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PROJECT INNOREF SUB-PROJECT BRIE

TECHNICAL, ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF BIOMASS UTILIZATION PROCESSES

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Content

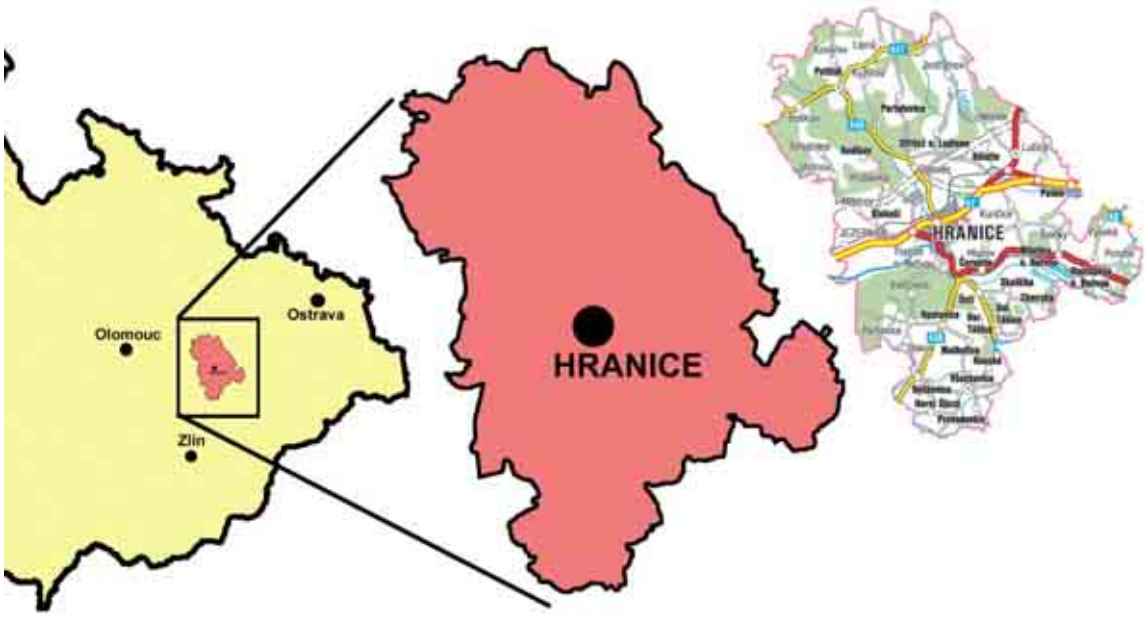
1. Hranicko Region – Basic Information

The Hranicko Region is situated in the eastern part of the Czech Republic east of the city of Olomouc. The region occupies the area along the significant river Bečva. Only the town of Hranice varies the rural character of the rest of the region. Most of the industrial production is located in this town or its industrial suburbs. The rest of the region aims for agriculture and small local farms. Forest land covers approx. 20 % of the area.

The region belongs to the genial climate zone. The rainfall totals are between 700 – 800 mm per year as the average. There are mineral waters near the town of Hranice and the spa of Teplice nad Bečvou.

Picture 1 – Location of the Hranicko Region within the Czech Republic

The Hranicko Microregion is an optional formation of 24 municipalities. As we are talking about the Hranicko Region, we have 31 minucipalities on our mind. This is the former District of Hranice.



Picture 2 – Eastern part of the Czech Republic and the Hranicko Microregion

Basic geographic and demographic information:

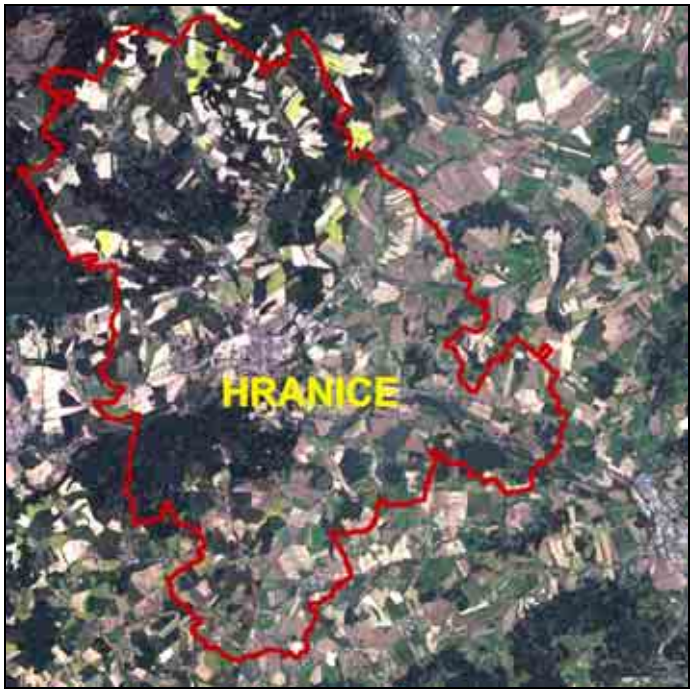
Population:	around 32 000
Area:	325, 32 km^2 (32 532 ha)
Population density:	approx. 98 inhabitants per km^2
Arable land:	21 580 ha
Forestry:	7 312 ha

Characteristic of the region

Regarding production characteristic the Hranicko Region can be divided into two main parts: forest land (south-east part) and agricultural land. This distribution determines also the priorities in relation to the possibilities of biomass production: forest biomass or biomass of agricultural production. The air map of the region can be the proof of the fact.

Geologic and natural conditions together with the land use are the main elements at the analysis of the potential of biomass for energetic use.

Approx. 8 % of inhabitants work in the sector of agriculture.



Picture 3 – The air map of the Hranicko Region (www.mapy.cz)

In the region, there are significant geographic differences between particular municipalities. The differences refer to the kind of land use, kind of vegetation but also the use of the area. The specifications have to be considered in the analysis, project proposals and pilot studies as well.

2. Introduction – Production and Consumption of Biomass

Considerations about energy-saving realizations and use of renevable sources of energy have the roots in some basic elements. The most important of them are the level of power consumption within the Czech Republic, high dependence on import and duty factors of economic operators regarding fuel and energy costs. One of the most important elements are also the tendency of energetic sources decentralization and positive economic impacts while using regional energetic sources in the region.

In the Czech Republic, the National Energetic Conception was approved in the year 2004. The Government Environmental Policy asks of achieving 6 % rate of renewable energetic sources of the total primary power sources' consumption by the year 2010 and achieving 8 % rate of electricity going from the renewable energetic sources of the gross electricity consumption by the year 2010. Aside from water energy, the increas also within the biomass consumption is anticipated.

The long-term goal of the Government Energetic Conception by the year 2030 is the rate of renewable energetic sources of the total consumption of primary energetic sources for 15-16 %.

2.1 Biomass Sources

Rearding the BRIE sub-project´s goals it is necessary to analyze and iniciate the positive shifts not only of biomass consumption (combustion and heat production) but also in particular the economic and efective biomass potencial. In the folowing, we will target the biomass in the solid state.

Biomass acording to the source:

- waste biomass;
- agroenergetic production.

Waste biomass (solid state):

- forest waste (so-called dendromass, waste after logging);
- idustrial waste (waste after wood raw material processing at all levels, wood waste, technologic waste and so on) ;
- agricultural waste (postharvest residues, waste after processing of agricultural products and so on);
- other waste (waste after prunes and municupal maintainance, public gardens and parks, stream-banks and so on).

Agroenergetic production (solid state):

- wood species (so-called short rotation forestry, e.g. poplars, willows, ..., lignocultures and so on);
- herbs (sorrel, grasses, fodder crops, eventually the classical agricultural production set for energetic purpouses and others).

Regarding the sector production, the regional potencial is based on the sources:

Sector	Biomass	Note
Forestry	waste biomass after logging	
	waste after primary processing	
	firewood logging	
	waste at the wood maintainance	
Agriculture	postharvest residues (straw)	
	waste after africultural production	(including animals)
	devaluated production	
Municipal utilities	public and municipal gardens´ maintainance	(green biomass -hewed grass- as a specific problem)
	stream-banks and riwer-banks, lanes´ maintainance and so on	
	sawage works´ biomass	
Industry	waste after wood processing	
	other wood waste	
	wrapping and others	
Citizens	garden waste	(green biomass -hewed grass- as a specific problem)
	other wood waste	

Potencial quantification of particular sources and its progress in time will be followed and assigned within the next BRIE activities.

Regional situation

The table covers the areas of particular crop-plants within the agricultural production in the Hanicko Microregion, 2005:

Crop-plant	Area [ha]	Crop-plant	Area [ha]
cereals	4 570,5	sugar beet	251,0
rape oil	1 104,2	poppy	421,0
corn	512,4	soya	145,0
pulse crops	92,2	fodder crops on arable soil	1 225,0
consumption potatoes	30,0	grass weed for seed	410,0

Considering the intensively exploited agricultural areas, the attention within the biomass sources potential will be first paid to the waste after africultural production, secondly to the possibilities of energetic herbs cultivation. In the other part of the region, where forests are dominating, the attention will be paid to the forest biomass use (as a waste, at maintainance, at logging and wood processing).

3. Analysis of the Biomass Use Process

There is no strategic plan in the region today regarding the use of bioamass as an important regional energy source. As far as the biomass is used as an important energy source in the region, this only can be seen in single units as agricultural companies, small businesses and so on. However, biomass is the most spread source of renevable energy that is used by people. The lump wood or waste wood is being combusted in low power kettles for heating family houses.

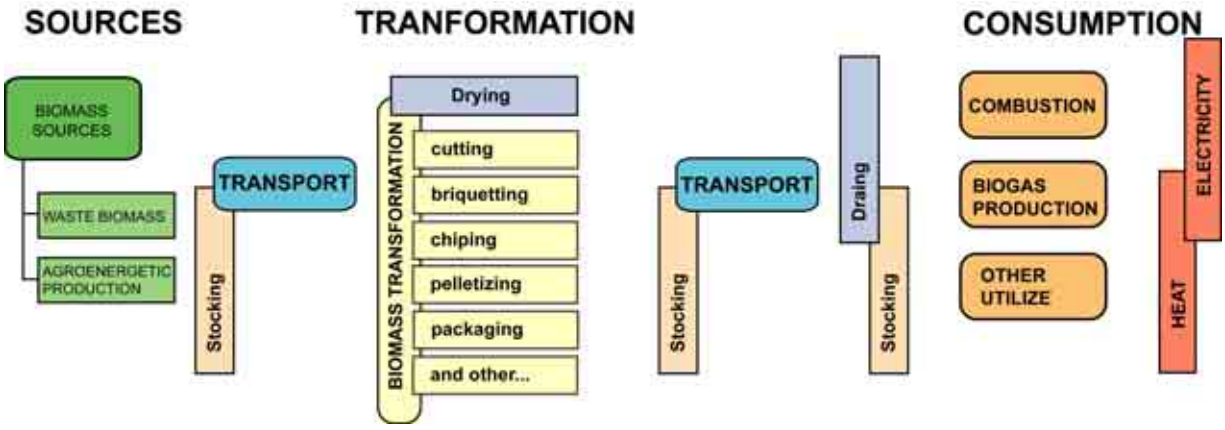
To guarantee the wood sufficiency of good quality is one of the most important elements of economic and efficient biomass use within municipalities and at lower levels. Local authorities play an important and positive role in this case. If the municipality or any larger unit (region) is thinking of a biomass source installation, then several itmes have to be taken into consideration. The fuel sources' providing has to be considered carefully in term of spatial aspects (transportation coasts, route loading, storage conditions …), time limits (supplies constancy) but also competition (negative competition for smaller sources or citizens).

One of the BRIE objectives is to prepare an analysis of the present biomass use in the region. This is followed by the qualified and critical analysis of an available, economic and effective potential of biomass for energetic use in two stages: **waste biomass – agroenergetic production**.

There are many aspects within the analysis of the bioenergetic cycle and the wide range of inputs and aspects enter this subject. The bioenergetic cycle can be described as production – transportation – storage – transformation – consumption chain.

Waste biomas of non-energy use in case of composting, mulch and others have to be taken into consideration while the analysis of energy biomass use. Economic efficiency of new systems using biomass of the region versus classic fuel systems is the main difficulty of the item. The regional limited land capability let us say the economic efficient potential of the energetic biomass also belongs among very important elements.

The Hranicko region is a very specific region. It is devided **into three completely different areas in term of the biomass potential and its possibilities**. The nord-east part is mostly wooded. The town of Hranice and its surroundings belong to the industrial zone. The southeast part of the Hranicko region concentrates on agricultural production. All the regional specifications have to be considered within the regional analysis. The regional analysis can show the productive potential of the region as a whole or of the particulat parts of the region.



Picture 4 – The network of energetic biomass production and consumption in the Hranicko region.

Considering the local conditions, biomass can be used at the levels of single units (buildings), groups of buildings, part of villages or whole municipalities. Regarding the heat source, biomass can be used as a subsidiary heat source (fireplace, tiled stove …) or as a central heat source (kettle).

3.1 Technical Aspects

The plans and experience of biomass use derive form the basic technical conditions of the region, particular farms or business units. The conditions can show us what kinds of technical means are available for what particular type of biomass production, its transformation and energetic use.

The travel distance that is necessary for the transportation of fuel from the source to the place of consumption is also one of the most important technological but also economical elements. At present, it is necessary to count the oil and travel costs (approx. 0, 9 EUR[1] per km + 1, 5 EUR per 1 ton of stuff at 8 tons on lorry) together. The possibility of bio-fuels production (of crop-plants) using existing and available technologies is the next element of renewable energy use. Farmers can use the following technologies:

- field chopper self-propelled machine – direct harvesting
- hopper bale breaker – into bale gathering
- cleaver, chopper, grader
- other common technology (tractors, lorries…)

Using existing and available technologies minimizes the large amount of initial investments into technical equipment and machine features. That can be one of very important arguments. Operating costs and investments to basic machine features play the important role in economic calculations of production efficiency and assurance of price competitive strenght.

Basic information about cost price of selected machine types for energy usable production:

Type of Machine Equipment	Conversion Unit	Cost Price	Note
field chopper	per 1 ha	51 €	gathering within rows
special field chopper	per 1 ha	66 – 73 €	for harvesting of whole fodder-crops
chopper/ dozer	per 1 ha	9 €	gathers residues of 2 rows at once
tractor with trail	per 1 hour	23 €	at 8 tons of load

Technical equipment for biomass combustion is in a sufficient offer in the Czech market. It is not a problem to choose the proper power-source in the technology and nominal energy output regard at present.

Huge energetic sources using biomass can face the problem of sufficient fuel volume assurance. Long distances constitute additional financial costs but also adverse effect of airborne releases. This is the reason why the larger energetic sources have to be considered and measured preciously in term of economic efficiency and sufficient fuel volume assurance for the future.

[1] Exchange rate CZK/ EUR - 27,5 CZK per 1 EUR

Picture 5 – Harvesting of sorrel (uteuša) (Farmers Cooperation of Owners, Fryšták)

As we can notice after some time of work experience, the suitable ways to affect positively the economic efficiency of biomass use in the regions are the precious needs, requirement processing, and above all the processing of the usable regional potential. All of that can be carried out within the Territorial Energetic Conceptions or specialized analysis aimed for biomass as a complex or for its particular forms.

Underestimation of conceptual attitude while building the energetic sources for biomass can be seen in the unwilling source competition, efectivity reduction of every single instaltion, advantage limitations of those systems and many other problems.

Particular problems relating to the cultivation of three chosen energy crop-plants were taken into account within our fieldwork. Conclusions are summarized in the table.

Crop-plant	Harvesting period	Problems
maize	September, for energetic purposes till October	higher seed costs per 1 ha (at better crossbreed up to 110 € per ha)
		annual seeding need
		punctual seeding-machine (rows in a distance of 70 cm, 15 cm distance within the row)
		higher humidity compared to sorrel
		necessary to provide natural land richness and nutrient reserve
sorrel (uteuša)	June, July	no yield potential
		deficient grown technology (protection against weed)
feterite	October, November	seed cost 44 € per ha
		annual seeding need
		higher humidity compared to sorrel
		necessary to reduce humidity – higher costs at pelletizing process
		necessary to provide natural land richness and nutrient reserve

Different situations touch the field of forest waste biomass use, which means waste after wood logging, waste after primary processing of wood materials and wood production. The lack of machines that can provide economic and efficient waste gathering after wood logging in common but also hardly accessible land is one of the most difficult problems. Other problems can be seen in the negative impacts (collection and chipping at one place, measure of land devastation), transportation from forests towards to the place of consumption or the storage area.

Picture 6 –The transportation and processing of residues after wood logging are economically demanding.

Heavy technology and machines for massive waste processing after logging are very expensive. We cant' assume that small or middle sizes forest enterprises (there is the majority of them in the region) would purchase the heavy technicque on their own.

The situation regarding this topic is better in the **field of municipal sphere**, which means the maintainance of public parks, gardens so on. Companies in charge of municipal maintainance usually are the owners of small chipping machines. The wood waste is processed into chips that are mainly mulched. The municipality of Střítež nad Ludinou is the only exception from the region. Local bioenergetic system is growing in this municipality. Representatives of other two municipalities in the region are also thinking about the system like this. The technical-economic studies are elaborated within the BRIE sub-project.

3.2 Ekonomical Aspects

The economic apects have to be evaluated in a complex way but also according to their single phase. We can devide:

- investments
- operating costs
- alternate use (non-energetic use of biomass).

Regarding the complexity and sensitivity of the bio-energetic systems of costs, it is necessary to consider each intention of the energetic use of biomass individually. To optimize the system´s advantages at all levels (production, transformation, comsupmtion, employment rate…) and to develop positive actions are considered as the main goal.

In the Hranicko region, all three basic opportunities within the creation of closed bio-energetic cycle are possible to be realized:

PRODUCTION – TRANFORMATION – CONSUMPTION

PRODUCTION RANGE

- plantation establishment – for agroenergetic production
- short rotation forestry - establishment
- use of agro-energetic waste production
- use of wood residues

TRANSFORMATION RANGE

- transportation
- chipping machines, grinders
- pelletizing and briquetting units
- gasification
- storages

CONSUMPTION RANGE

- heat production (low and middle powers)
- combined electricity and heat production (CHP)
- individual consumption – inhabitants

It is necessary to consider every singe intention for energetic use of biomass in the region individually and in relation to the biomass asvailibility, transportation costs, food production costs, agricultural costs and so on.

Ekonomic parameters and inputs into economic models are basicly specified by:

- production potentail of biomass in the region (production possibilities)
- rate of biomass for energetic use
- price level of food production
- price of other fuels
- aid programmes

Regarding the biomass souruces assuring, the particular privation can occure. This is connected to the building of high-power and meaningful sources with a high demand of biomass. Because of the high demand, the biomass price in the region is increasing. Then there is a lack of biomass in the region, supplies for smaller consumers are limited or even stopped. As result of the mentioned processes, the biomass price for smaller sources is getting higher. That means that the price of primary inputs is rising. It often is necessary to buy biomass from other regions where the travel distances are longer. That means cost rising but also adverse effects on the environment. All the aspects can cause also economic troubles in the long term.

On that ground, it is very important to consider carefully every single intention of building-up of a larger energetic biomass source. Investments, operating cost and environmental impacts are inseparable part of every intention.

Energetic crop-plants

In addition, the costs of particular energetic crop-plants and their transformation processes in the place of the production were investigated within the fieldworks[2]. There are some basic economic parameters and cost prices in the following tables.

Annnual direct and indirect costs for energetic crop-plants production per 1 hectare (with transportation to the pelettizing unit).

Crop-plant	Annual costs per ha (direct and indirect)*	Peletizing costs - 60 % dry matter
sorrel (uteuša)	364 – 436 €	55 € cost of fuel for finishing drying + other costs
feterite	545 – 582 €	
maize	618 – 655 €	

*Costs included feu duty, land cleaning, nutrient reserve and others.

Picture 7 – Feterite field, Farmers' Cooperation of Owners, Fryšták

The numbers show the differences in the economy of the production of particular plants for energetic purposes. Asside from the costs for the crops production and their transformation into pellets, other extra costs or looses can occure during the whole process and can influence the economy. The next table shows calculations of cost price for 1 ton of pellets (in a given company) and the weights of pellets as final products per one hectare of the one-crop production.

[2] Farmers' Cooperation of Owners, Fryšták is not a part of the Hranicko region but belongs to its neighbourhood (45 km distance). Information from Mr. Jiří Moravec, Farmers' Cooperation of Owners, Fryšták.

The humidity of bio-pellets makes max. 15 %, standard humidity makes 12 %.

Average production based on the regional conditions (according to the experience).

Crop-plant	Weight of pellets as final product / 1 ha production	Cost price per 1 ton of pellets production[3]
sorrel (uteuša)	6 tons	76 €
feterite	10 tons	62 €
maize[4]	14-15 tons	48 €

As mentioned above, we want to reach for the reasonable use of postharvest residues from traditional agricultural production for energetic use. The classical field chopper with the special adaptor that is gathering the matter form rows harvests them.

Crop-plant	Weight of postharvest residues (average) per 1 ha
Rape	4 tons
soya	up to 2 tons
sunflower	3 tons
old grass	4 tons
corn sraw	6 tons

In case of postharvest residues, the experience shows many problems. Here are some of them:

- gather the postharvest residues in time (if they stay longer on the field, they come out and it lowers the production);
- troubles with the variable humidity – to harvest quickly, sometimes it is extremely dry;
- final drying on the field in case of wetting, further operations, land contamination – rising share of ash;
- the production depends on the amount of dry harvested material;
- disposal of fertilisers (rape and soya straw have very positive carbon balance, soil richness is increasing in contrast to the corn straw);
- longer traversing (turn-off) – higher costs for harvesting;
- in case of unfavourable weather there is a delay with work (increased drying of the land and so on).

In case of favourable weather and ample time for gathering, the costs of pelletizing are getting lower (lower, or sometimes zero final drying costs).

[3] Considering the avarage cost value according to the previous table.

[4] Crossbreeds intended for seed production. In case of crossbreeds for solid-state growth of bio-gass production it is possible to gain up to 20 t of production per one hectare.

Forest biomass

Forests are also the important source of biomass. The principal elements in the view of customer – consumer are the cost of the fuel, its time and territory availability in the place of consumption. The market with solid bio-fuels in the Czech Republic is in the stage of its progress. Present price levels of chosen commodities are mentioned below. (Information about prices comes form the national gateway www. www.tzb-info.cz.)

Pellets are one of the most perspective forms of all fuels. **The prices of chosen providers within the Czech Republic and other data are in the table below.**

Supplier	Average (mm)	Package - pellets	Price level per 1 ton incl. VAT 19%, year 2005	Summer price per 1 ton incl. VAT 19 %
Verner EcoStar s.r.o. Zbytiny, Prachatice region	6,8	65 × 15 kg PE bags pallet (that means 975 kg) Big Bag (1 000 up to 1 200 kg)	138,5 € 132,6 €	129,7 € 121,2 €
BIOTHERM s.r.o. České Budějovice	6	60 × 15 kg PE bags pallet (that means 900 kg) Big Bag – 1 200 kg	158,5 € 134,4 €	158,4 € 134,4 €
Jesenická Biopaliva, spol. s r. o. Zlaté Hory	6,8	67 × 15 kg PE bags pallet (that means 1 005 kg) (price incl. VAT and one-way pallet) Big Bag 1 000 kg (price incl. VAT and one-way pallet, deposit for Big Bag - 300,- CZK)	138,2 € 125,5 €	133,7 € 120,4 €

Wood-chips are the other impotant and widely used form of biomass. Its quality can vary in accordance with the kind of wood, admixtures (rind and others) but also with the humidity. The next table shows the list of the five basic price levels according to the kind of wood-chips.

Energetic wood-chips (chipped waste)

Humidity	Price per ton, year 2005	Note
40 % - wet	51,7 €	into kettles, where the combustion runs by the so called gradual burning
up to 20 % - dry	93 €	into kettles, so called pyrolysis

White wood-chips (white wood)

Price in 2005, CZK (stacked cubic meter - scm)	Note
18 – 29 €	especially for industrial use – wood-pulp

Approximate **prices of other fuels (wood-based)**

Kind	Price in 2005, CZK	Units
briqutes	91 – 145,50	€/t
rough wood	37	€/m^3
saw-dust	4,40	€/scm
baled brushwood	2,20	€/bale

Last year there was an essential price increase especially of pellets and wood-chips. Other wood for combustion was affected only by slighter price increase.

3.3 Environmental Impacts

Environmental aspects of production and consumption of energetic biomass differs from regional conditions and the structure of production and consumption (travel distances, kind of biomass, technology used ...)

General environmental impacts of biomass use

	Environmental Impacts
Substitution of fosil fuels	Polutants reduction (emissions and immisions)
CO_2 reduction	Greenhouse effect reduction
Diverzification of energetic sources	Landscape exploitation but also its maintainance
Decentralization of fuel sources	Traffic intensity reduction

Short rotation forestry fields (SRF) can not only fulfil the production function (the function of biomass for energatic use) but also a wide range of other functions. In the table there is a brief list of other functions of SRF.

Function	Example
biological	- biocorridors and forest communities - production of O_2 and absorbtion of CO_2 - increase of biodiverzity - shelter and feed sources for animals ...
ameliorative	- windbreak (protection from wind erosion) - protection from soil erosion - increase of storage capacity of the land - improvement of the land quality - biological improvement of wetlands (melioration) ...

insulating	- separation of areas of different use - dustiness and noisiness reduction - protective root layer at water sources - windy flows fragmentations ...
sanitational	- river-banks protection - vegetation settings of saving areas - dry-lands use - air moisture increase - rainwater filtering ...
cultural	- green items in the landscape (at line building structures)
aesthetic	- aesthetical improvements of the area - landscape segmentation - line borders in the landscape - surrounding of municipalities or ponds ...
instructional	- for instructional, promotion or research purpouses ...
non-energetic production	- wood production for packing material - beekeeping

The SRF cultivations can also be used in the areas that are economically unfavourable or difficult to be cultured. There are also positive impacts of employment in the regions.

Regarding the environmental aspects it **also is improtant to refer to the adverse effects of intensive use of energetic biomass form fields**. After repeated gathering of the whole plants or residues, the soil starts to have the lack of nutrients and the land quality is decreasing. Then the land is less productive. That is why we need to find the balance between the energetic use of the residues and its staying on fields. Opinions are usually different. We need to wait what will the experience show.

Picture 8 – The example of heat production - the combustion of waste corn in the farm.

4. Conclusion

Having all outputs of the analysis, there are some obvious expert findings for the Hranicko region. It is necessary to develop the questions regarding the energetic use of biomass in the following points of view:

- production
- transformation
- consumption.

The important outputs of the sub-project are:

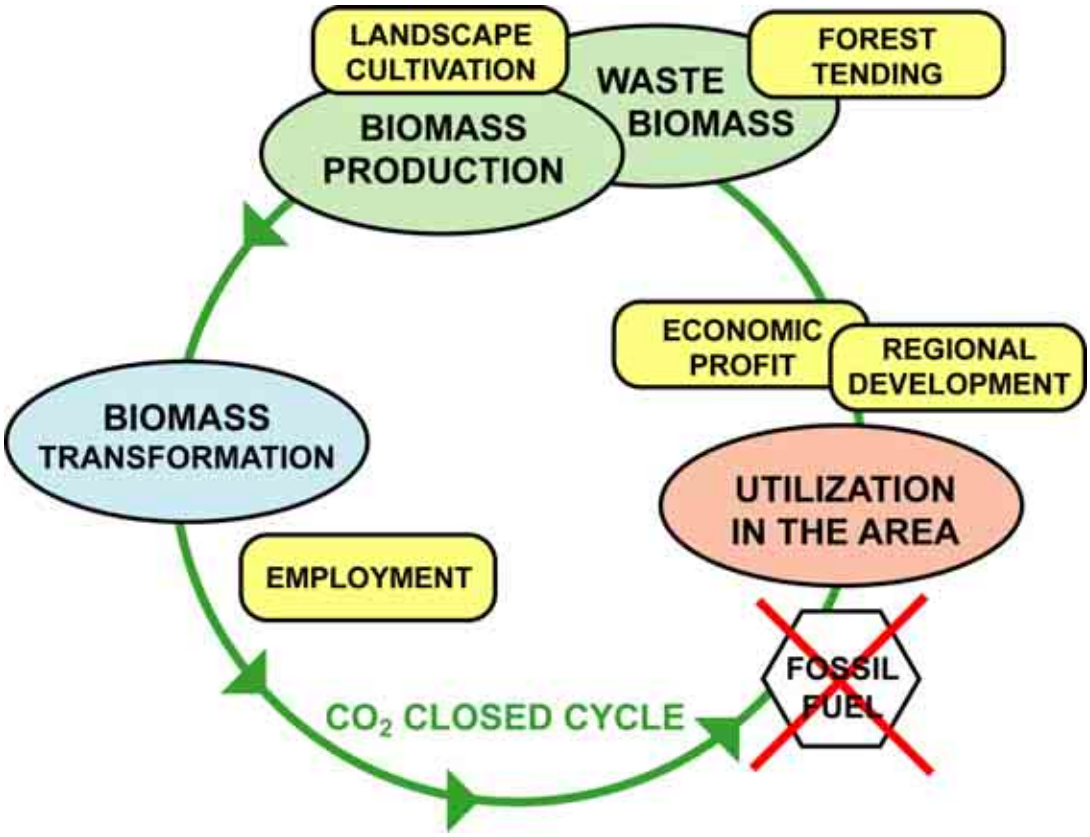
- the present level of biomass use in the region
- mapping the economic availability of the production potential of different types and power-outputs
- mapping the economic availability of the consumption potential of different types and power-outputs

We need to concentrate on the economic efficient use of waste biomass that is available at all levels and in all sectors. Then the next steps can be directed towards the foundation and development of the agroenergy production based on herbs. In addition, the consumer sector will be developed and supported along with the limitation of fuel sources in the region and export reduction.

In relation to the conditions of the Czech Republic (and the Hranicko region as well) there are some marked **limitations in use of the agroenergetic production** that the experience show. The limitations are:

- high investments in technology and transformation processes (field maintenance, storage areas, pelletization units …)
- level of costs
- farming businesses don´t feel the restrictions in the field of food production yet
- high dependence on the weather, worse climatic conditions
- worse grants disposal and its administrative difficulty
- low level of the will to restructure the silvicultural plans
- distrust of supplier – consumer relations in a long-term
- others

Farmers in our region meet all the above-mentioned troubles in their everyday life. The process of the slow increase of the energetic biomass use, its production and transformation are one of the most important goals of the BRIE sub-projet in the Czech Republic.



Picture 9 – Scheme of the biomass cycle: production -transformation-consumption.

Advantages of the energetic use of biomass:

- biomass is a renewable source of energy with the neutral CO_2 balance (at growing and at combustion)
- it is a regional renewable source
- it can be relatively easily stored
- there is an idle capacity in the Czech Republic (can differ region by region)
- we are albe to use the waste material
- high level of competition among producers of combustion technologies or of other devices using biomass in the Czech Rebublic but also abroad
- certain level of the versality of biomass use (as a central, local or seasonal source) – technologies for biomass combustion are available, commonly used technologies are affordably priced
- unmanned technologies are available and in common use, the servicing comfort is increasing (automatic kettles with fuel bunkers)
- conceptual bioenergetic systems can generate and sustain the employment rate
- possibility of fuel preparation (pelletizing, wood-chipping) for automatic and controllable kettles
- grants possibilities (fossil fuels substitution)
- others

Disdvantages of the energetic use of biomass:

- possible excess of demand of biomass for energetic use (than the supply level is)

- additional energy need at the transformation process (pellets, wood-chips)
- transport costs
- higher labour inputs, storage areas availibility, higher dustiness
- the combustion process generates pollutants (airborne dust above all)
- the market of biofuels is still developing and is not as stable as e.g. abroad markets
- others

The perspectives in the Hranicko region:

- possibility of the energetic use of biomass (all sources)
- initiation of agroenergetic production (herbs, SRF – regarding the particular areas and results of our fieldwork)
- review of particular instalations of the energetic sources using biomass (in given municipalities)

The **detailed elaboration of the analysis** of the region regarding the production capability, economic efficiency, sustainable development, environmental improvement, employment rate but also the other aspects of development is the primary presumtion of the further efficient work in the Hranicko region. Together with all that we have to review the possibilities and needs of the biomass for energetic use in the region and aslo in all related sectors.