

MENDEL UNIVERSITY IN BRNO

Faculty of Regional Development and International
Studies

**Biogas Plant as a Source of Energy for
Village Nové Bránice**

Bachelor Thesis

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In Brno, 18th May, 2016:

I would like to thank to supervisor of my bachelor thesis, Ing. Alice Kozumplíková Ph.D., for mentoring and scientific advices, for helpful comments and support in the most complicated parts of my thesis.

I would like to also thank to the municipality authority of Nové Bránice, to all citizens for helping me to find out important information that created a base for my bachelor thesis.

Annotation

SCHOŘOVÁ, H. A Biogas Plant as a Source of Energy for Village Nové Bránice, Bachelor thesis. Brno: FRDIS in Brno, 2016.

The main aim of the thesis is to get enough information about renewable energy resources for potential construction of biogas plant in the municipality Nové Bránice. The task is to find out if agricultural producers are able to offer enough amount of material for duration of one year that are comparable with existing project that has similar conditions as Nové Bránice. To obtain information from local producers of biodegradable waste for biogas plants I chose the method of interview with producers and local authorities. I analysed the informations and then I evaluated all the discovered facts. I found that the mayor disagreed with the potential construction of biogas plant. I also found out that there are materials to be processed in biogas plant but the amount of them is not sufficient for one entire year of processing and generate energy.

Key words

Biomass, natural renewable recourses, energy self-sufficiency, biogas plant

Anotace

SCHOŘOVÁ, H. *Bioplynová stanice jako zdroj energie pro vesnici Nové Bránice*, Bakalářská práce. Brno: FRRMS v Brně, 2016.

Hlavním cílem této bakalářské práce je získat dostatek informací o zdrojích obnovitelné energie pro potenciální stavbu bioplynové stanice ve vesnici Nové Bránice. Cílem je zjistit, jestli jsou tyto zdroje, které Nové Bránice nabízí dostatečné natolik, aby poháněly bioplynovou stanicí po celý rok. Ke správnému porovnání dat je nutné použít reálný projekt, který má stejné podmínky jako vesnice Nové Bránice. Pro získání informací od lokálních producentů biologicky rozložitelného odpadu pro bioplynovou stanicí byla zvolena metoda rozhovoru se všemi producenty i lokálním úřadem. Byla provedena analýza informací a poté vyhodnocení všech zjištěných faktů. Bylo také zjištěno, že pan starosta by s vybudováním bioplynové stanice nesouhlasil. Zdroje, které jsou použitelné pro proces tvoření energie v bioplynové stanici, jsou ve vesnici dostupné, ale není jich dostatek na to, aby udržely v chodu celou stanicí po jeden celý rok (každý rok).

Klíčová slova

Biomasa, přírodní obnovitelné zdroje, energetická soběstačnost, bioplynová stanice

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1. Introduction and a goal of the work

This part contains of introduction to the theme and goals of the work. I introduce facts that had impact on development of idea to use other ways of natural recourses. As a second main thing I set the goals of the work that I want to discover.

1.1.Introduction

Energy is a world widely spread power that is necessary for living in modern civilization. During many years energy has started to be created for exact purposes and also people have started to extract variety of natural recourses. They have found out the unpleasant fact about depletion of recourses. Renewable natural resources can be a solution of lack of natural recourses. At the beginning it was hard to get enough of natural material but people found many ways of how to get them and reuse them many times again. Costs of obtained power that is produced by big companies supplying energy on international level are quite high. Utilization of resources results in higher and higher prices for them. Some people want to use other possible energy that would be ecological friendly and would be renewable. An idea of self-sufficient village came from local small areas of citizens who discovered that they can further use the rests of their agricultural production. There were developed techniques of getting biomass but a financial availability was inconceivable for normal people (citizens of villages). International organization in Europe, as the EU (European Union), commenced activity of supporting of those villages but in exact state there were no directions how to act in this situation so far. Then there were developed local organizations caring about subsidies for example for biomass processing purposes.

At the present we can find many areas that are powered by biomass energy and that are self-sufficient in way of energy or electricity. They use variety of biomass according to their target production or availability in area. A crucial thing for every village that want to use biomass for energy is amount of used resources to be able to continuously supply material to biomass station located in village.

1.2.Goal of the work

The main goal of my work is to find out if the village Nové Bránice has some amount of biomass to be processed and if it is able to produce enough of mentioned

material to theoretically built biomass station. I would like to know how many potential producers of biological degradable material are situated in village and what amount of theoretically useable bio material are able to supply for biomass processing. Results I will compare with other already existing project with similar conditions. I will also ask major of chosen village on his opinion of construction of biomass station in the area of the village.

2. Literature research

In this part I focus on recourses of energy, recourses of biomass and its further processing in biogas plant. I also give examples of places in the world that have implemented some project based on energy self-sufficiency with usage of biomass.

2.1. Energy self-sufficiency and sources

We can distinguish among many sources of energy that are used on the Earth. People have found lot of possible ways how to get power needed, nowadays almost in every average life. But during of processing and developing of new technologies nobody cared that the techniques could have bad impact on a nature. It was known that some of the energy is renewable and some not. These facts lead to finding more new possibilities how to get energy for population.

In the other hand there is also economical aspect that make people thing about finding some cheaper way of energy and also more ecological friendly.

To introduce all energy sources we should mention [1]:

- Solar energy
- Wind energy
- Geothermal energy
- Hydrogen energy
- Tidal energy
- Wave energy
- Hydroelectric energy
- Biomass energy
- Nuclear power
- Fossil fuels

A crucial thing about mentioned sources is that not each of them is available for everyone. Significant factors of building or application of technical equipment arranging exact type of energy are location of supplied area, environmental conditions, material or recourses of energy, limits of law, etc.

If we want to choose one of the energy source that is almost everywhere around people and it is ecological friendly and renewable, we definitely should point

out biomass. The biomass is used as a power able to support entire areas of households and enable them sufficiency from energetic point of view. In many ways also economical results if a production overheads and rest of energy could be produced further out of targeted production area boundaries.

2.2. Biomass and its utilization

The biomass is now one of the most important resources of energy. It came to fore due to energy problems with fossil fuels. There have been many solutions of an energy crisis that started in year 1973-1974. The fact of possible energetic crisis and increasing prices of energy usage for households in a future leads to find a new available sources of energy.

As alternatives for creation of the energy a solar energy, wind, photovoltaic and ocean power system were taken. But it is proved that the energy from biomass is available in wild range of raw carbon resources the most. Natural chosen promising way how to get the energy to sustain keeping of technology and people's welfare was to use biomass. The energy from biomass needs to be produced in special technical equipment which is expensive and took lot of time to be built, but it could be very helpful to get energy to produce heat and electricity for future [2]. At the current world there are simply found a few places where the bio energy is used. Those places became synchronized system for energy creation.

What is biomass? The biomass is accumulated solar energy affecting cells in plants with help of carbon dioxide and water. To get 0, 78 kWh of heat is necessary to combust glucose in inside of closed system without water condensation temperature. A content of biomass is cellulose (40-50%), hemi-cellulose (20-30 %), lignin (20-30 %) and smaller pieces of elements [3].

There has been distinguished types of biomass division connected with processing or some types of usage. One of the basic division is on a waste biomass or targeted produced biogas. Waste biomass is understood as a rests of some productions that were not given to be used further for other purposes. It contains rests or secondary product from maintenance of green lands, organic matters from municipal waste and sediments from waste-water purifier. And rests from industry wastes (wood processing, paper production, food industry, textile industry) or from

agriculture and animal breeding [4].

The biomass can be also divided to three categories due to its processing and further usage. Mainly we talk about chemical processing where are used pyrolysis and gasification if the final product is oil, gas or tar. The process called an esterification creates biodiesel. The second treatment is combustion that brings heat or electricity. Combustion techniques are divided to three methods where final product are heat and power:

- 1) Grate-firing (GF) -biomass is combusted with an air in boiler during its moving through it (150MWth/50MWe)
- 2) Fluidized bed (FB) -biomass is mixed with medium and combusted in bed with low temperature that enables gasification of part of processed material (from 30-300MWe)
- 3) Pulverized fuel (PF) -the most effective concerning to power, material is almost made to powder that is simply combusted but during the combustion is used high amount of energy (up to 600MWe)

The most widespread techniques from biomass processing is the first one Grate-firing. It enables to combust almost all sizes of material. If we talk about emissions and its reduction we should point out the second type-Fluidized beds. This method is newer one and brings a new possibilities how to combust wet and coarse material due to mixing with other material (sand, etc.). Fluidized beds method is not focused on large-scale combustion. In the other hand there is a method called Pulverized fuel dealing with dry powder material but a problem is that high temperature of combustion causes damages on the technical equipment. Therefore the final product is mixed with coals for further co-firing [5].

The last one is a biological processing where an anaerobic fermentation to methane occurs as a main product or alcoholic fermenting by which is bio-ethanol created [4].

World energy use in current situation is about 450 EJ (for one person) for average standards of living. This situation can change increasingly to 1000 EJ. People use fossil fuels to create energy for usage. But these types of energy resources are non-renewable. It means that after we as the users of energy exhaust all these mentioned ways there will be nothing to use at all. In this case we consider getting some other possible way of energy creation. The resource is biomass. At the present

there are only few of areas that would care about biomass energy production. We still use fossil fuels energy by 80% and the biomass energy occurs about 10% for whole world. The other aspect that adds us statement to use renewable and organic material (resources) is an environment. The environmental aspect brings us view to see importance of amount of CO₂ in the atmosphere. An effect of high amount of CO₂ is devastating. We try to capture the energy from sun, water and wind. In addition to these we process biomass to create biogas in biogas stations to create bio-energy [6]

The biomass is an organic matter from vegetation production that is able to create alternative energy for further use. The matters can be produce as main product for energy creation or it can be a subsidiary material in agricultural production. Its production is world-widely spread. As for EU countries a production of renewable sources is ten times bigger than production of classical non-renewable sources. Despite of these facts there is used only 5% of bio-energy as for EU [7].

There are some limitations connected with usage of biomass for energy purposes (disadvantages):

- a targeted production of biomass can face problems connected with other use of biomass (food industry, fodder, etc.)
- a need of more production land to fulfill the necessary amount for next processing that brings other requirements. These facts increase a capital issue.
- a price of renewable energy can hardly be an advance to use. The energy that we get from non -renewable resources is still one of the cheaper. It depends on government directions in future.
- to find a place with adequate conditions for energy transformation and its capital

The advantages of use of biomass for creation energy [7]:

- an environment and improvement of negative impacts on it
- a renewable character of energy
- the resources of bio-energy are not limited by location
- creation of new landscape by rebuilding due to biomass production or processing
- an reduction of storage spaces for rests of biomass

- an domestic (inter-state) source of energy that brings some advantages for economy of state (payment balance, diversification of regional businesses, use of agricultural land that are not use in other way, etc.)
- decentralization of energy sources

2.3.Raw materials relevant for potential biogas plant processing

A biomass yield of crops from *agricultural residues* (according to season and variety) - part of it is used as a fodder for cattle, other part is used as a fuel and the rest is returned back to fields as nutrition. The biomass yields from *forest* that means *wood production*. A possible source how to get the biomass is also cattle. The *livestock* produce dung which is used for production of energy, too. In this case we do not include information about it, because it is not necessary for this thesis [8].

2.3.1. Agricultural production

Agricultural production is one of the way how to get bioenergy. The agricultural crops are mainly used for feeding purposes and crop residues are used for processing in biogas stations. The agricultural production can produce energy to next production in farm. Farmers can easy get energy from their rest of crops that are not use for other processing. It means the products except for main products they want to produce are utilized as an energy creator in biogas stations. Apart from this way, farmer can use digestate from biogas station for fertilizing fields which is the most health way how to get good harvest without chemicals [6].

Wine grapes are most common producer of rest that is not used in other way. This type of waste form agriculture occurs in vineyards areas. Normally the rests are produced during squeezing period when is wine processed and prepared for the fermentation for further transformation. The rest of grape small balls are the right matter that should be used in biogas stations. Lot of farmers and owners of vineyards dispose these rests back to the fields or have it done by some company that treat it by other ways.

2.3.2. Residues from wood processing

The material including a rest of a wood and mill residues. The residues from wood are the most important energy source to be processed in biogas stations. It

depends on sources the exact area has. For example if there is enough wood to get results for biogas processing or if the area, where biogas plant is built is able to give exact amount of rest. The amount of residues and also amount of energy (heat, electricity) depend on length of area and the number of citizens (eventual consumers). As was mentioned there are used mill residues consisting of shavings, bark, slabs, cut-off blocks, plywood trim, saw- and sander dust. These can be a targeted products of forests or secondary products not used by other way. In forest are recognized as a tops, limbs, thinnings, orchard removals and cull trees on the forest land [9].

An energy value of the dry wood with amount about 1 ton is able to create 19 GJ/t. If the wood is wet the energy value should decrease to 15 GJ/t. From non-renewable sources point of view coals make about 26 GJ/t or if we have a look on fuel oil, it is about 45 GJ/t. It is obvious that there are still advantages of using of these types of energy sources, but the same way we can find positive aspects in renewable sources field [10].

2.3.3. Households as producers of waste

The waste from citizens living in the area where biogas station is. An important part of local waste management that is ecological, sustainable and also brings advantages and profitability. Concerning to households, there should be some criteria of waste that can be used in processing of biomass. Products which can be really used in process of energy creation are organic food. Sewage is not included. It is production that is compostable. Additionally, it could be matters from gardening (residues of vegetable, fruit, leaves, etc.). These are connected with citizen's knowledge about waste to find out what can be exactly deposited to this type of waste.

The same way is treated with goods in shops that have not been sold and the expiration date has already run out.

2.4. Technical processing of the raw material

The biomass, as it was mentioned before, contains of wood materials, crops and other agricultural products that creates 14% of entire energy demand in the world. It means that biomass energy is the fourth of energy sources in the world. By the 1/3 fewer of carbon dioxide and carbon sulphur dioxide are produced via the processing of biomass. The amount of produced carbon dioxide and sulphur dioxide during the

combustion is more acceptable for environment, because green plants are able to process the exact value by photosynthesis [10]

Technical equipment for biofuels combustion:

- a machinery for harvesting, production, processing, for desiccation and storage
- a machinery for fuels adding, burnt oxygen and power regulation delivering
- an equipment for burnt rests cleaning and for manipulation with dust
- a final equipment for distribution of heat, production of heat and measurement [10]

2.5. Biogas

This substance is mixture of methane (CH_4) and carbon dioxide (CO_2). Biogas is product which is got from anaerobic digestion of bio material (biomass) [11].

A formation of biogas is caused by fitting groups of microorganisms that have effect on rests of organic matters. It should be done in anaerobic surroundings. The combustion occurs when the organic matter consists of enough dry materials. If the material is more wet, a value of water constituent is high, should be processed in biogas processing. In this process is used its own flammable substance of waste organic matters placed in combustion place [10].

2.6. Biogas plant in The Czech Republic

Our state, due to environmental goals and its protection, supports construction of technical equipment for biogas production in connection with investment from Environmental State Fond for 20 years. The result was a big development of biogas technologies and from 2003 was built about 487 biogas stations [4].

At the present the situation tend to be bad conditioned for whom with idea to set own biogas production. The 2014 stated that no levy will be given for these purposes [4].

2.7. Countries with energy self-sufficient villages powered by biogas plant

We can find self-sufficient villages around the world. I chose some of them to show examples of how the energy self-sufficiency could work in real projects implemented on villages.

2.7.1. Germany

Feldheim

If we talk about energy and creation of energy by own sources of exact village, there is one important place that should be mentioned. Feldheim is a small village located southern from Berlin. Amount of citizens is about 200 people. A main aim was to create self-sufficient community of households that could produce energy from alternative sources gotten from nature. It started in 1995 only by wind farm that produced about 175 million kilowatt hours per year. All of this electricity is not entirely used by local households. They use only 1% of it (a rest is sold back to grid). The wind farm was only beginning. They started to create energy from the sun and of course from biomass, the most important recourse in this case. They started to produce more manure and crowd silages that are used to produce heat [12].

At the present, the village take all possible advantages of natural sources to by processed (close forest –timber, bio-wastes of households, etc.). Cost of this project was partly financed by government (2 million euros= a cost of entire plant) [12].

2.7.2. Austria

Güssing

This small town in Austria is significant for its ability to be self-sufficient in energy issue. There is about 4 000 population that can be supported by its own energy that is created in town. Their production is not focused only on heat but they are able to create power for use [13].

Historical events led to luck of sources to pay all costs connected with energy usage and electricity of citizens. An idea of energy production came from poor and unemployed people living in Güssing. They were not able to pay for energy coming from other central sources, they firstly implement energy saving for all town by 50% [14].

They found out a possibility to use renewable recourses around the town. They could not use wind as a power due to there is not windy. Entire town is surrounded by forests belonging to town's property, they decided to use this type of material to produce heat. At the beginning they implemented only one district heating for 6 houses. Results were significantly positive, that is why other heating districts were built for more houses in the town. An expansion could happen because they have

enough hectares of forest supporting using of heat energy of population. There were about 133 hectares of usable raw materials from forestry practices. Later they got some subsidies from federal government to build gasification plant that would use thinned wood chips to produce hydrogen and carbon that is separate by steam. This procedure makes natural biogas propelling power plant for entire city [14].

A main aim of entire technical implementation is to process biomass to gas and to combustion. The gas engine is a final product of gasification zone where is fluidized by steam generated from heat appeared during entire process in combustion zone. The combustion zone is all influenced by air working. A gas engine and a rest is combustion as a final product [13].

Güssing was one of the first town where was biogas station plant and became a model for all other villages and cities interested in usage of biomass as a power [14].

2.7.3. The Netherlands

This country is well known for its interest in ecology which including biomass and, of course, bio energy production. There is no exact place (village) where would be bio station only for a few hundred citizens were established. In this case we talk about huge project on regional level.

Entire idea of bioenergy was applied on bigger areas of regions. Typical implementation are companies caring about production and that ensure delivering of energy or electricity from central production place to other areas of households (for example: ECN, etc) [15].

In 1995 The Netherlands set white paper about energy policy where is set to use renewable sources as a source of energy by 10% of all energy production of the state. This fact has duration to 2020 and still it is supplemented by Ministry of Economic Affairs. A density of Netherlands population is high but on the other hand the biomass waste streams, residues and dedicated crops that are proceed do not reach high value. They tend to increase amount by cultivation [16].

2.7.4. Denmark

To introduce all major European countries standing in the forefront of renewable energy movement lets mention Denmark. It is also one of the big producer of energy by using bioenergy. At the beginning CO₂ emissions were high amount and that was one of the main factor leading to change connected with biomass utility[17].

At the present Denmark still increasing production energy by biomass from

1989 to 2009 and the utility is almost fourfold. They mostly use sort of straw, wood and renewable wastes that create 70% of all renewable recourses specified to by procced [17].

The situation in Denmark is really positive in connection with plants for processing manure. There are about 35 farms creating supply of manure (3% of overall manure production in Denmark) which is good reused in biogas processing. These farms are part of system producing from biomass together with cooperation with 20 community plants (biogas plants). They are able to produce 2, 6 PJ (Petajoule, 1PJ = 1 000 000 000 000 J) a year. A first plant in Denmark was established in 1984 in Vester Hjermitsev with help of new implemented project 'Village Energy Project'. The plant processed only liquid and also solid manure. It has been built many more plants that are source of energy and electricity for almost entire area of Denmark. The main aim is to be 100% addicted only on renewable resources, they keep sustainable by implementing new regulations and offering better prices for citizens (households) [18].

2.7.5. The Czech Republic

Kněžice

It is one of the energy self-sufficient beginning village in the Czech Republic. They started to produce heat and electricity from biomass. The village has about 400 people using this way of getting energy to their houses. They began with central heating and biogas station in 2006. They have used rests of grains, straw, legumes, corn and other crops. Later, they started to produce exact biomass for processing in biogas station. Final products are biogas, electricity, hot water heating for most municipalities, fuel pellets from biomass and quality fertilizer for agriculture. The agriculture fertilizer that is eco-friendly and in most cases it improves quality of soil. It helps to local farmers not to use only chemicals for fertilizing but use natural sources of minerals supporting fertility of agricultural lands. Technical parameters of biogas plant are: electricity output of bio station is about 300kW and its heat production is about 1200 kW [19].

Citizens consume 2 000 MWh per year that the biogas plant is able to supply. All power goes directly to 149 households (95%). Entire production produced is reused by 15% back in production of this power. The village has many prizes for its ability to support it-self in energy production. For example the European Energy

Award in 2007 or a Prize of Health in 2009 and the most latest prize A Village of Year of Central Bohemia 2014 [19].

3. Methodology

In the first part of the work I gather information from different sources to get enough information to be familiar with targeted theme. I also generally talk about all ways of renewable recourses of energy. I include only important information directly applicable to village issue.

The second part focuses on a practical part of work. I use description of area of Nové Bránice where theoretically biogas plant could be situated. I describe socio-economic situation, natural condition of area and I includes structure of land recourses. I apply analyses of information based on interviews mainly. I interview 5 persons that are connected with production of useful material (for processing in biogas plant). All interviews are face-to-face interviews. I basically use information from municipality authority that leads me to other steps and other interviews.

Questions for assistant of major of Nové Bránice:

“How many of agricultural producers produce in area of Nové Bránice?”

“What structure of land is in Nové Bránice? “

“How the structure of land is used (for what purpose)?”

“What type of waste is produced by citizens of Nové Bránice?”

“In which amounts is the waste produced by people in last year?”

“Is here in Nové Bránice any place where could be biological degradable waste gathered?”

“Where is the biological degradable waste transported?”

Questions for owners of agricultural companies producing in area of Nové Bránice:

“What size is your agricultural land where you produce crop?”

“What kind of crop do you produce?”

“How much of by-product (rests) do you produce in one year?”

“What do you do with these rests of crop that are not used other way?”

Questions for owner of a local grocery:

“Do you have any rests of goods that past their sell-by date?”

“What kind and what amount are these rests of goods?”

“How do you treat with them?”

At the end of interviews I return to local municipal authority to ask major about his opinion on potential biogas plant in village.

Questions for major of Nové Bránice:

“Are you familiar with biogas plant and its function?”

“Do you think that Nové Bránice is able to offer enough biological degradable material that would power potential local biogas plant?”

“Would you be interested in construction of biogas plant in area of Nové Bránice if it would be possible?”

As the last method is synthesis that gives me opportunity to take all learnt information, make tables and get exact numbers that are presented to specialists in energetic. By this step I find if the village is able to offer enough biological degradable material to keep potential biogas plant active.

4. Description of chosen area

I deal with localization of village and also I describe structure of land and characteristics of the village. I mention natural resources that are available in the area of Nové Bránice.

4.1. Localization of the village

Nové Bránice is a small Czech village located in the south of Moravia, about 30 km from Brno. A cadastral area is 621 ha [20]. There are about 725 citizens and the number still increasing. Lots of people from bigger cities or towns move to the village to be more close to the nature. We can talk also about its advantageous location because it takes a few minute to get to Brno. A map of municipality Nové Bránice with marked red lines in the figure (Fig.1).



Figure 1 Map of Nové Bránice (Source: www.google.cz/maps/)

4.2. Socio-economical structure

The most of people living there work in agriculture sector or have their own small production of food or raw materials for their consumption. A budget of village is not so high because of building and reconstruction of paths and roads after sewerage system was created. That means that the rate of indebtedness is higher but they can deal with it. At the current situation Nové Bránice tries to more save money not to invest to some new incredible projects. A financial help comes from citizens that own agricultural company ZOŠI Agro s.r.o. and ZOŠI Trans s.r.o. Also people

working in some other companies try to somehow improve a village quality.

It is visible that village cares about environment and applies waste separation on a local level. According the idea there are dustbins for various materials (glass, paper, plastic and for biomass-compost, second hand clothes). There is a cooperation with companies caring about waste where is included also bio waste.

4.3.Natural conditions

Nové Bránice is situated near the river Jihlava and lies in the middle of higher lands. Surrounding create fields, vineyards or forests (not its ownership) (see Fig.1)

Ownership of forest, fields or other lands is in a low level. Nové Bránice has some parts of edge forest. Almost all land except built-up areas are in a rent of local agricultural companies.

4.4.Structure of land recourses

As you can see the table below shows coefficient of ecological stability of village 0, 53 %. This indicator tells us how the village is changed from natural status and how much was change by human activity. In this case the situation (Tab.1) of changes is somewhere in the middle of entirely changed and not changed [20].

Table 1. Structure of land resources in Nové Bránice

Total size of area (ha)	623
Arable land (ha)	362
Hop garden (ha)	0
Vineyards (ha)	16
Gardens (ha)	11
Orchards (ha)	0
Permanent grass cover (ha)	1
Agricultural land (ha)	390
Forest (ha)	187
Body of water (ha)	1
Built-up land (ha)	11
Coefficient of ecological stability (%)	0,53

Source: data of the municipality

5. Practical part

At the beginning of my practical I name potential sources of biomass available in the area of Nové Bránice. I concentrate on all producers of biomass in the municipality and I interview them by questions that I introduced before. I analyze all gathered data from answers. I compare them with requirements of potential biogas plant to know if the resources are sufficient to support biogas plant's existence. Then I describe biogas plants according to their size and performance to get an idea about exact amount of biomass that should be produced to keep potential biogas plant functional. Finally, I give some recommendation to the municipality about further possible steps.

5.1. Analyses of potential sources of biomass for Nové Bránice

We can sort some of sources of biomass that are available in this village. Mainly we should mention rest of agricultural production, waste from households, rests of food from products that were not sold in local shop. Also a land covered by forest.

Households- Citizens living in area of Nové Bránice produce lot of municipal waste. If the waste would be divided to organic material and non-organic material, the organic one could serves in process of creation of bio power.

Local farmers, companies- In this case there are three small companies in comparison with entire country. However, they are taken as a big in local level: **ZOŠI Agro s.r.o., Regina Coeli, Zemědělská výroba Chrást** (commodity).

Local grocery- Can offer rests of unsold products that are not treated by other way. These goods are used for fermentation and further creates liquid (digestate) used for fertilizing of fields.

Forest area owned by Nové Bránice- There is about 283 284 m² of land that is covered by forest that is in ownership of Nové Bránice. Land is not used as a kind of wood production and mostly is covered only by locust tree. It means there is no processing production for wood.

5.2. Interaction with local producers

The main producers of waste are citizens living in Nové Bránice. They can also

supply bio-waste which some of people here have possibility to throw organic material out to separated bin placed in the village. To see how much of municipal waste and overall waste they produce in one year and how much of bio-waste they produce I compiled this table (Tab.2).

Table 2. Municipal waste in 2015

Year 2015	Amount of materials (tons)
Biological degradable oils	0,02
Paper, cardboard materials	0,88
Plastic materials	4,72
Composite material	0,47
Glass material	8,18
Material contents rests of danger content	0,01
Absorption, filtering, cleaning materials polluted by dangerous materials	0,0033
Solvents	0,17
Vanishes, resins content chemicals	0,44
Mixed communal waste	144,24

Source: data from the local municipality

The table below shows overview of municipal waste with dangerous waste in year 2015. Although, mentioned information is only source of information about ecological behavior of citizens, we can suppose that there could be material of bio-character that was not separated from municipal waste.

To know what amount of biological degradable matters are supplied by citizens I compiled following table (Tab.3):

Table 3. Amounts of biological degradable waste

Months in 2015	Amount of organic material (tons)
July	3,85
August	2,56
September	4,64
October	4,83
November	3,45
December	2,10

Source: data from the local municipality

In the table are displayed values of organic material in tons during four months in 2015. In July 2015 was the first month of application of bio bin in the village. It means that it is new facility for people and we can suppose that some of them do not know what type of matter belongs to this bio bin. I should mention that the village has contract with a firm caring about biological decomposable material and a transport takes it every month to other biogas station.



Figure 1 Bin for biological degradable material
Source: own photo

They are local companies producing agricultural products and that I interviewed. I have found some data about company **ZOŠI Agro s.r.o.** (Tab.4). It is company producing vegetable to supermarkets and also for smaller customers. The owner of the company gave me information about residues that are re-used back to be ploughed. The company owns fields about 400 ha around micro-region Ivančicko.

Table 4. Rests of agricultural production of ZOŠI Agro s.r.o.

Product	Annual amount of residuals (tons)
Potatoes	155- 200
Peppers	250- 300
Cabbage	270- 300

Source: ZOŠI Agro s.r.o.

The production is seasonal and depends on quality of weather so the table below shows us only rough values of rests from production.

The second agricultural producer acting in the village is **Regina Coeli**, wine producer. It is small scale of production, it is type of family company. They own

about 30 ha of wine yards located in Nové Bránice. They use white grapes and blue grapes for processing of wine. A usable material for biogas station would be only blue grapes because white grapes are transported to nearest forest to become a feed of wild animals (personal attitude of the owner). The final amount of rests from processing of grapes is about 30 tons.

The third mentioned producer (**Zemědělská výroba Chrást**) produces commodity (grain) and own machine for liquidation of rests that are re-used back as a fertilizer of production field. No further information was available.

One of the potential supplier would be a local grocery but the residuals (useful in fermentation) are not enough to satisfy needs of potential biomass station. Grocery's owner gave me information that the amount of not utilized goods is really low and any other rests in a year are given to domestic animals of the owner of the shop.

The last eventual resource of biomass for energy is the residual from forestry production. A problem is that the village itself owns only small part of woody land in the area. This woody plant is about 283 284 m² but it is not undivided forest. Woody area is actually dispersed forest mainly on the boundaries of the village and there is no woody production that would offer some bio material.

Overview of values usable for processing of biomass material to create energy in potential biomass station (Tab.5):

Table 5. Total value of biological degradable waste

Source of material:	Amount in tons:
Biological degradable material from households	21,43
Agricultural residues	705
Total value	726,43

Source: data of the municipality

The final table indicates values of annual supply of potential biomass available in area of Nové Bránice. The number of "Biological degradable material from households" is estimated because we included only half of year 2015.

5.3. Calculation of material sufficiency of potential biogas plant

We should focus on two types of biogas plants according to focusing on municipality recourses that are consider to come from agricultural production and

from households. First, we want to use communal biological degradable waste that was about 21, 43 tons in six months. If we assume that the amount of produced biological degradable waste will be stable we can calculate $21, 43 \times 2$ to get a number of produced tons in one year which is 42,86 tons/year. The second thing is an amount of residues produced by agricultural companies acting in the municipality that are available for biogas processing. The discovered amount was about 705 tons/year. Material is mixed together and we exactly do not know which type of crop it is.

We know that approximately 1 m^3 of biogas comes from 1 kg of organic dry matter from processing of biomass in biogas plant. The 1 ton gives 280 kg of dry matter where is needed methane included the most [21].

- If we calculate it as following:

705×280 , we get 197 400 kg/year.

- If we apply this calculation on mentioned biological degradable waste we get: $42, 86 \times 280 = 12 000, 8 \text{ kg/year}$.

A summation of both outputs are 209 401 kg of dry matter as an input for energy processing in biogas plant. This calculation was only for representation of what amount of biogas is produced in that case.

Generally, 1 kg of dry matter is able to create 0, 38 kJ (kilo joule) of energy. We calculate: $209 401 \text{ kg} \times 0, 38$ and the result is 79 572, 3 kJ. We convert it to the MWh (megawatt per hour) to be able to compare it with mentioned municipality Kněžice (consumption of heat is 2000 MWh), it is: 22, 1 MWh per year. It is visible that municipality Kněžice with 400 of citizens is able to produce more compared to municipality Nové Bránice with approximately 700 of citizens. It is caused by insufficiency of biological decomposable material that the municipality Nové Bránice could offer [21].

5.4.Reaction of major of Nové Bránice on idea of biogas plant

I asked major of the village questions connected with biogas plant. He was familiar with this issue. He told me that he is not into construction of biogas plant station. As a arguments he used: insufficient amounts of recourses, a fact that there are lot of biogas plant in Czech Republic that are also close to Nové Bránice. He mentioned problem with one targeted production only to be a crop for biogas plant and its bad smell that could interrupt normal life of citizens.

6. Recommendation and discussion

It was founded out that ability of village Nové Bránice to produce enough biological decomposable material to satisfy potential biogas plant is on the low level. We proof insufficiency of supply of biological degradable material by comparison of potential output of biogas plant with real output of similar municipality that has already implemented the biogas plant. Entire village does not produce enough biological decomposable waste to be able to power potential biogas plant for entire year in a long-term. The waste that is produced by agricultural producers, citizens and local grocery is in low amounts. The most of agricultural producers already reuse residues in other efficient processes or have contracts with companies that utilize it by other way. On the base of information learnt from major of village, two other biogas plants work close to the village Nové Bránice and they gather biological decomposable waste from all villages close to the place. It means that one village as Nové Bránice is not able to satisfy needs of one biogas plant.

These results lead to think about other project that would connect more villages to construct one biogas plant for their utility. Of course, there would occurs necessity of research on citizens knowledge about sorting of waste. An additional project about biological decomposable bins that would be implemented in every household.

In this case there is no recommendation that would give advices to implement biogas plant because the results are negative and the major of village is not interested in construction of biogas plant in area, anyway.

7. Conclusion

In my bachelor thesis I wanted to find out if the village Nové Bránice is able to produce enough biological degradable waste that would power potential biogas plant in local area. I need to get enough information about the topic through the literature research. On the basis of these informations I was able to decide what is important to know about village to get right data. I found information about renewable resources of energy from local municipality authority and from producers of waste. I also get information about ability of the area to offer enough material for potential biogas plant. I interviewed agricultural producers, owner of local grocery and the major of the village. I also asked the major about opinion of implementation of potential biogas plant in the village and he would not to be for the potential project. I calculated sufficiency of biomass supplied by the village in comparison with other village that has already implement biogas plant. Local producers are able to produce about 726, 43 tons every year. Totally, the municipality was able to produce 22, 1 MWh. According to comparison with the similar project amounts are not sufficient to be able to create energy for village during entire year for a long time. I suggested some possibilities for citizens of Nové Bránice if they would be interested in implementation of biogas plant. The informations I analyzed were negative and a potential of chosen are to produce enough biological degradable waste was insufficient to power potential biogas plant only itself.

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