INVESTMENT MEMO LITHUANIA

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1. Introduction

This report is one output of ABOWE project (Implementing Advanced Concepts for Biological Utilization of Waste) which belongs to EU Baltic Sea Region Programme 2007-2013. ABOWE works with two promising technologies to unlock investments. Two mobile pilot plants have been built and will be tested in several Baltic Sea regions. These pilots are based on a novel biorefinery concept from Finnoflag Oy, Finland, known as Pilot A as well as a German dry fermentation process, known as Pilot B. The pilots form the basis for compilation of Investment Memos and organizing Investor Events. Also a regional model is used to evaluate the new processes' economic and climatic impacts in each region. The desired outcome from ABOWE is implementer/investor driven continuation projects targeting full scale plant investments of the two technologies.

The purpose of ABOWE Work Package 2 is to gather and communicate information from many aspects of technologies which are piloted with Pilot A and Pilot B to support investment decisions for full scale plants. In practice, a demo full scale plant would be needed in order to convince the commercial investors and implementers to full scale plants. This means that ABOWE provides with profound information and a step forward regarding the two technologies. After ABOWE, the technology will need development for full-scale, and the feasibility will need further analysis. An implementer and investor should be found to conduct development further towards full-scale demo plant. The following chart illustrates this idea.

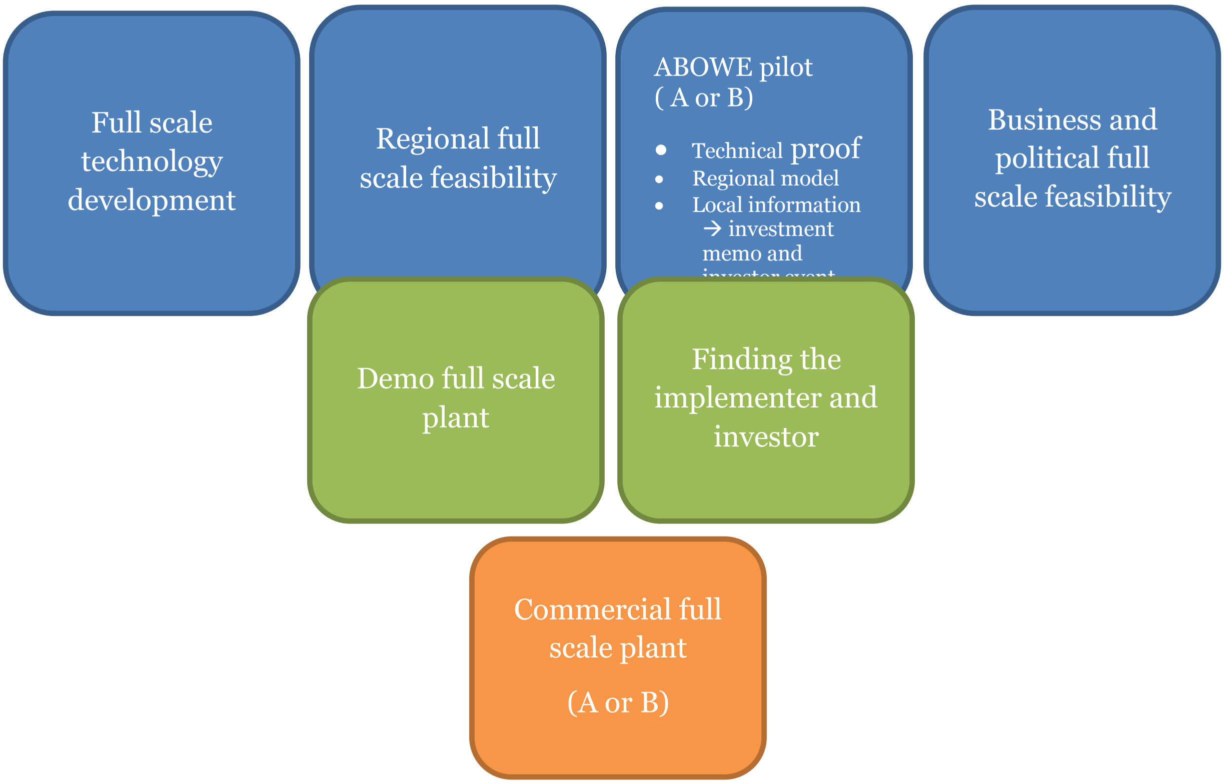

Figure 1. ABOWE in the path towards full scale plants.

Coming back to ABOWE, the following chart illustrates the process of Investment Memo and Investor Event.

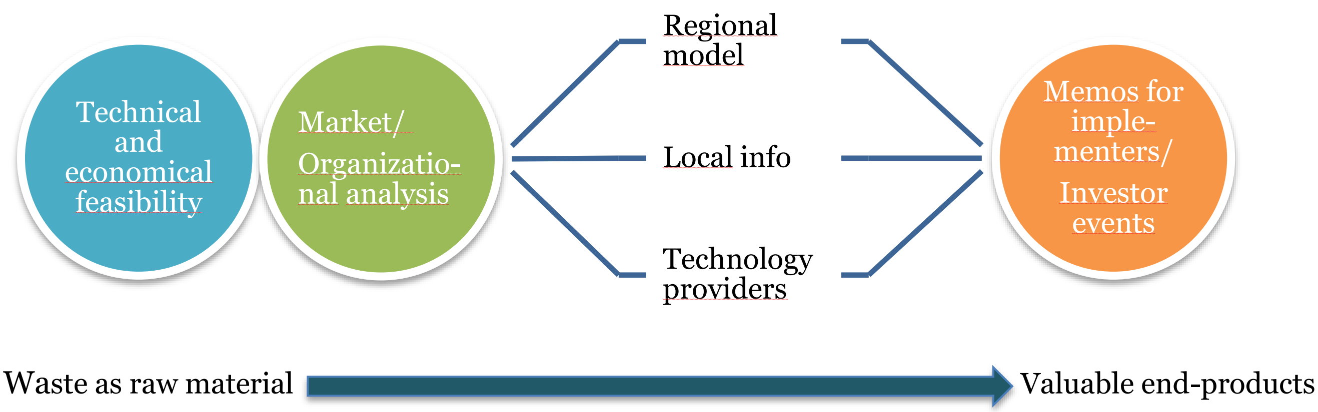

Figure 2. The process of Investment Memo and Investor Event.

In Business model creation, the Business Model Canvas with some added features is applied. The business model process includes evaluation and ranking of business model items, which is helpful and practical in the identification of the core business model.

This Investment Memo concerns the Lithuanian target region and Pilot B and has been compiled in co-operation between Klaipeda University as the testing partner, Savonia University of Applied Sciences as facilitator and University of Eastern Finland as regional modeler. Ostfalia University of Applied Sciences as Pilot B provider and educator of the related dry digestion biogas technology has given essential information in their separate report about the Lithuanian Pilot B tests.

2. Executive Summary

ABOWE Pilot B Lithuania Investment memo is a document that gives view of operating environment, pilot plant and test, biogas electricity production from household bio waste and cattle solid manure, regional model, business model, investment costs and strategy to large scale business.

Research, development and innovations are increasing finding sustainable solutions for waste management and reducing overall environmental load. They are part of EU's long-term climate and energy targets.

In 2010 the European Union member states developed renewable energy action plans (REAP). REAP recommended that until 2020 at least 35 % of the manure, 40 % of the available organic waste suited for biogas production and the sludge of water treatment is used to produce biogas. The Lithuanian government aims to generate 23% of total power from renewable resources by that time.

Objective of ABOWE is the transfer of knowledge, focusing on specific challenges in terms of biogas utilization in the Baltic Sea Region (BSR). The pilot plant was set up in small farm in Šilutė region. The use of the technology for the treatment of cow manure from small farms was new and generated wide public interest.

Pilot B was considered to be as a place of learning, for the operators, the University, the neighbours and the stakeholders of the region where it is placed. It provides an onsite impression of the technology and its possibilities.

The business model and investment memo creation process is also a learning process –the core business model created with the local stakeholders in September -October, 2013, gives a first insight on which are the core business model elements in terms of business potential and feasibility for a village size biogas plant based on pilot B. This participative business model creation process could be repeated, since the overall understanding and possibilities, and community awareness and interest on biogas technology has increased. With all the new information, and understanding of the customer needs, competition, offering, key resources , and profit logic, it would be possible to establish and develop a more detailed business case, which could finally lead into full scale investment.

3. Operating environment

Based on the statistics Lithuania population was 3 516 000 in 2013. (2) Almost 30% were under 24 years old, while the age group between 25-64 accounts over 58, 3% and number of persons over 65 accounts 16,5% of total population. However the Lithuanian population is ageing. Based on the statistics the number of population over 65 years old will increase by 15% while the number of persons will decrease by 10% in ages 25-64. This could be the important concern in the future; in the long-term perspective the support of pensioners will be at employees shoulder. (3)

More than 60% of the graduates from secondary school every year choose to continue education at colleges and universities of the Lithuanian higher education system. In 2011 the population with higher education was 0,54 million, that is more than 35% of employed people.(2) The education level in Lithuania is relatively high compared to Europe.(3)

Lithuania's economy has shifted from a planned economy to a market economy and increased rapidly in the last decade. It has gradually recovered from a sharp economic contraction in 2009. The structural reforms, growing private sector (80% of GDP), competitive taxation and an efficient regulatory system have contributed to country's overall transition towards more stable economic position. In 2012 Lithuanian's GDP structure by sectors were as follows: agriculture 3,5%, industry 23,1%, construction 6,2% and services 65,3%.(1)

Most of the trade is directed to Eastern and Central Europe. In 2011, the total imports were 78.8 billion litas. Lithuania's major importing countries were Russia (32.1% share), Germany (10.0%), Poland (9.1%), Latvia (6.6%) and the Netherlands (5.0%).

According to Statistics Lithuania, in 2012 the export value was approximately 23.1 billion euros. It increased 14.5 per cent from the previous year. The majority of Lithuanian exports go to Western European countries and U.S.A. Exports form a major aspect of the country's foreign trade. The significant exports of Lithuania include food, live animals and manufactures. About 80% of the agricultural exports go to Russia.

In the energy sector plays a significant role in the Lithuanian economy. Lithuania imports almost all of its fossil fuel from Russia; all natural gas and most of oil. Lithuania is one of the highest deficit electricity markets in the EU with approximately 60% of electricity imported from other markets. Lithuania has been actively promoting projects to diversify its sources of energy for example the construction of electricity transmission in Poland. The situation will continue to press the Government to search for solutions. (2) (16)

3.1 Overall situation of biogas production in Lithuania

3.1.1 Biogas in general

Biogas is a mixture of gases generated by the anaerobic fermentation of biomass degradation. Gas contains 60-65% methane (CH_4) and 30-35% of carbon dioxide (CO_2). In addition, the biogas is, among other things: water (H_2O), nitrogen (N_2), oxygen (O_2), hydrogen (H_2), ammonia (NH_3) and hydrogen sulfide (H_2S), depending on feeds.

Biogas is an interesting energy source which is part of stable economic, agricultural and rural process and environmental protection. Producing biogas from livestock manure, municipal, organic waste and sludge promotes energy sources diversifies and increases energy supply protection, stability, competition and in addition provides more new income opportunities to the farmers. (7)

Biogas can be used in multiple purposes such as electric energy production, heating cooling and car fuel. It can also be supplied to natural gas network. European Parliament highlights the advantages of using biogas decreasing gas emissions that affect climate warming and strengthening EU energetic independency. (7)

The biogas-technology is on the way of becoming a significant part of the biomass-to-energy chain. Installing systems that generate both power and heat increases efficiency significantly. Increased efficiency reduces greenhouse gas emissions and fuel input compared to power and heat systems that are separated. Producing electricity and heating from biogas also increased economics for power generation where expensive natural gas and other fuels are replaced. Below is described in example of agricultural biogas CHP.(8)

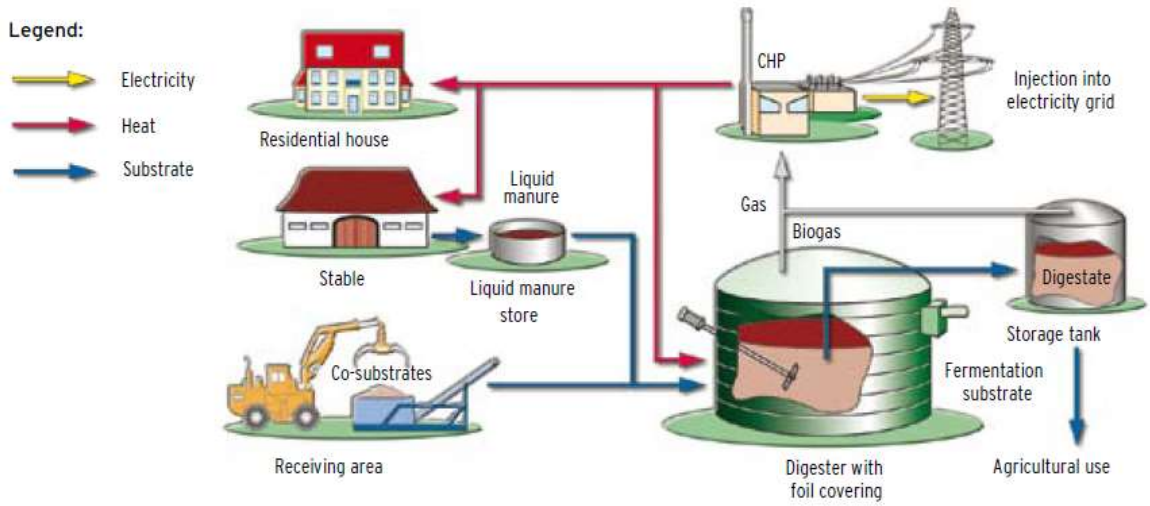

Figure 3 Example of agricultural biogas CHP. (13)

Lithuanian has had challenges in the district heating sectors and it opens opportunities to integrate local and renewable energy resources to use. The use of renewable energy resources eases achieving targets for sustainable development and helps energy supplies to be more diversified. Atmosphere in investing field appears to be major problem for private investors' to participate in large-scale district heating projects. One of the reasons is lack of metering in old houses which complicates district heating business. Lithuanian government aims to cut costs through competition and by reducing district heat prices as they are considering to introduce non-discriminatory third-party access (TPA) to district heating grids. (12)

3.1.2 Renewable energy policy

Lithuanian Parliament has approved National Energy Independence Strategy on June 2012 where Lithuanian state policy for renewable energy generation is determined. Strategy determines national mid and long term main objectives for implementing strategic initiatives and sets guidelines in Lithuanian energy sector development until 2030 and 2050. The principles underlying the strategy are energy independence, competitiveness and sustainability principles.

Also important is that strategy sets competitive and affordable price of energy as the main criterion for decision-making in relation to the support systems for renewable energy development. This has significant impacts on recent legislative initiatives and it is independent from decisions of the regulatory authority.

The Directive 2009/28/EC decrees a RES (Renewable Energy Sources) target by 2020 of 23% for the final energy consumption with at least 10% renewable energy in the transport sector. According to the RES the share of biogas to the electricity consumption is estimated to increase up to 17% in 2020. Also the primary energy balance had to be increased by 1,5% per year until 2012 and has to be 20% until 2025. Lithuania is seeking to meet its 2020 energy mix targets and have continuously supported renewable energy generation. (6)(15)

3.1.3 Biogas plants in Lithuania

As a result of the Government's support, numerous renewable energy projects have been initiated and are now at the stage of development both in electricity and heat production areas. Currently biogas is produced at least in waste water treatment plants in Kuanas and Utena, in three pig farms and one food industry enterprise in Rokiskis. Sewage treatment plants are planning to invest in a new plant and it will use sewage as substrate. All plants have small scale combined heat and power units and are selling electricity to the national power grid, because of special tariff for "green" electricity. Heat produced in these plants is used for industrial needs (for own purposes of enterprises) or is supplied to district heating networks**.** (14)

In May 2014 Idavang and Modus energija opened the first two combined heat and power generation plants in Lithuania, which will neutralise odours from pig farms. One of the power plants has been constructed near Idavang pig farm Sajas in Kelmė district. The second power plant is near Lithuania's biggest pig farm Pasodėlė owned by Idavang in Panevėžys district. Both power plants produce biogas by processing liquid manure accumulating in pig farms. When processed, it becomes almost an odourless high quality organic fertiliser.

4. Pilot plant and tests

There is a separate report prepared by ABOWE WP4 team on the Pilot B and test. As a result it was concluded that Pilot plant gave similar kind of results as full scale plant in terms of bio methane production. Pilot plant can be used to test the technology for different substrates, and the results can be up scaled to large scale biogas production. Technological proof for dry digestion biogas production is comprehensive, and the technology is reliable.

4.1 Overview on Lithuanian case study

The region of Šilutė is located in Western part of Lithuania at the Curonian lagoon. The region constitutes of the city Šilutė, seven small towns and more than 300 villages. It is the second biggest city of the coastal area with more than 52 000 inhabitants.

54% of the region is agriculture area, 18,84% are forest and 16,4% waters. The industrial sector consists of food/beverage, bioethanol, wood processing, furniture and textile. The Šilutė Municipality energy system consists of a district heating supply and decentralized heating. There is a regional electricity supply system via national grid and distributed electricity generation by RES producers. Natural gas network do not exist in the near region.

Pilot B run in Klaipeda during May-August, 2013. The pilot plant placed on a small farm in Šilininkų km. Švėkšnos sen. Šilutės raj. Lietuva . At the pilot period farm consists of 14 cows, 13 calves, 7 bulls and 5 pigs. The food for the cattle is produces on own fields, whereby no chemical fertilizers are used. (6)

Figure 4. Pilot B location in Lithuania

Substrates which have been used during Lithuanian operating period were cow manure, distillery waste, food waste and algae. At the end of the Lithuanian operating period only manure was used in addition to the developed scenarios. The use of manure for biogas production offers also several benefits:

• it avoids CH4 emissions during the storage of the manure

• it reduces CO2 emissions by replacing fossil fuels

• it offers an additional energy carrier that does not compete with other uses

• the substrate as final product after the biogas production is a valuable fertilizer

The main reason to use only manure was a major change in the substrates water content in Lithuania. The water content rose to a very high amount, so the decision was made to stop the feeding in pilot plant.

All substrates which have been used during Lithuanian operating period are shortly described below. The selection was chosen due to local availability

Manure is normally stored on farms for several months and then used as fertilizer. The manure already contains micro-organisms responsible for biodegradation and anaerobic digestion creating methane, ammonia and carbon dioxide which are released into the atmosphere during storage.

Distillery leftovers were collected in a bioethanol factory in Šilutė. The company sells these leftovers to local farmers which use them to feed the cattle and as a fertilizer on the field. The distillery uses wheat and triticale.

The food waste was collected in three different kinder gardens in Klaipeda. Main component was potatoes, rice, bread and vegetables. Small amount of meat and fish have also been present and last substrates algae were collected at different location near Klaipeda.

Pilot test results were compared of parallel Ostafia laboratory tests. Overall the pilot plant test shows good correlation between estimated and measured methane yields. The results shows that the biogas potential of the distillery waste is about 40 Nm3/ t fresh mass, food waste 85 Nm3/t fresh mass and cow manure about 20 Nm3/t fresh mass.

In general food waste has a large share of the waste in Lithuania, example in Kaunas region it is 39% of all waste. As a result of the first meeting of stakeholders in Lithuania became clear, that the deposition of this waste is an important problem at the moment. Also the missing waste sorting is one of the reasons for the small amount of biodegradable waste. In reality the amount of available food waste is 27kg per inhabitant. The reason is that many schools and restaurants have only very small amount of food waste for utilization by one or two small farmers with “free of charge”.

Based on data gained from pilot plant and laboratory test wastes have been analyzed under laboratory conditions and in the pilot plant to determine their suitability for full-scale biogas production. This report calculation gives assumptions for up scaling calculations. (6)

Full load operating time CHP unit	8,760h/a (7,900-8,200h/a realistic)
Electric efficiency CHP unit	34% (10 kW), 41% (500kW)
Energy content methane	9,97 kWh/m3
Organic loading rate fermenter	3 kg (oDM)/m3*d

Table 1. Assumptions for up scaling calculations

5. Biogas electricity production from household biowaste and cattle solid manure

To increase investments in waste-to-energy sector a biogas electricity production system was modeled in the Western Lithuanian target area which considered Telšiai, Šiauliai, Taurage, Klaipeda, Panevežys provinces (Huopana et. all; 2013). By using the model operational income and saved GHG emissions in European emission trading system (ETS) was maximized in the system which considered feedstock transportation to the plant, biogas electricity production in the dry digestion plant, heat delivery to the end user as well as digestate transportation and spread to the nearest fields. Household biowaste and sewage sludge was considered as feedstock in biogas plants which included sanitation while cattle solid manure was considered in plants without satiation. Public data including information about biogas production cost, feedstock origins, heat users and digestate utilization areas was used to run the model. (11)

5.1 Operational income

Operational income per processed mass unit seems to have growing trend when electricity production and digester volumes are increasing, but local costs in feedstock transportation, heat delivery as well as utilization of digestate would give the final form for plant economics. In this case costs in feedstock transportation was estimated to be 0.173 LTL/(t·km). Machinery work in digestate transportation and spread was estimated to have costs of 172 LTL/hour. When costs from CHP unit and digester investments, personnel and maintenance were considered, it seems that annual operational income per ton of feedstock have growing trend versus reactor volume and electricity production power (Figure). Annual shortening for investment loan was determined from ten years of payback time and annual load rate of 5 %.

Incomes are considered from heat and electricity sell as well as from fertilizer sell and gate fees. Calculations in this study considers constant prize for biogas electricity of 441 LTL/MWh, because energy industry representatives usually desire free competition in electricity production markets which guarantees sustainable economic development for electricity production. In addition, heat prize of 138 LTL/MWh is considered. Heat loss and electricity consumption were considered in the heat delivery process which had significance especially if there was need to deliver heat very far from the plant. Heat and electricity consumption in the plant was fulfilled by the heat and electricity which was produced in the plant. It was assumed that fertilizer would be transported and spread to the nearest fields with fertilizer cost of 1415 LTL per ton of nitrogen. Gate fees of 69 LTL per ton of waste was considered for household bio waste and sewage sludge while no gate fee was considered for cattle solid manure. (11)

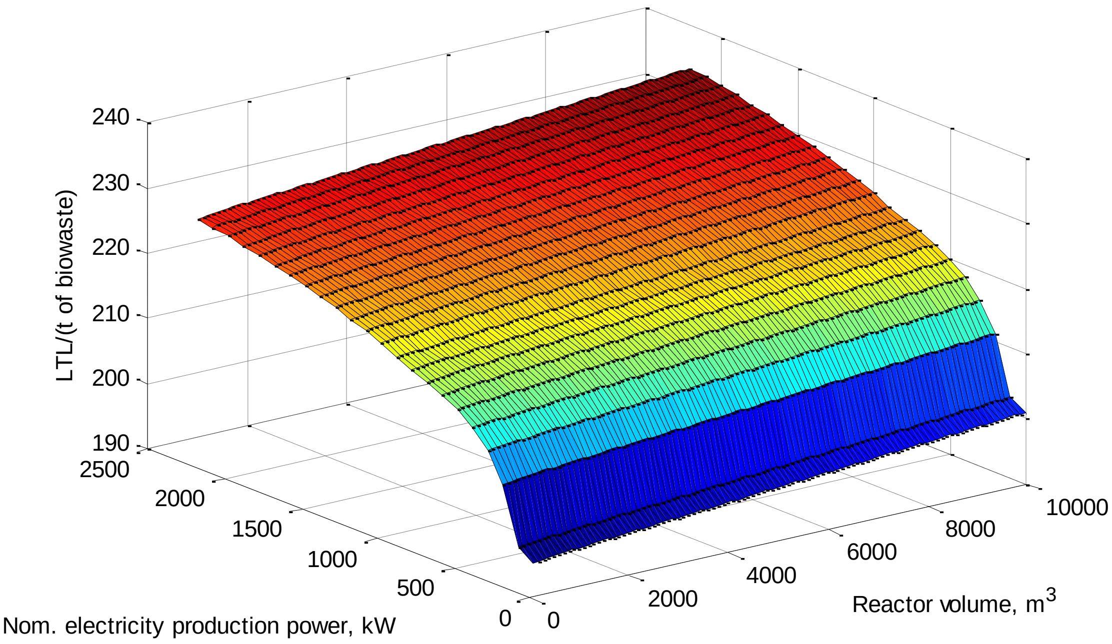

Figure 5. Operational income per ton of household biowaste versus reactor volume and the plant electricity production power is shown when costs from feedstock delivery, heat delivery and digestate handling are not considered.

5.2 The most cost efficient biogas electricity production plants

Model results show that two of the most cost efficient biogas electricity production plants could be located next to UAB Kretingos šilumos tinklai and UAB Radviliškio šiluma district heating plants with anaerobic reactor capacities of 1000 m^3 and 1700 m^3, respectively (Figure). With estimated household biowaste availability of 27 kg per inhabitant, biogas electricity productions in Kretingos' and Radviliškio's plants are 6 GWh/year and 10 GWh/year. Operational incomes for the biogas electricity production system of 3.6 million LTL and 6.1 million LTL were estimated for Kretingos' and Radviliškio's plants. Labor demands of three and five person per year are needed to run these plants in Kretingos and Radviliskio, respectively. In total, saved GHG emissions in ETS are 8800 t of CO_2 eqv./year which would have annual market value of 130 thousand LTL per year if the prize of one ton of CO_2 eqv. remains at 15.3 LTL.

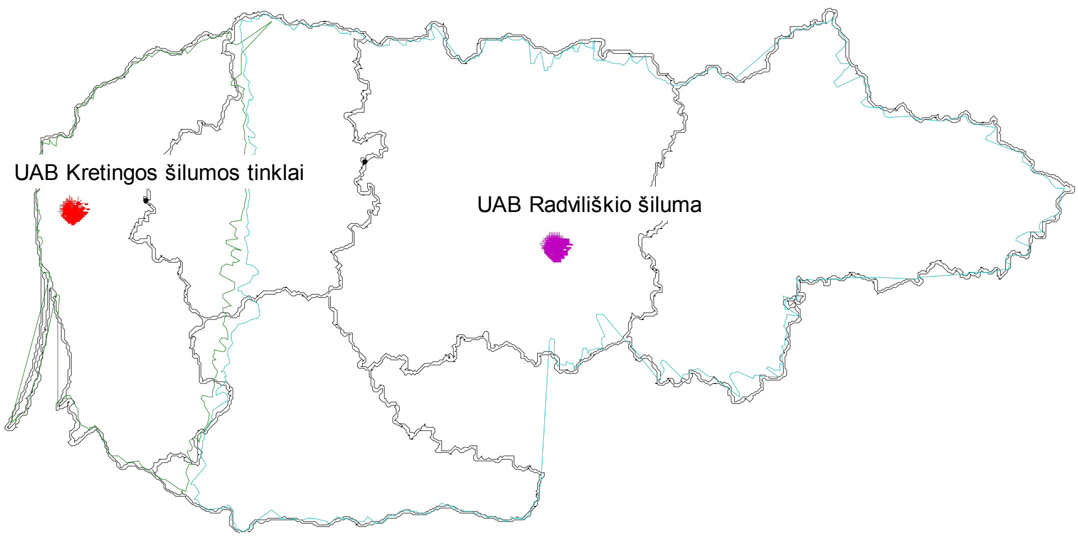

Figure 6. The most cost efficient locations for the biogas electricity production system utilizing household biowaste and sewage sludge was derived with feedstock collection areas around plants.

Utilization of cattle solid manure in biogas electricity production system would result decentralized electricity production in the target area. The most cost efficient locations for plants were found from Baisogalos, Kupiškio, Pasvalio, Akmenės, Kelmės, Šilalės and Skuodo (Figure). Total electricity and heat productions in those plants were 41 GWh/year and 44 GWh/year, respectively. Operational incomes in these plants are 15 million LTL/year when incomes and outcomes are 29 million LTL/year and 14 million LTL/year, respectively. Incomes result from electricity sale of 18 million LTL/year, fertilize sale of 5 million LTL/year and heat sales of 6 million LTL/year. Outcomes consists capital and operation costs of 10.3 million LTL/year, digestate management costs of 1.7 million LTL/year and cattle solid manure transportation of 2.3 million LTL/year. Direct labor demands in those seven plants are 31 employees per year. District heating plants that belong to the ETS would have total benefits as saved CO_2 evq. Emissions of 16900 ton which would have market value of 260 thousand LTL per year if the prize of CO_2 evq. ton remains at 15.3 LTL. (11)

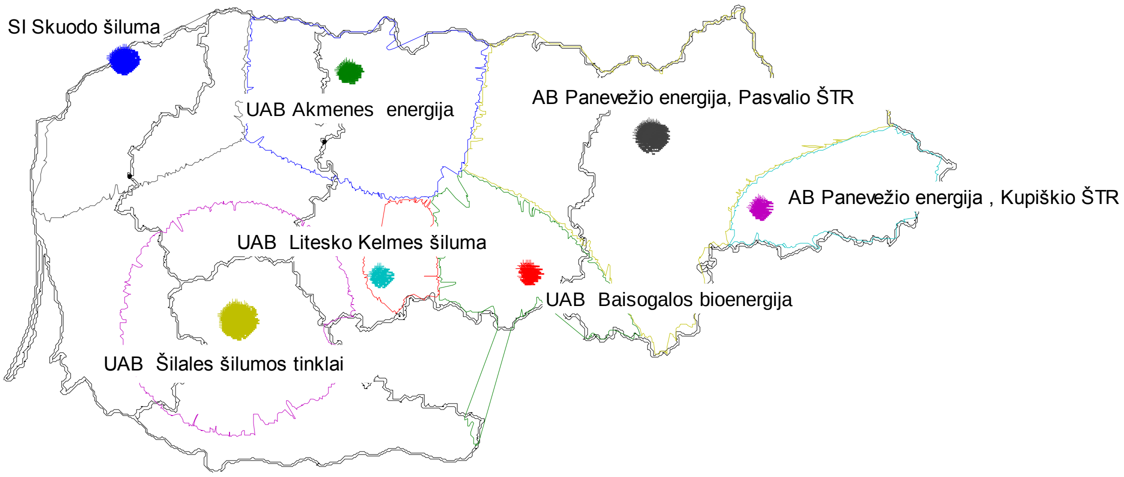

Figure 7. The most cost efficient locations for the biogas electricity production system utilizing cattle solid manure was derived with feedstock collection areas around plants.

6. Business model

The business model analysis take stand some key development items to develop the model. In this case, it will give guidelines to questions such as:

- What are the end user/customer needs in Lithuania?
- Which are the competitive solutions?
- Which key activities/steps are needed for a Full Scale Investment?
- How to develop customer relationships?

The Business model canvas (BMC) is an analytical tool for developing new or existing business models. It is a visual chart with elements describing following items: value proposition, customer segments, customer relationship, channels, key activities, key resources, key partners, cost structure and revenue streams. It is a business tool that advances understanding, discussion, creativity, and analysis.

6.1 Extended Business Model Canvas

Our method was based on Extended Business Model Canvas for business model design as well as additional tools developed in Savonia University of Applied Sciences. This model includes 12 business model blocks –in comparison to 9 business blocks in Canvas. The extended blocks are: customer needs, company solutions and competitors. (10)

In order to establish a business model for the Lithuanian biogas plant, the following steps were realized:

1. Definition of the decision context and making the preparations for a planning process like selecting and briefing the participants.
   - Startup meeting, June 2013 in Klaipeda. The relevant items of the business model were
   - WP2 Stakeholder workshop, 22-24 September 2013 in Klaipeda
   - Idea collection and analysis resulted into 43 business block items.
2. The relative importance of each business model item was determined using an MCDS method
   - Evaluation in internet with Savonia InTo tool, 25 September -1st October, 2013
   - Six evaluators evaluated the 43 business items against business potential and feasibility
   - Decision making analysis, core index analysis, was done in Savonia UAS.

3. The business model was designed with the aid of the evaluation information

The main focus was in a community based biogas plant, for a village size 2000 inhabitants, and a plant size of about 1 MW. On the other hand, results from regional modelling gave understanding on larger scale biogas production. A first business model was created which includes the core business elements for a community based biogas plant.

Extended Business Model Canvas was created, based on the results from steps 1-3. Based on the core index values, 26 most important ideas were selected into the business model. Result of the workshop 22-23 September 2013 is illustrated below.

Customer/competition	**Customer segments** 1. Heating networks	**End user, customer need** 1. Energy 2. Lower prices	**Company solution** 1. For heating Budgetery Institutions 2. Heating of houses 3. 1 MW power plant	**Competitive solution** 1. Existing industry
Offering	**Value proposition** 1. Lower energy price 2. Independent energy source	**Channels** 1. Heating station/boiler of local community	**Customer relationship** 1. Contracts	**Profit Formula** **Revenue streams** 1.Technological process 2.Heat 3.Biogas
Resources	**Key resources** 1. Utility waste 2. Technology -	**Key partners** 1.Meat farm and industry 2.Milk industry 3.Waste management authority 4.Other Farms 5.Water supply company	**Key activities** 1.“Make a business plan” 2.EIA 3.Permits	**Cost structure** 1.Capital investment 2.Material & technology 3.Salaries

Table 2. The Core Business Model.

6.1.2 Customer/Competition

The results showed that the most benefit from the biogas plant would be the heating networks. State organization has possibility to get finance from ministry, to which this organization belongs, for building or reconstruction heating system. From the target customers' point of view, the most important need would be to get pure green energy with the lower prices. Competitors are the other 15 biogas plants that are currently operating in Lithuania.

6.1.3 Offering

Based on results the problem, for which the biogas plant would provide a solution, is the lower energy price, and it would also provide an independent energy source. The customers would be reached through heating stations and boiler of local community. Customer relationships will be maintained by means of agreements.

6.1.4 Resources

Resources section describes the most important resources, partners, and functions that enable business model to work. Resources are needed at all stages of business such as sales, communication, customer maintenance, revenue streams, etc. The results show that the most important resources necessary for the creation of a business are proven technology and sufficient supply of waste. Main partners are milk farms and industry, milk industry and waste management authority. Also other farms and water supply companies were mentioned. The most important key functions is making of a business plan, which includes e.g. a detailed description of all revenue streams (product sales, advertising, services, licensing) and the company’s cost structure (salaries, rent, inventory, maintenance). Local law regulation needs to be taken into account with regard to permits issues.

6.1.5 Profit formula

This section contains the profit formula of the business model, revenue streams and cost structure. The input currents describes how the biogas plant can be obtained in each income group of customers, and the cost to take a position on all the costs related to business execution. According to the results the biogas plant could generate revenue through technological process, heat and biogas.

7. Strategy to Full Scale plant investment and operation

For planning the construction and implementation of a biogas plant, many aspects have to be taken into account. Among technical aspects especially the economic aspects are significant for the implementation of biogas technology. The most important factor when implementing biogas technology is to assure a safe substrate availability. The biogas plant has to be supplied with material during the whole year. Also the utilization of the produced energy, either as the conditioned biogas itself, resulting heat or the electric energy generated by CHP unit, has to be assured.

7.1 Investment example for biogas plant

Pilot B was a biogas plant for training people in biogas technology, and the design and size of the plant is not suitable for economical biogas production. Therefore it is not possible to calculate an economic analysis for biogas production based on the pilot plant results. This reports´ investment cost calculation is based on two different sizes agricultural biogas plants in Germany.

There are two types of costs associated with biogas plant construction:

Investment cost:

- Engineering, permission of authority, connection to the public grid
- Functional units (substrate delivery and pre-treatment, digester, gas storage, biogas treatment, CHP unit, pumps, piping, offices, land costs, digestate storing, vehicles and others)

Operational expenses:

- Variable costs: substrate cost, analyzing costs, process energy, consumables maintenance and repair
- Fixed cost: depreciation, interest, insurance, labour cost and land

The size of a biogas plant has to be adapted to the individual situation, especially to the availability of input material in close proximity to the facility. Units of agricultural biogas plants normally reach sizes of 100 to 500 kWel (gas production around 28 to 140 m3/h). Larger plants are economic if the input material is readily available in close range, for example cattle manure, fields of dedicated biogas crops or waste water treatment facilities. Comparing the specific investment cost it is significant that the bigger the size of the plant the lower the specific cost for the investment €/ kWel. Table below gives an overview of typical investment costs for biogas plants for different sizes. (6)

Size of biogas plant	Specific investment costs
75 kWel	ca. 9,000 €/kWel
150 kWel	ca. 6,500€/kWel
250 kWel	ca. 6,000€/kWel
500 kWel	ca. 4,500 €/kWel
1 MWel	ca. 3,500 €/kWel

Table 3. Specific investment cost related to biogas plant size (German literature source)

One important factor considering of household bio waste demands a special treatment. Especially the hygienisation of the material is a necessary demand based on EU regulations. This regulatory factor is shown more expensive investment cost. The investment cost for plants using biowaste as substrate are one third higher than for biogas plants using for example renewables.

Another significant observation concerns of small/farm biogas plants. It seems that the most economical solution is to use the produced biogas as well as heat for own requirements. The sale of the gas presents a suitable possibility for revenues but the needed investment to upgrade the biogas for selling is only suitable for the bigger size biogas plant because of the high investment cost.

The investment cost (divided into functional units) of two German agricultural biogas plant of different sizes are shown in figure 8. Though the data are of the year 2004 they serve as comparative value for the investment cost of different plant size. (6)

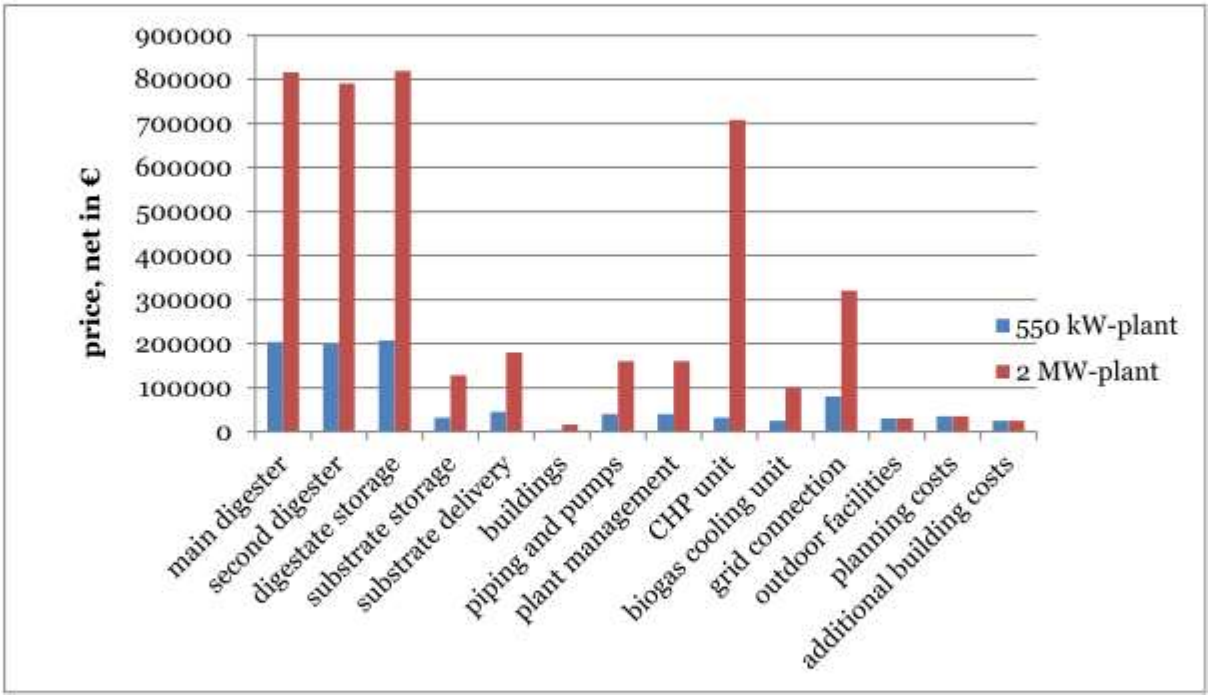

Figure 8. investment expenses of two German agricultural biogas plant (2004)

The comparison for the Germany agricultural biogas plants is the UAB Dontuva Experimental Farm in Lithuania (Biogas feasibility study/EU Baltic Sea Region programme). Table 4 shows a comparison calculated scenario of 250 kW biogas plant which was built to use cattle manure and maize silage as input material. (6)

	250 kW Experimental farm
Investment costs	1 724 637 € (6 900€/kW)
Required working time	2 employees
Personnel costs	11 594€/year
Theor. revenue (electricity; without deduction of own requirements)	156 521 €/year (0.2 /0.3 LT/kWh) Heat: 86 956€/year
Operating costs (total)	159 420€/year *
Substrate costs	Silage production: 86 956 €/year
Maintenance and repair (CHP)	-
Maintenance (total, up to 6%)	2,5%; 43 478€/year

Table 4. Investment and operating cost of existing experimental farm in Lithuania

For the economical implementation the different cost are varying according to the country in which the biogas plant will be build; operating expenses comparison is not valid between different countries (German and Lithuanian) for example of the big difference of wages. Next table take a stand of investment cost by showing which plant component the investor's point of view would be profitable to do in Lithuania and which one in external equipment supplier. (6)

plant component	Acquisition and construction in Lithuania estimated economically	
	Probably yes	Depending on quality/availability
Substrate storing and pre-treatment	x	
Substrate delivery	x	
Main digester	x	
Secondary digester	x	
Gas storage	x	
Biogas treatment		x
Flare		x
CHP unit		x
Pumps and stirring technology		x
Office building	x	
Control unit		x
Digestate storage and conditioning		x

Table 5. Estimation of economy for building of plant components

In conclusion the cost items are depending three factors: size of the plant, construction type of the biogas and the used input materials. Pilot B in Lithuania is non-profitable but for testing and representing the biogas technology with different substrates and it can be used to produce electricity and heat. However, the results show that depending of the local feed-in-tariff the small scale biogas plants can also produce electricity in economical price.

Heat sales, selling and processing of waste gate fees could be the key factors to make the plant businesswise viable. Also it is not possible to calculate any productivity rates of Pilot B because the operating period was very short (including star-up phase). (6)

7.1.1 Case Fortum: The first waste-to-energy combined heat and power plant in the Baltics

In May 2013 Fortum Corporate set up first waste to energy combined heat and power plant in the city of Klaipeda, Lithuania. The power plant uses municipal and industrial waste as a fuel. The district heating produced are sold to Klaipedos Energija and the electricity to the Lithuanian national grid.

The plant power production capacity is 20 MW electricity and 50MW heat. Annually plant will produce approximately 140 GWh of electricity and 400 GWh of heat, which covers about 40%of Klaipedas district heating demand. The plan production took 1,2 million hours to complete. The total investment cost was 435 million LTL or about 130 million euros.

8. SWOT Analysis

This SWOT analysis has been made based on the community plant. It was presented on the investment event in Klaipeda October 4th 2013. The strengths, weakness, opportunities and threats are identified below.

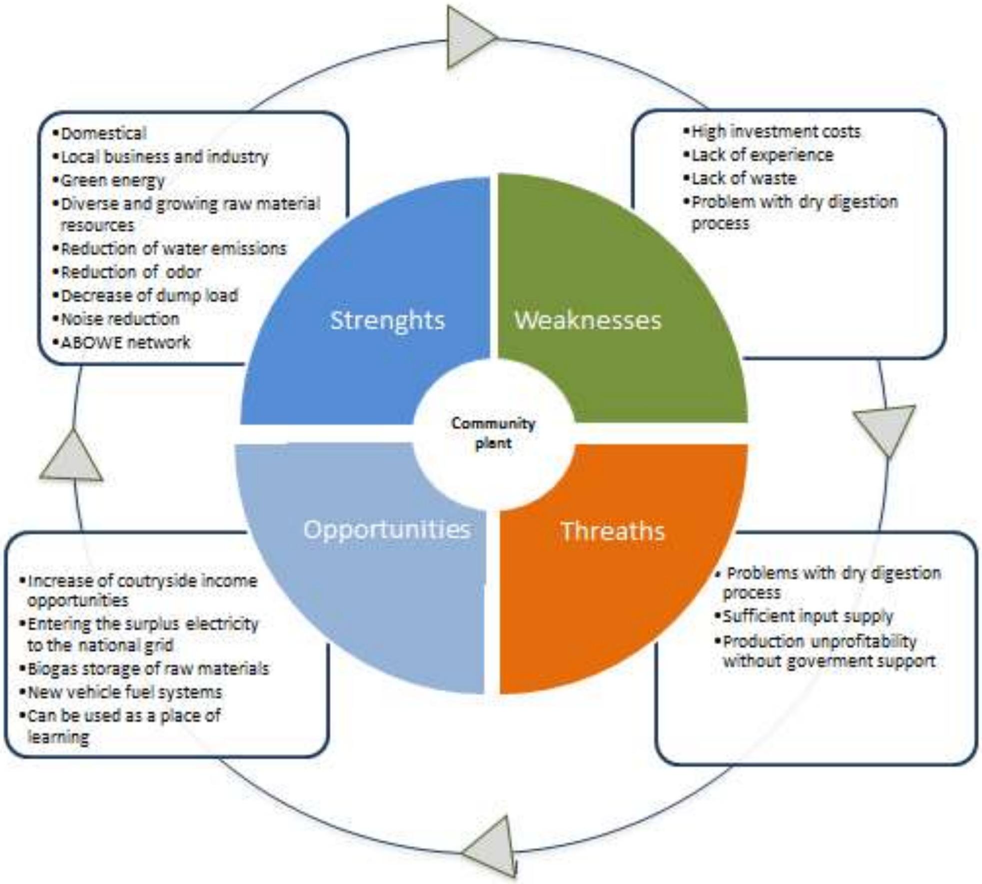

Figure 10. SWOT analysis based on community plant

This SWOT analysis presented the main advantages and disadvantages, the drivers and barriers based on community plant. If we look the community plant strengths in a large scale, it indicates that biogas has considerable potential as a household energy source. One important concern in the future is how to enable economic and sustainable utilization of heat from existing and future biogas plants, which is currently wasted. Also the need of increase capability and capacity in biogas heat utilization is noticed.

Based on the information what this study has to offer the small biogas plant can improve local business and industry, produce domestic clean energy that is renewable source of energy and increase work opportunities. Even though knowledge of this kind of technology is not yet wide spread in Lithuania, this kind of community plant can revive interest in biogas technology and its possibilities. The plant would have not only economic but also educational, scientific, experience sharing and technological development purposes.

The biggest disadvantages are high investment cost and lack of experiences to build this kind of small plant, because this is first of the kind. Also it should be able to show that the technology can be handled and the perils are not uncommon high. Even though the construction of biogas plant is costly it would make a big difference in rural household's way of living. Although this kind of new energy source could solve the energy issues being faced by villages all over the world, very few investors are willing to put in the startup capital. Also production can be unprofitable without government's support.

In conclusion, the study has shown that the technology itself created a lot of interest among the workshop participants, still more investment/cash flow calculations and modeling based on different substrate feeds are needed. However in a small village it is not profitable to establish biogas plant at the moment. Also there is need for research and increasing awareness.

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