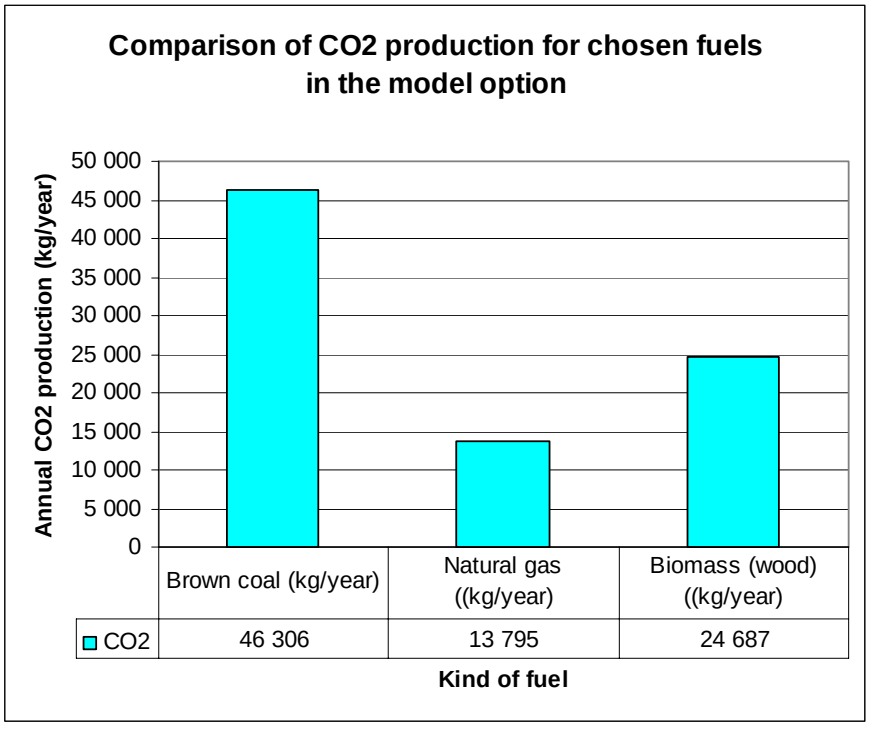


Chart no. 4 – Carbon dioxide production at particular fuels use, building with heat requirements of 250 GJ. Source: REC, o. p. s.

While natural gas using the production of **carbon dioxide** is the lowest. But natural gas is a fossil fuel (non-renewable source) so there is the increase of greenhouse gas in the atmosphere. In the case of biomass use we talk about the **CO_2 neutral** fuel. Carbon dioxide consumed while plants growth (removed from the atmosphere) is while its combustion released to the atmosphere again. There is a so called supplement CO_2 production into the earth's atmosphere. The worst situation occurs at solid fossil fuel – brown coal – use. The CO_2 production is more than three times higher when compared to the natural gas and is nearly double compared to biomass use.

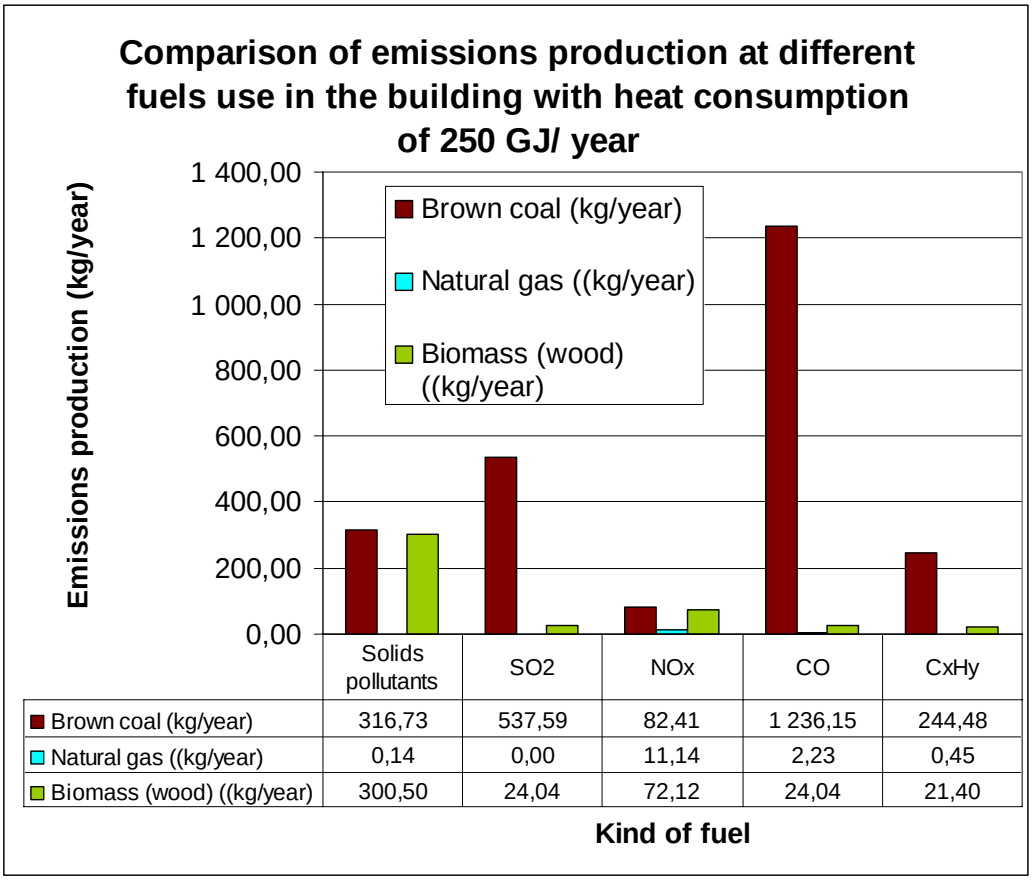


Chart no. 5 – Production of other chosen pollutants at particular fuels use, building with heat requirements of 250 GJ. Source: REC, o. p. s.

Chart no. 9 shows the calculated **values of main emissions**: solids (airborne dust), SO_2 – sulphurous dioxide, NO_x – nitrogen oxides, CO – carbon monoxide, C_xH_y – benzoatepyrens). The chart confirms again the ecologic benefits of natural gas regarding emissions production. Also the advantage of biomass use compared to brown coal is evident. Especially carbon monoxide and benzoatepyrens productions are very high in the case of brown coal use.

The considerable old age and technical imperfection of overall majority of kettles for biomass is the topical problem in the Czech Republic. In practice it contributes to the **increased production of pollutants also while biomass combustion** (unsecured optimal conditions of combustion, very limited possibility of regulation, wrong service and use).

Also politicians are aware of this problem and have answered by the effort to adjust the unfavourable conditions. In the article 3) they say: "*The Ministry of Environment of the Czech Republic will start the massive support of heating exchange soon. Its ideal goal is to push coal combustion away from*

municipalities and replace it with ecologic fuels. But this intention can crash if people will only replace coal with wood or other biomass and will keep the old kettles the same..

…

The country intends also by generous supports to contribute to old kettles replacement in order to use modern and more ecologic ones."

While solid fossil fuels (coal) replacement with biomass at 15 and more years old kettles' keeping the production esp. of soft airborne dust is increasing. It compensates the positive effects of wood combustion.

Travel distances shortening needed for fuels transportation from the place of production into the place of its combustion is another environmental benefit while the use of local biomass sources.

All above mentioned facts confirm the **positive influences of energy biomass use** in combination with modern technologies (and energy requirements of buildings reduction). The regional use of local biomass sources for energy requirements covering (or parts of the total) of the region is considered as advantageous in the combination with other benefits.

10. Management of the implementation process of system for energy biomass use

Reasons for energy biomass use are different. Sometimes they are of **economic character** (effort to reduce costs for heating), **environmental character** (effort or necessity of pollutants reduction) or the particular subject has **the possibility to use another waste biomass** he did not have before. Also dotation support of national or European programmes can play its role or it can just be the business intention.

10.1 How to proceed at the intention of energy biomass use

As we could see, the reasons are various. Sometimes it can also be the combination. Each area, subject, region or municipalities have different conditions – natural, financial, technical or personal. We tried to compile the manual that could help to those who consider biomass use and are not very convinced of its advantageousness. On the other hand it also could help to those who are firmly decided but are not aware of all risks and problems.

The balance between biomass sources in the given region and its real consumption (need) considering possible changes of its demand (climatic changes) are the **basic presumptions of success and sustainability of the project for energy biomass use in the long term**. Not only waste biomass but also agroenergetic production of biomass, imported biomass and waste after transformation can be considered as biomass sources.

In the next chapters we will talk about the possible reasons why to actually think about the energy biomass use. Which aspects should be considered before the project implementation? In the chapter 10.2 we will think about the beginning of projects implementation. In the next chapter 10.3 we will mention the main problems we can face and their solutions as well.

It is important to say that the following information is of general character. It can be applied to particular types of project intentions. In practice it is necessary to result from particular information, initial situation and to accept local conditions and specifications.

10.2 The initial motivation

We already were talking about the reasons of local systems implementation of energy biomass use. Motives are different, but there is one risk. **Every reason** that leads us to the idea of the project realization **should be verified independently**. If our reasons result form truth information and it the project is sustainable in the long term. E.g. the surplus production of corn (together with the redemption price decrease) in one year is not the reason why to build the sources for corn combustion. The price can change in the following years again and then the problems will occur. The same principle must be followed at other forms of biomass.

In practice we usually meet one or two people that are the leaders of the project. Their view at the poetical and real problems cannot be quite objective (they made up the project and protect it). This fact can lead to the real problems minimalization or underestimation that can occur either at the beginning or after several years first.

Skilled project managers are already aware of these risks and can notice the arguments and real facts. They consider very carefully possible risks and weak points of the project. They are searching for procedures and steps how to minimize it as much as possible.

Overview of the most common reasons towards biomass use:

Reasons for project implementation - consideration	**Note**
Operational costs reduction	One of the most common and most essential reasons. It is important to specify the intention and verify by the calculation if costs will be reduced after all relevant costs inclusion. It is necessary to specify all risks and find the way of their limitation. To figure out the impacts on the economy of the intention (e.g. local demand of biomass increase, seasonal changes of its availability…)
Energy biomass systems support – funding, programs	Funding policy of the country and the EU leads in the case of heat source necessity (emergency conditions) to the consideration about such source implementation where the dotation program exists. It is necessary also in this case to verify the benefits not only in the investment phase but also in the operating one. Extra emphasis must be placed on the sufficient number of fuel sources and its stability in the long term.
Limitation of pollutants production in the region	Areas with deterioration of quality of environment find ways how to replace efficiently the fossil fuels combustion in local sources with other financially reasonable fuel. In the case of the intention preparation it is necessary to place the emphasis on the sufficient number of biomass sources again considering the needed kind of biomass, its quality and amount and the delivery stability (sources).
Necessity of new source purchase for heat production	In the moment of heat source replacement the biomass source is considered as one option (regarding the funding policy). The intention must be verified from the technical and economic point of view as well as the energy biomass delivery in given quality must be ensured in the long term.

Accessible (easily) biomass source – regional transformation capacities (wood processing companies, agricultural products processing and so on)	These are usually particular companies but also municipalities having sufficient number of biomass at their disposal (by reasons of primary sources or products processing). The stability of the source in the long term must be verified again. In practice it is the waste biomass (agricultural production, wood processing industry, furniture manufacturing and others). Within the intention it is necessary to verify the alternate biomass supply of different energy source (in the case of production limitation, stopping of particular activity, structural changes in the economy…)
Best practice inspiration	Here it is necessary to consider if there are the same or similar initial conditions. If we are able to build the similar system and ensure the comparable capacity utilization.

Table no. 7 – Brief list of the most common reasons and motives towards the projects for energy biomass use implementation.

In practice there usually exists the combination of some motives mentioned above. Its list is not entire of course. If our motivation is so strong, we should start.

10.3 Where to start

Biomass in our conditions is mainly used for the heat production and only sometimes for the power production. Also this circumstance should be considered at the beginning. At some systems, the power production is on the other hand the main goal and thanks to the heat consumption the economy of the whole intention can be only better. Here we are talking esp. about the combined heat and power systems driven by bio gas or another gaseous fuel made of biomass. This is the power production by turbines or engines at larger installations.

The idea of energy biomass use is the first presumption. No matter the motives that are pushing us. We will not deal with larger energy systems in industry or public sphere. Those questions are more difficult and very individual. On the other hand the principles and procedures of smaller system can be applied also on the large ones.

Most of the intentions of energy biomass use focus on its **use for heat production for heating the building** in the housing, public sector and the sector of services. Biomass is often used also in the sectors of small and middle businesses (mostly at companies producing waste biomass).

The first step is the **information managing**. There is a large number of information. It is necessary to choose those ones that are trustful and certifiable.

Information can be gathered from the following sources:

- special publications and manuals
- special or non-fiction magazines
- internet (website of installation producers, similar equipment users and operators, non profit organizations and so on)
- conclusions of research works, studies and analysis
- consultancy on European consultancy and informational centres of the Czech energy agency (EKIS ČEA) or similar (usually non profit organizations)

Information gathered this way will serve for the general orientation. Then it is better to meet the best practices, to visit **similar installations** and gain **practical experience**. Except of the technical information and experience also the economic information is very important. Not everybody will be glad to tell you information like this.

If we will find out after all information gathering that the intention is realistic, we can continue. The next chapter is a brief manual how to proceed if we really want to implement our intention of energy biomass use.

10.4 Process of energy biomass systems implementation

It is practically impossible to create the universal scheme or a guide for preparation and implementation of projects for energy biomass use. That is why we will try to refer to the main areas that needs to be solved (block diagram). In the next chapter the problems and risks will be analysed together with their limitations.

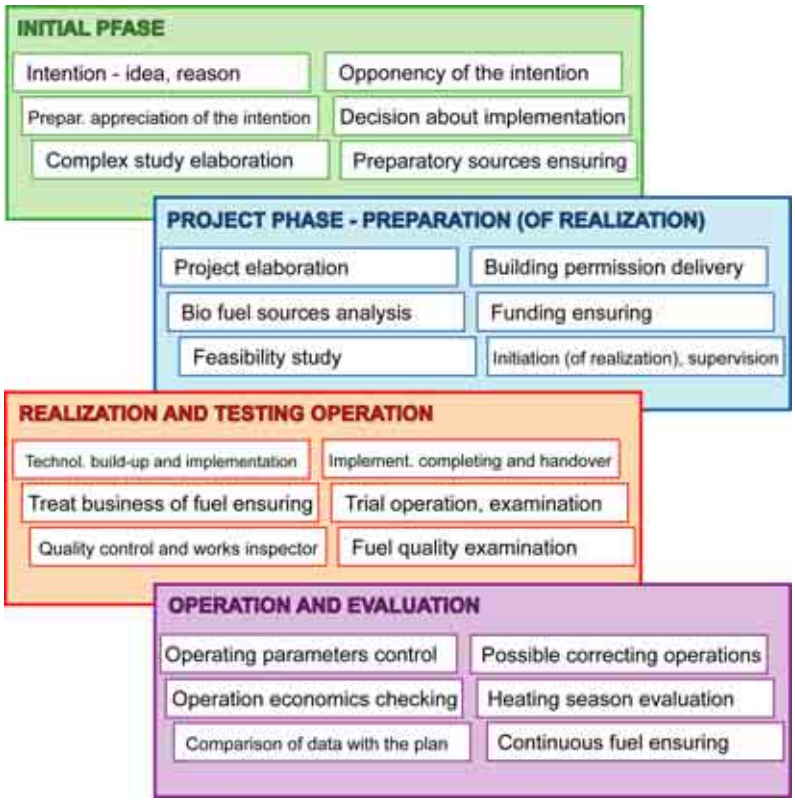
There are **three main areas** in general that need to be solved mutually and the utility must be ensured in the long term. Those components are:

- suitable biomass sources (sources)
- transportation, biomass transformation, storage (transformation)
- biomass conversion (combustion) and transformed energy use (consumption)

The long term stability of all components of the system is the necessary condition of the efficient and acceptable biomass use.

On the basis of experience with preparation and realization of projects for energy biomass use the block diagram was compiled. The block diagram will help to orient and direct within the particular activities, its terminology and context. As already mentioned the diagram is only for route-identification. In practise some situations and cases that are not described here can occur.

Block diagram of activities, actions and problems:



The above mentioned diagram must be considered as a route-identified. Every project is unique and meets unique problems that need to be solved specifically.

The **detailed examination of the building** cannot be underestimated – in term of thermal parameters, heat looses, its utilization, character and many other aspects. The maximal attention must be paid to problems of biomass sources mapping, its long-term efficiency, risks of other biomass demand, transportation possibilities and costs, storage capacity, basic technical conditions observation and others.

10.5 Problems and risks

During the project preparation and implementation we face a range of problems that can threaten the fruitfulness of the project. Problems can be of different character: technical, organizational, legislative, personal and so on.

It is very important to **identify the risks within the own conditions** and to find the **possible solutions** for their limitation.

Main troublefull areas at the preparation and implementation of energy biomass use are:

- sufficient local source of biomass (quantity, quality, stability in time)
- problems rising from the long-term contracts (price increase, delivery limitations…)
- technical solutions of installation regarding the supplied building, servicing requirements…
- initial phase funding
- others

Management and analysis of risks

Important part of the project preparation is the analysis of all possible risks we ca face within all phases of the project realization. Under the word **risk** there is hidden the danger of damage or project failure because of doubts. Risks are a natural part the project realization and it is necessary to work with them and to manage them.

How to work with risks?

To work with risks (to manage them) means:

- identify the possible risks situations
- mark the sources of this situations out (influences, effects)
- identify the procedures in the case of given risks arising (risks elimination)

There is the brief **table that summarized the most common risks**, their sources and possibilities of their elimination. It is evident that this is only a selection. In the case of particular project implementation it is necessary to identify own risks and to find the ways of their elimination or reduction.

Risk	Sources of risk	Possibilities of its reduction
Price of fuel increase	- price of fuel on world markets increase - increased demand on biomass-based fuel - jump increases of input raw material prices	- tendency to diversify suppliers, providers (if possible) - identify own possible biomass sources - fuel reserve ensuring - well timed order and purchase of fuel (out of the season) - long-term contracts with suppliers, treaty about price increase, fees for conditions defaults (exactable)
Increase in costs for fuel transportation	- activity of local biomass processor stopping - limitation of local production of biomass (or its export – preferable economic conditions) - necessity to transport fuel from longer distances	- mapping of possible fuel suppliers and providers in the region - calculation of increased transportation costs into the models within the feasibility study (analysis of sensitivity) - participation in local companies producing (transforming) biomass
Sale limitation - heat – power	- if the energy is sold to the third bodies, there is a risk that they can change the source - energy requirement reductions of own and other buildings	- technical source proposition and design with the possibility of efficient regulation (e.g. cascade kettles of lower input ordering) - mapping of other possible consumers (if their connection is possible) - in the preparation phase the supposed possibilities and steps should be included (according to the impacts to propose the source)
Lack of fuel	- poor crops or natural disaster (fires, floods, droughts…) - extremely high demand for bio fuel	- particular fuel reserve - emergency plan of supply providing - emergency and own sources of bio fuel mapping
Unbalanced fuel supply	- unreliable suppliers - conditions default - technical troubles with distribution	- storage of adequate emergency fuel supply - reserve suppliers
Technical failure of the source	- failures of kettles technologies and other systems	- regular servicing and checking - contracted partner for repairs and servicing - emergency source (?)

Table no. 8 – Most common risks, their sources and possibilities of their elimination.

11. Possibilities of projects funding

Except the limited production possibilities of the region while energy biomass production in the Czech Republic, the development of bio energetic is restricted by the **limited number of financial sources** (investments) for new capacities build up (not only for consumption but also transformation and production).

Not only private investors but also the public sector and people face this kind of problem. This is the reason for several supporting programs existence. They provide dotation sources (event. dotation on credit interests) or other ways of support aimed at the number of implemented projects of all sectors growth. This can also bring some problems. Several sources build up can lead towards the local shortage or lack of the particular commodity, mutual competition, transportation costs increase, and so on. Because of this reason it is necessary to prepare the investment projects regarding the situation in the region.

Even if the dotation programs are the significant sources of investment, some administrative and other requirements are connected with this activity. Some of the applicants can be discouraged form the intention right because of the bureaucracy. However there are **other possibilities of funding**:

- shareholder's capital – profit, owners deposits …
- bank loan - standard or soft loan
- ESCO method – third body financing, repayment from savings realized
- leasing – machinery, equipment
- Others

The business sector is mostly realizing only those projects that are returnable in relatively short time (usually without any dotations) and where the dotation is a very welcomed source of support. However most of the projects (regarding other fuels and energies competition and high investments) need the financial support to realize the planned project.

In the case of project intention it is necessary to be informed about the possibilities of funding, dotations, national and international programmes of support, foundations and similar activities.

12. Optimization of the option choice

In practical implementation of projects for energy biomass use, transformation or production it is usual, that goals can be reached by more than one possible procedure or technical solution. Then we have to choose, regarding the criteria, which technical, technological and organizational solution will be for our **project the most optimal** with the lowest level of **risks**.

Analysis of the situation and procedures in the particular case is not easy at all. Experienced realizing team, at smaller projects the specialist knowing well local factors are very important.

Those people should together with the investor and other people (users, consumers…) elaborate a **matrix of criteria**. On its base the project will be evaluated and optimized. Each investor has different requirements resulting form his priorities and needs. That is the reason why the optimization must be made always for particular project. The problem can arise when the investor (or his assistants) is not able to specify exactly his requirements and priorities. Then the specialists have to solve more tasks. Conversations and dialogs with investor are very important in order to know his particular conditions, operation and needs.

The basic and most common **criteria for optimization** are listed in the following table.

Criterion of optimization	**Notes**
Reliability of heat supply	- concerning the character of the operation or building (e.g. rest homes, kinder gardens…) the reliability of supply is the priority - the source must be advanced reasonably, suitable rooms for fuel storage must be ensured - it is suitable to advance also the source of power in the case of its failure
Operating costs	- all similar projects are build up in the effort to reach for savings at bio energy systems use - sources of saving can be of different character: costs of fuel, transportation, new technology servicing, labour costs reduction, new different working places

	creation, emissions limitation and the fees as well, others - it is recommended at the preparation phase to make the model calculations of financial flows and benefits incl. the analysis of sensibility on inputs change (price of fuel growth, transportation costs…)
Investments	- investor is mostly limited by his financial possibilities, but he has the requirements that are hardly connected to each other (necessity to interpret, argument) - investment sources limits can influence possible technique solutions - increased investments extend the time of economic return or increase the internal rate of return - it is necessary to explain that investments reduction can (but not necessarily) lead to the reliability reduction, operating costs growth and others
Possibility of different fuel use	- investor's requirements about the possible fuel diversification - this usually leads towards investments increase (two kettles, kettle for different waste combustion…) - the system's efficiency can be reduced (systems for one kind of fuel combustion have usually higher efficiency due to the more specialized technique solutions and regulation) - it is convenient to express the real demand of more kinds of fuels and to verify its accessibility in the region
Time-distribution of heat supply	- in the majority of projects we notice the great difference of delivery of energies during the summer and winter months (or in transitional period) - source and technology must be planned in such way, in order the technology complex can operate with the sufficient power expansion together with the optimal efficiency ensuring - perfect status – yearly heat consumption – economic benefits increase and shortening of repayment time
Given level of emissions achievement	- this requirement is usually solved by particular technology use, which fulfils the required emission limits (with a particular reserve) and the bio fuel of needed quality is ensured - further it is possible to be influenced by staff education, right regulation…
Servicing requirements	- mostly unmanned technologies on the base of pellets, wood chips and so on - labour savings, on the other hand sufficient technical equipment that must be operate correctly, fuel of needed quality must be ensured as well as the servicing, … - number of operating staff reduction is the important part of economic calculations (operating costs reduction)

13. Final evaluation of the possibilities of energy biomass use in the region

Conclusions arising form the conditions and possibilities of the regional analysis and experience with similar projects were summarized in the following:

- energy use of biomass brings the following **economic benefits** if they are well designed:
  - operating costs reduction
  - energy self-sufficiency increase
  - systems servicing reduction (boiler-rooms)
  - higher level of employment in the area of biomass production and transformation
  - others

- **environmental benefits** at diversification of biomass production, waste biomass use and its consumption
- **emissions reduction** of the majority of pollutants, CO_2 neutral cycles
- bio energy systems can be a part of the economic development of the region incl. its positive influence of tourism
- nowadays there exist **several programs for energy biomass use support** regarding its production (energy crops foundations, dotation per hectare…), transformation (investment support for pelletizing units build up) and consumption (investment support for sources of heat, combined production of heat and power from biomass…)
- **to utilize the programmes of support efficiently** within the region
- while preparation of the intention for energy biomass use (or production) it is very important to **map and analyze well the current situation**, to define possible development in the particular sector, competition in production and consumption and so on
- effort to **create the partnership, consortium** of the subjects dealing with energy biomass use, transformation and consumption – to support the functional regional market with biomass
- **find new possibilities of biomass use**, identify and utilize the free (so far) potential of biomass production and consumption
- accept **new directions, ways and tendencies of development** in the field of technology, agrotechnical and transformational procedures and so on
- use available know-how and **build the development on the base of regional partnership** of particular regions within Europe
- support and realize **projects aimed at awareness rising**, best practises and education in the given area accessible to all people and subjects
- **monitor and analyze results of the implemented projects** and compare them with the expectations, analyze differences and apply the experience into the new realizing and implementing projects
- **others**

Regional bio energy systems are workable and sustainable in the long term on the base of local conditions analysis.

14. References

1. *Technical, economic and environmental assessment of biomass utilization processes*, study within the BRIE sub-project, 2006
2. *The agricultural and forest biomass transformation for fuel production,* study within the BRIE sub-project, 2006
3. Baroch, P., *Ecologic heating destroys the air. Czech will change the kettles.* On-line – aktuálně.cz. 19. 6. 2007. Link: http://aktualne.centrum.cz/domaci/zivot-v-cesku/clanek.phtml?id=448073
4. *Technical manual for implementation and pilot actions – biomass use in local systems,* study within the BRIE sub-project, 2007