BIOGAS IN ASIKKALA

An initial feasibility study

Project Report, 2014

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Introduction

In a global setting of growing environmental concerns, Finland aims to become a pioneering country in achieving climate change mitigation targets. Regional-level decisions, particularly in rural areas, will have an impact on this goal. Local solutions for renewable energy, such as biogas, will contribute to meeting the country's goals and increase competitiveness [1].

In accordance with national targets, the Municipality of Asikkala located in the Päijät-Häme region in southern Finland, became a HINKU member in 2013 with the aim to address energy inefficiencies and the sub-optimal use of natural resources (see box) [2]. Through the deployment of biogas technology, a significant reduction in emissions could be achieved. For these reasons, a project investigating the feasibility of a biogas system in the area has been undertaken. Study activities included an examination of best practices, meeting with relevant local and regional stakeholders, and identifying and addressing potential challenges.

The findings of the study are presented in this report. This includes an analysis of biogas technology and its suitability to the local context, an outline of the proposed biogas system, and recommendations to the local authorities and stakeholders.

HINKU

The HINKU initiative was launched in 2007 and is administered by the Finnish Environment Institute (SYKE). It aims to find ways of curbing GHG emissions in Finnish municipalities and to provide its members with scaleable long-term strategies.

The 16 municipalities currently members of HINKU are committed to reducing their GHG emissions by 80% by the year 2030 from 2007 levels. SYKE measures emissions in CO_2 equivalents, and standardises the calculations to ensure comparability over time and between municipalities.

www.hinku-foorumi.fi

BIOGAS PRODUCTION

Biogas is an energy source most often produced by anaerobic (oxygen-free) fermentation of organic material. This naturally occurring process includes steps of microorganisms breaking down carbohydrates, proteins and fats [3,4]. Biogas is a mixture of mainly methane (CH_4) and carbon dioxide (CO_2) (table 1). The respective fractions depend partly on the choice of organic input materials (*substrates*) [5], but from an energy perspective, methane is the important fraction, as it can be utilised for energy production through combustion.

Biogas is a renewable energy source and particularly attractive since it does not suffer from some of the weather dependencies that other renewables do [6].

Table 1 Chemical composition of biogas

Compound	%
Methane, CH_4	50–75
Carbon dioxide, CO_2	25–45
Water vapour, H_2O	1–2
Carbon monoxide, CO	0–0.3
Nitrogen, N_2	1–5
Hydrogen, H_2	0–3
Hydrogen sulfide, H_2S	0.1–0.5

Substrates

In principle, any organic material is suitable as a biogas substrate. The higher calorific value and the higher the number of carbon atoms, the more methane the substrate will generate. Gas production may be maximised by combining different substrates [7].

A high liquid content is beneficial for the process, with a dry matter (DM) content of about 2–12% being preferable. This ensures thorough mixing and increases the dissolving of CO_2 in the water, increasing the methane content of the biogas.

Microorganisms need nitrogen (N) to form proteins, and the amount of nitrogen available to the bacteria is often stated in relation to the amount of carbon (C). Normally, the C/N-ratio has to be less than 30, as nitrogen otherwise becomes a limiting factor for growth, but should not be too high either, as this inhibits fermentation [3,8].

Liquid sludge and manure are commonly used substrates. Fermenting manure helps avoid methane emissions otherwise associated with its storage. Since manure alone does not give a high biogas yield, it is often combined with energy crops [9]. The high liquid content of manure makes local sourcing important in order to reduce transport costs.

Slaughter- and food wastes are also suitable substrates, although they must be sanitised prior to fermentation to eliminate harmful bacteria [7].

Sludge from sewage treatment plants may also be used; however, it may complicate potential applications of the fermentation residues (*digestate*). The spreading of sewage digestate on farmland, although technically and chemically feasible, is associated with ethical and regulatory concerns. The digestate can alternatively be dried and then incinerated for energy production [10,11,12].

Forestry residues could have high potential as biogas substrates, considering the size of the Finnish forestry industry. However, its low calorific value requires a different gasification technology and has therefore not been considered in this study.

When planning a biogas plant, it is important to ensure a stable and even supply of substrates in order to prevent interruptions in production. Similarly, it is essential to investigate the long-term availability of the chosen substrates, and potentially sign contracts with suppliers [13].

Biogas Technology

Anaerobic digestion is an energy efficient and environmentally beneficial biogas technology; a simple and reliable process that can be applied on a small scale [4,14].

The chosen mix of substrates (①, figure 1) is mixed, crushed, sanitised and pre-heated depending on substrate ②. The mixture is then fed into an anaerobic digester where it is left to ferment (*retention time*) ③ [5]. Required retention time depends on type of microorganisms, temperature, and the uniformity of the substrates. Two types of methanogenic microorganisms exist: mesophilics, which require lower temperatures (32–42°C), and thermophilics, requiring higher temperatures (48–55°C). In general, the energy balance is better in the mesophilic range than in the thermophilic, but the thermophilic digestion results in a 50% higher

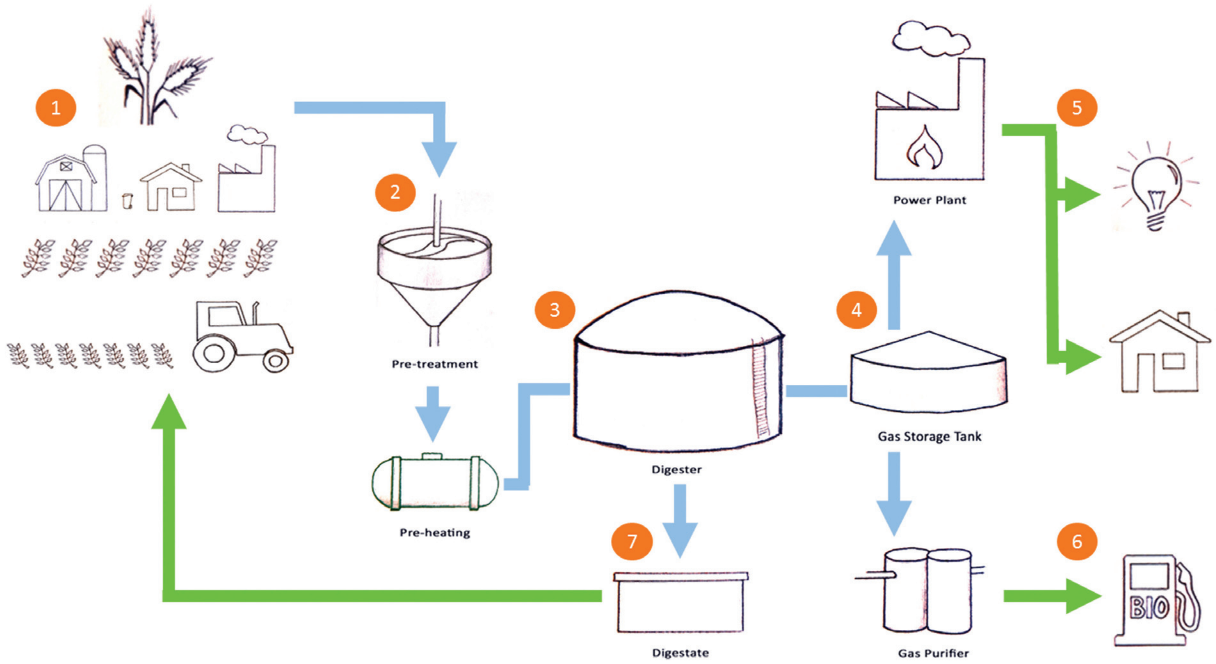

Figure 1 Schematic illustration of the various steps in the biogas production process (Ill. Mia Pantzar, 2014)

rate of degradation and thus a higher biogas yield. However, thermophilic methanogens are more temperature sensitive than mesophilics and small variations in temperature can cause a substantial decrease in activity. In general, the longer the substrates are exposed, the better the anaerobic decomposition [3]. The gas is collected and stored in a storage tank ④ and the resulting digestate is stored in a separate gas-tight tank for later use (see below).

Benefits of Biogas Production

It is commonly said that biogas production offers several benefits, e.g. reduced greenhouse gas (GHG) emissions, reduced loss of nutrients, and the transformation of waste into a high-value by-product.

The gas can be incinerated in a Combined Heat and Power (CHP) plant ⑤, producing steam to drive a turbine generating electricity and heat. A conventional CHP plant transforms roughly a third of the energy to electricity and the rest to heat. Consequently, the plant's location largely affects its profitability [7].

The biogas may also be used as vehicle fuel ⑥. However, the gas needs to be *upgraded*, in order to be suitable as combustible gas for fuel or the grid. Upgrading removes impurities and the bulk of CO_2 until the methane content is at least 96%. The fuel is then compressed and distributed to tank stations either via pipelines or by trucks [5]. If gas-driven vehicles replace fossil fuel-driven vehicles, CO_2 emissions can be reduced by more than 100% [15].

Upgraded biogas can alternatively be fed into a national or local grid. It may thereby help diversify and decentralise energy supply and increase energy security [16].

Biogas production can help convert problematic and expensive waste streams such as food waste and sewage sludge, into a valuable bio-fertiliser ⑦. The digestate can replace artificial fertiliser, the production of which consumes energy and causes GHG emissions [8]. Depending on the substrates used in fermentation, the digestate will have different qualities. Generally, all nutrients contained in the substrates remain in the digestate, making it a high-quality bio-fertiliser and soil conditioner [6,7]. Using the digestate as bio-fertiliser thus contributes to closing the nutrient cycle and further reducing the overall environmental impact, as it achieves energy and nutrient recovery (figure 2).

It is important, however, that the digestate is tested regularly for heavy metals and other harmful substances, depending on the applicable regulations.

Manure substrates are more liquid, alkaline, and ammonium rich after fermentation – improving the digestate quality as a bio-fertiliser. It penetrates better into the soil and contains a more easily available form of nitrogen. After about 12–24 hours of storage, the digestate loses its smell and becomes essentially odourless. However, the high ammonium content of manure digestate together with the higher pH can lead to increased ammonia emissions [3].

Finally, biogas is beneficial in waste management terms since it reduces waste volumes and the need for alternative treatment such as landfilling. Consequently, it may contribute to the protection of groundwater resources and to a more sustainable waste handling.

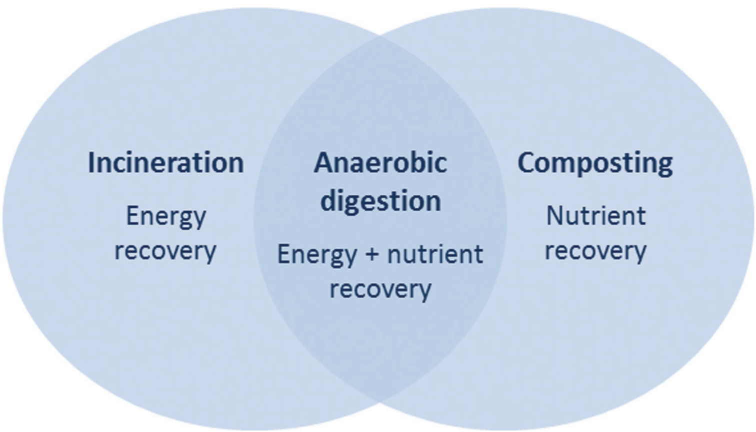

Figure 2 Combined benefits of biogas production (own illustration)


Summa
17,88
Euro
Määrä
11,44
kg
Hinta/kg
156,3
Senttiä
Biokaasu
Pienin mitattava määrä

JOUTSA

In Joutsa, located approximately 100 km north of Asikkala, a biogas plant processing sewage treatment sludge, biological household waste and waste oil and fats began operating in April 2014. The plant is located on municipal land which has been leased for 30 years. It cost EUR 1.6 million to construct and the payback period is estimated to be about seven years. Figure 3 illustrates the financing structure of the plant [17].

The plant has the capacity to handle 7 000 tonnes of slurry per year, which is small for an industrial plant. Currently the plant has a permit to handle 4 750 tonnes. The composition of the slurry is 2 000 tonnes of sewage sludge, 500–1 000 tonnes of septic tank waste and about 1 000 tonnes of household biowaste, which is transported to the facility from nearby municipalities.

The plant produces about 1 500 MWh of biogas per year. The gas is upgraded to fuel and sold at a biogas station, located in connection with the plant, at a price of about EUR 80/MWh. The digestate remaining after fermentation is hygenised and analysed, and subsequently used as bio-fertiliser by local farmers [17].

The Joutsa biogas plant generates revenue by selling fuel and charging gate fees for waste handling. The gate fees are EUR 70/tonne for bio-waste, EUR 55/tonne for wastewater sludge, and EUR 13/tonne for septic tank waste. Gas sales provide roughly a third of the plant income, while the remaining part comes from waste management fees. The plant provides employment for 1 person on-site, but additional jobs are created through transportation of inputs and digestate, as well as other related activities [17].

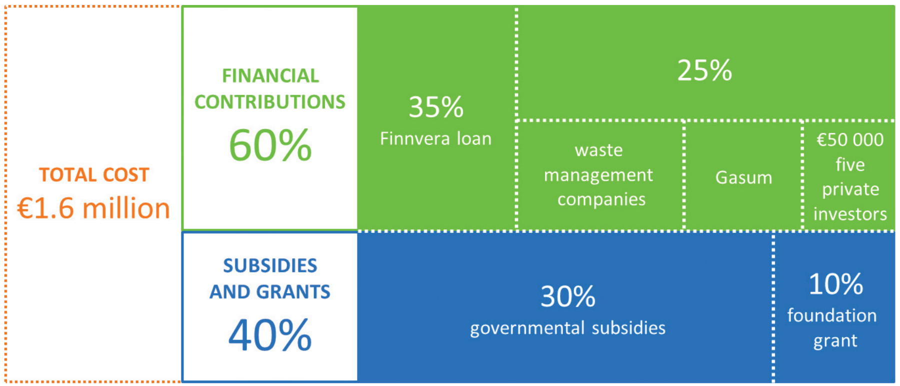

Figure 3 Financing structure – Joutsa biogas plant

> Gas sales provide roughly a third of the plant income, while the remaining part comes from waste management fees.

SUBSTRATES

Asikkala's tough HINKU emissions reduction commitment requires investments in the energy, transport, and agriculture sectors. A biogas facility could contribute to this [18]. The following section proposes a likely scenario where the potential for biogas depends on a number of factors, including:

- the substrates available;
- the use of the final product;
- the location of the plant;
- the financial investments; and
- the legislative context.

Therefore, the actual or realistic potential is significantly smaller than what is theoretically, technically or financially possible (figure 4) [2].

A number of substrates are available in the region. From a financial point of view, an important distinction between the various substrates is whether they are revenue generating, revenue neutral or incur a cost. Revenue generating substrates allow the facility to charge a gate fee to take the material, as is the situation with sewage sludge in Joutsa. Revenue neutral substrates are available for free, as is the case with industrial waste at a biogas facility in the nearby municipality, Laukaa. Finally, substrates that incur a cost include those that the facility would have to purchase, e.g. energy crops [17,19].Utilisation of bio-waste is expected to grow in the near future due to EU regulations. After 2016, landfilling of bio-waste will be limited; biogas could play a role in the sustainable reuse of these resources [20].

Sewage Treatment Sludge

Sewage sludge from the wastewater treatment plant could be a potential revenue-generating substrate. The municipality, through the wastewater treatment plant, is currently spending a significant amount of money transporting and treating the sewage sludge produced (EUR 70 per tonne) [21]. Fermenting the sludge to create biogas reduces both costs and waste, creating a win-win situation for Asikkala. The quantities available are currently 900 m^3 per year at a 20% DM content.

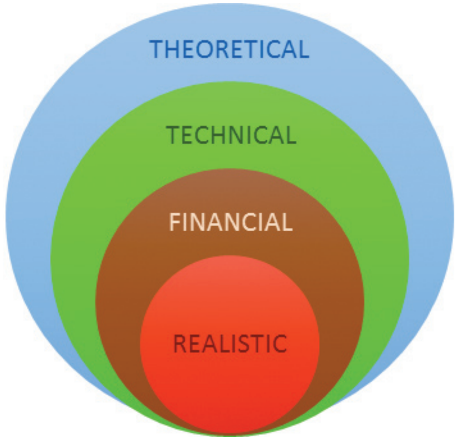

Figure 4 Levels of feasible biogas potential(own illustration)

Farm Residues

In Asikkala there are about 200 farmers producing substrates suitable for biogas production [12].

Most farms producing manure are spreading it onto their fields. Unless given a financial incentive, it will probably be difficult to convince these farmers to send the manure to a biogas plant and receive digestate in return. However, farmers who have excess manure and currently pay to dispose of it might be interested in delivering it to a biogas plant [22]. The amount of manure considered waste is estimated to be at least 10 000 m^3 of pig manure and at least 2 000 m^3 of cattle manure per year [23,24].

Most farms in Asikkala plough their crop residues back into the soil. Given financial incentives, farmers indicate that these residues could instead be set aside for biogas production. However, ploughing crop residues back into the soil improves soil quality, limiting the amount that can be extracted sustainably [23]. The potential has not been assessed in this study, as other substrates are easily available.

Industrial Waste

A small number of industries in Asikkala generate organic by-products that are suitable for biogas production. As landfilling of organic waste will be limited after 2016, the potential to utilise this waste should be assessed in detail at a later stage [20].

Municipal Household Food Waste

Using municipal household food waste to generate biogas is common in both Finnish and foreign biogas facilities, and the Joutsa plant (page 4) handles about 1 000 tonnes per year. In Asikkala municipality, food waste from residential areas is currently collected and transported to Kujalan Komposti in Lahti for composting. One way for the municipality to meet its obligations under the new waste management law is to ensure collection of the all food waste for biogas production. The potential for household food waste to be utilised for biogas production is estimated to be in the order of 1 700 tonnes per year, including what is currently composted [25].

Energy Crops

There are several local farmers currently growing crops and feed grass who have expressed interest in switching to growing energy crops for biogas production, if financially attractive [23,24]. The potential for growing energy crops in the region is very high, and would be more than enough to cover the needs of a biogas facility of the proposed size.

> Fermenting the sludge to create biogas reduces both costs and waste, creating a win-win situation for Asikkala. ”




> It resonates with municipal and national plans to move away from Russian gas dependency.

POTENTIAL APPLICATIONS

There is evidently a range of suitable substrates available to feed into a potential biogas plant in Asikkala. For the project to be feasible, however, the end products – the biogas and the digestate – need to find suitable applications. This section presents potential uses that have been identified and suggests what could best suit Asikkala.

Energy Production

Asikkala currently receives all its electricity and natural gas from Lahti Energia. The gas, originating from Russia, is expensive and local development of heat and power production is therefore attractive [26,27]. It also resonates with municipal and national plans to move away from Russian gas dependency.

Combining the biogas plant with CHP production is only financially viable if there is sufficient local demand for the heat and the electricity. The district heating system in central Asikkala could use the heat, but Lahti Energia, who owns the heating network, will arguably choose the cheapest option [26]. There is no significant industrial heat demand, and although farmers need heat for e.g. space and water, their temperature needs peak at a maximum of 70–90 °C [22,23,24]. These farms are also sparsely located, making the location of a CHP plant problematic.

Farmers have expressed interest in using biogas to cover their electricity needs, if financially attractive [22,24]. Given its limited scale, however, Asikkala's biogas plant would not receive the national feed-in tariff and the electricity would be sold at market price. Combining the biogas plant with a central CHP facility is consequently not considered economically viable in Asikkala.

Farmers could alternatively receive biogas through a local grid to use for on-site energy production. However, this option might be unnecessary since farm-scale heat production is commonly run on wood chips from forests owned by the estate, which is a cheap and sustainable solution [23,24].

Vehicle Fuel

As CHP production is an unfeasible option, the most financially attractive use of the biogas is to upgrade and sell it as vehicle fuel, similar to what nearby Joutsa and Laukaa plants are doing. These sites, and VA Syd in Lund, demonstrate that a stable and increasing fuel demand exists and that fuel sales can generate considerable revenues. The demand in Asikkala is currently unknown, but a biogas plant should produce enough gas to fuel at least 200 cars driving 15 000 km per year. Three potential sources of demand have preliminarily been identified [10,17,19]:

- *Vehicles passing through the region, e.g. to and from vacation homes*: the Finnish Transportation and Infrastructure Directive aims to extend the gas station network by 2020. Biogas plays an important role in meeting this target, especially in areas not connected to the gas grid [11].

- *Local agricultural vehicles:* agriculture has a high use of vehicle fuel compared to other Finnish industries [7]. A pioneering group of local farmers has shown interest in biofuels, e.g. using rapeseed oil for biodiesel production. The same cluster might be interested in local fuel-grade biogas production and assist its development [12].

- *Investing in new biogas vehicles, and potential retrofitting of existing vehicles from gasoline to gas*: No local public transportation system exist, meaning that demand for gas-driven vehicles have to come from individuals and local industry. Retrofitting may prove challenging as no existing car shop in Asikkala currently performs such changes.

Distributing the upgraded gas through a grid is not considered feasible. Use of gas burners for household heating is unusual in Finland and the national gas grid is highly limited [11].

Digestate as Bio-fertiliser

In Asikkala and neighbouring Padasjoki, crop farming is more common than live-stock farming, and most livestock farms also have cropland for growing their own feed. As the supply of manure cannot meet the demand for this, farmers purchase artificial fertiliser, meaning that there is a potential to meet local demand by using the digestate as bio-fertiliser [7,12,22,23].

In the 1990s, part of this demand was met by spreading sludge from Asikkala's wastewater treatment plant onto the fields. Since then, national regulations have restricted this application, leading to composting of the sludge. Demand for manure and artificial fertiliser could partly be met by spreading the digestate onto the fields. However, the EU Water Framework Directive (2000) restricts the amount and types of nutrients, such as nitrogen, that can spread onto agricultural lands. As the current wastewater treatment plant in Asikkala does not remove nitrogen from the sludge, there is a risk that the resulting digestate would contain high levels of nitrogen, limiting application [21].

SUGGESTED FACILITY

Based on the availability of substrates and the potential use of the gas, a mesophilic, two-step biogas facility is suggested for cost, ease-of-use and public acceptance considerations. This would require fermentation tanks of 1 300 m^3 and 800 m^3, an upgrading facility to convert the gas to fuel grade, a vending station to sell the gas, and storage capacity for 6 000 m^3 of by-products and digestate. Such a facility has a capacity to handle 7 000–12 000 m^3 of substrate per year. This would cover the substrates currently available in the region, while having capacity to increase intake as new substrates become available. The digestate could be used as bio-fertiliser on nearby farms.

Two potential substrate scenarios are suggested. The above-mentioned substrates can be combined in numerous ways, as long as technical considerations, such as dry matter content, C/N-ratio, retention time, and fermentation processes are taken into account. The calculations of dry matter content, biogas and digestate production, storage needs, and energy consumption are based on a Finnish context. The data on the sludge was provided by the wastewater treatment plant (table 2) [28].

In *Scenario 1*, the plant runs on sewage sludge, manure, and cut grass or energy crops. In *Scenario 2*, the plant runs on sewage sludge and manure. It is assumed that all of the sludge is utilised. Both scenarios have 7 000 m^3 of substrates, which is in the lower range of the capacity of the proposed plant. However, gas production is 35% higher in *Scenario 1*, due to the addition of energy crops, as this

Table 2 Total amounts of substrates available

Input	Amount (t)	DM content (%)	Methane potential (m^3CH_4/tDM)
Sewage sludge	1 000	20	300
Pig manure	10 000	5	300
Cattle manure	2 000	7	200
Household bio-waste	1 700	27	400
Cut grass	1 000	35	350
Total	**15 700**	**10.5**	

Table 3 Biogas scenarios

Input	Scenario 1	Scenario 2
Sewage sludge	900	900
Pig manure	5 000	5 000
Cattle manure	700	1 100
Grass/energy crop	400	0
Total substrate (t)	7 000	7 000
DM (%)	8.84	7.24
Total DM (t)	619	507
Total CH_4 production (m^3)	152 600	112 490
Potential CO_2 savings (tCO_2e)	483	356

improves the fermentation process. It is therefore imperative that energy crops are added to the substrate mix, even if these must be procured at a cost. The direct GHG emission reductions from substituting fossil fuels with biogas have been estimated using an efficiency of 22 km/kgCH_4 for biogas cars and replacing emissions of 166 gCO_2/km for conventional fuel. The detailed figures are in table 3 [29].

In both scenarios, the plant retention time in the two fermentation tanks is set to 21 and 15 days, respectively. Most of the heat and electric energy to run the plant is produced in a gas burner on site, requiring about 10% of the produced gas, while the remainder of the heat and electricity demand is bought on the spot market.

From a GHG perspective, production of biogas has a dual benefit: the reduction in CO_2 from fossil fuels used in transport and the reduction of methane from manure, caused by storing and spreading it. Methane emissions are significantly reduced if the manure is digested in a biogas plant before being spread onto the fields, and the reduction could be of the same magnitude as the reduction in CO_2 from the replaced fossil fuel. This would bring the total GHG emission reduction to around 1 000 tonnes per year in Asikkala's case, although it depends on local conditions. Biogas also has indirect environmental benefits such as a reduction in pollutants contributing to eutrophication, a reduction in waste volume, and a reduction in the leakage of nutrients into the environment. Crop residues can leak up to 30 kg nitrogen per hectare.

This leaching will be dramatically reduced if crop residues are used for biogas production, although soil quality issues must be taken into consideration. Furthermore, a recycling of nutrients through digestate application will reduce the need for fossil fuel-based fertilisers, further contributing to GHG emission reductions [30].

Legally, nothing prevents the building of a biogas plant but enough time and resources should be allocated to obtaining all the permits needed. The process for getting permits can range from months to beyond a year. Once the decision to move forward has been made, the legal requirements should be considered more in-depth [18].

Location of the Plant

The location of the plant influences transportation of substrates and financial payback time, as well as public support for the facility. Based on these factors, three possible locations have been identified, each with a number of drawbacks and advantages:

1. Location at wastewater treatment plant

The advantage of this location is that de-watering the sludge will no longer be necessary. Also transportation of the sludge is avoided, saving energy and fuel. Transporting substrates and digestate could lead to increasing traffic in the area, and as the plant is located in a residential area, a biogas facility in that location could lead to complaints from neighbours [21].

Figure 5 Map of Asikkala with potential biogas locations added [32]

2. Location at Saitta industrial ground

Saitta is set aside for industry and located roughly one kilometre west of Vääksy, the main residential area of Asikkala, on Road 24. This means that smell and noise will not cause nuisance to neighbours. Proximity to the road facilitates easy transport of substrates to and from the plant, while the area nearest the road would be a good location for the gas station. The drawback of this location is that the sludge would have to be dewatered and transported to Saitta.

3. Location at existing industrial ground

The biogas plant could alternatively be placed in proximity to a number of smaller industries located southeast of Vääksy next to Road 24. However, some of these areas are located on top of class-1 groundwater reservoirs, which could hinder development [31]. The advantages and drawbacks are similar to the Saitta location, the difference being that the area is located east of Vääksy on the road to Lahti, which could potentially increase traffic to a proposed biogas station.

Subsidies

The Ministry of Employment and the Economy financially supports investments in clean and efficient energy production. Two support mechanisms are relevant for biogas production: the feed-in tariff system and the Energy Investment Aid scheme. However, the minimum capacity requirements for the feed-in tariff system make the proposed biogas plant in Asikkala ineligible for this support [11].

The Energy Investment Aid aims to support worthy projects not eligible for the feed-in tariff system. Aid levels typically range from 25% to 30% of the investment cost, decided on an individual basis. Projects involving state-of-the-art technology can receive up to 40%. Support for the programme is sensitive to political considerations and budget constraints, and might change in the future. The investment aid is based on actual costs: half of the subsidy is given when half of the costs have been borne, and the other half upon finalisation of the plant. Therefore, the aid does not support the upfront investment [11].

Ownership

In order to ensure long-term stability and jointly share the risks involved, a collaborative ownership structure composed of companies, farmers associations and the municipality is recommended. This organisational structure would represent local interests and would be eligible to receive government subsidies, as this cannot be granted to individuals [11,12,22,23,33].

To attract private and commercial investors and build support for the facility, a local biogas association (*Asikkala Biogas*) should be established. This can serve as a forum for discussion, build support for biogas locally, and distribute information to relevant stakeholders and residents.

Investment

The total project cost is estimated to be EUR 1 500 000. As subsidies cover 25-30% of the cost, EUR 1–1.2 million needs to be raised for the project to be launched.

The municipality can contribute EUR 50 000 without the consent of the city council, but can in principle invest a larger sum [26]. The contribution from individuals is estimated to be upwards of EUR 100 000 [12,22,23,24]. Gasum and Lahti Energia have been identified as potential investors and would benefit from gas grid development. Additional support might be given through foundation grants. Assuming a financing structure similar to Joutsa, the project could also receive a loan from Finnvera, a government-owned financing company [11,17].

Highlighting the financial attractiveness of the project is paramount to gather private investments and should be central to the communication of setting up the plant. Obtaining support and commitment from local authorities is a vital factor for success, and is an important lesson learned from existing facilities of the same scale [13].

Plant Financials

The project cost for the plant is based on benchmarking and calculations for a plant with a capacity in the range of 7 000–12 000 m^3 of substrate per year. The subsidy level, interest rate, and administrative costs are assumed to be similar for the two scenarios, as is the price at which the gas is sold, and the gate fees charged to handle the sludge and manure. See table 4 [28].

Due to the increased gas production, *Scenario 1* is more profitable than *Scenario 2*, and thus has a shorter payback period and a higher internal rate of return. However, both scenarios have reasonable payback periods.

Table 4 Financial details for the two scenarios

Financials	Scenario 1	Scenario 2
Plant investment cost (EUR)	1 500 000	1 500 000
Subsidy level (%)	30	30
Interest rate (%)	4	4
Gas sales (EUR/kg)	1.55	1.55
Gas sales (EUR)	202 300	149 000
Total fees (EUR)	74 000	80 000
- Manure (EUR)	35 000	35 000
- Sludge (EUR)	45 000	45 000
- Crops (EUR)	-6 000	N/A
Administrative costs (EUR)	41 000	41 000
Operating costs (EUR)	71 300	56 300
Gross Revenue (EUR)	282 300	229 000
Net profit (EUR)	170 000	130 700
Internal Rate of Return (%)	12.75	8.00
Payback (years)	6.2	8.0

Investment Structure

As investors have different financial capabilities, as well as differing interest in the day-to-day operations of the biogas plant, a two-tier ownership structure is proposed. This would introduce A- and B-shares; A-shares have voting rights as well as dividends, while B-shares only have dividends. The A-shares are sold at a higher price, and are intended for commercial investors, while the B-shares cost about a tenth and are intended for private investors. The idea is to attract several individual investors, such as farmers and local businesses, each contributing according to their financial capacity.

The A-shares will comprise about 75% of the total value of the company, and will have a price tag of EUR 5 000. With an assumed total investment cost of around EUR 1–1.2 million, this will mean that 150–180 A-shares will be made available to investors.

The B-shares should ideally contribute at least 25% of the total value, as this increases the local and private ownership of the biogas facility. The shares will have a price tag of EUR 500, making them within financial reach of most individuals. With the suggested price tag and investment cost, a total of 500–600 shares will be available to individual investors.

The dividend paid to shareholders will be decided by the board, and will be based on the yearly profitability of the plant. An agreement should be made for the biogas company to have pre-emptive rights when investors wish to sell their shares.

When deciding upon a future course for biogas in Asikkala, a number of factors influence which scenario is the most suitable and must be taken into consideration. If a decision to construct a biogas facility in Asikkala is further advanced, these will need to be further studied. Based on the findings presented, a number of suggestions are provided.

Biogas Facility

It is suggested to construct a biogas plant and an upgrade facility to convert the gas to fuel-grade quality. The plant should have a capacity to handle larger amounts of substrates than is currently available, enabling it to meet future gas demand. Most importantly, the plant must be able to handle crop residues and energy crops, as this increases gas production considerably, which leads to increased plant profitability. The potential environmental benefits increase if manure is included and digestate replaces artificial fertiliser, as fugitive methane and production-related emissions are reduced.

Of the three alternatives, a location at the existing wastewater treatment plant would lead to the lowest environmental and financial costs. However, such a location is considered politically and socially unacceptable due to smell and nuisance. Therefore, it is suggested to locate the plant at the Saitta industrial ground, as this would still be financially and environmentally profitable, as well as politically feasible.

Financing and Ownership

The plant has a favourable payback time, and therefore, it is suggested to move forward with the process. In order to attract both private and commercial investors and build momentum, it is paramount to establish the *Asikkala Biogas* association. There is a need to raise EUR 1-1.2 million for plant development, out of which private and municipal investment is expected to cover at least EUR 0.2 million.

The profitability of the plant hinges on creating demand for biogas, as this accounts for over 70% of plant income. It is therefore imperative that *Asikkala Biogas* works towards fostering local demand. Competition for resources could become an issue, but as abundant amounts are locally available, it is not assumed to be problematic.

Achieving Political and Public Support and Engaging Stakeholders

The Municipality of Asikkala and the proposed biogas association are key actors in generating public and political support for the project. The biogas plant is financially viable, and, with a location at Saitta, it is expected that complaints can be minimised. The municipality can support the project financially through part-ownership and procurement of gas, but more importantly by informing residents and businesses in Asikkala about the benefits of the project. Support among farmers and industry should be built in collaboration with the biogas association, the agricultural expert organisation ProAgria, and the Central Union of Agricultural Producers and Forest Owners (MTK). The local farmers and other industries can provide substrates and receive digestate, which would otherwise cost money. Getting their support is vital for success.





BIOKAASUASEMA
JOUTSAN EKOKAASU OY
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JOUTSAN EKOKAASU OY


Securing financials for plant

The first challenge to get the plant off the ground is to secure investments for the project. There is a need to raise around EUR 1 million, either through loans or investments. Most of this will have to come from corporate investors, while a smaller amount should come from individuals. The proposed Biogas Association plays a vital role in contacting potential investors, liaising with them, and ultimately convincing them to invest in the project.

The first step will be to arrange a meeting for potential investors, where the financials of the plant are explained in detail. As the ownership of the plant will depend on financial structure, there is a need to have bilateral negotiations with investors, once commitment has been established.

Establishing the plant

The availability of substrates, especially revenue-generating ones, is essential to the economy of the biogas plant. The number and proximity of biogas facilities in the region will determine the amount of resources available. It is therefore imperative that long-term contracts with substrate suppliers are secured, as it is expected that the Asikkala facility will be competing for resources with other biogas facilities in the future. A large new biogas facility is starting operations near Lahti, opening in 2014, expecting to produce 50 GWh of gas for heat and electricity generation.

Local businesses and farms producing substrates or waste products suitable for biogas production should be contacted, and their willingness to provide substrates assessed in detail. This report found that several potential substrate providers are available, but a necessary precondition for taking this project further is signing contracts with these people.

Additionally, securing demand for the produced biogas fuel is a vital part of making the plant financially viable. It must be expected that private fuel demand will not be sufficient to sell all gas produced in the start-up period. Therefore, demand needs to be secured otherwise, for example through procurement guarantees with industry, farms, and the municipality. These entities will each sign a contract, promising to buy a guaranteed amount of fuel until sufficient local demand exists. To create local demand for biogas, there is a need to convince individuals to change to biogas cars. The proposed Biogas Association, in particular, plays a key role in fostering this demand, and should work to inform residents of Asikkala of the financial and environmental benefits of shifting to a biogas-driven vehicle. This could for example be done by providing informational material to households and hosting town hall meetings.

Finding a location should not be challenging per se, but there is a need to have an extensive stakeholder consultation weighing pros and cons before settling on a final location. A town hall meeting should be conducted, where people and businesses with an interest in this debate can ask questions about the proposed locations, to ensure that all viewpoints are heard.

Building stakeholder & public engagement

Creating a Biogas Association addresses many of the challenges outlined in the previous section and it is therefore imperative to establish this organisation as soon as possible. The main challenges with setting up the association are securing a budget for it, and finding volunteers to work for it, at least initially. Locals interested in sustainability in general, and biogas in particular, could be involved in this process.

Creating a Biogas Association addresses many of the challenges outlined ”

It is vital to get the municipality on board this project, as they can provide financial support and managerial expertise. Also, people often respond more positively to initiatives that have the support of the authorities. An endorsement of the project by the municipality could help overcome some initial scepticism from stakeholders.

The municipality can invest more than EUR 50 000 if the city council gives its approval. Convincing the council to invest in the project reduces the amount of investment needed from external sources and simultaneously builds commitment towards the plant. The first step is to provide the council with information on the project, and to highlight the financial benefits of constructing the plant.

Immediate

- The first step is to identify relevant stakeholders and consult these people and organisations on the future plans for the biogas project. Potential stakeholders include, but are not limited to, the following:

  - Local farmers, including crop producing, as well as dairy and hog farms. The agricultural officer of Asikkala Municipality can help identify these.

  - Energy companies such as Gasum and Lahti Energia. It is important to gauge their interest in the project, as they are potential large investors.

  - As outlined in the challenges section, it is important to involve Asikkala Municipality in this project at an early stage, and to liaise with them throughout the project.

  - As the development of the project hinges on securing investment for the facility, there is a need to consult potential investors at an early stage. These include individuals, local businesses, and farmers.

- It is imperative that a biogas association is established. This organisation facilitates contact with companies, individuals, and other interested parties, and should keep a close collaboration with the Finnish Biogas Association.

  - An important task for the Biogas Association is to communicate with stakeholders – ProAgria and the Agricultural officer of Asikkala Municipality to reach farmers, and kesäposti to reach the general population.

- On par with this report, there is a need to make a detailed assessment of the actual availability of substrates in the region, as this is a prerequisite to secure contracts for substrates.

Near

- When the immediate priorities have been resolved, there is a need to settle on a location, as described in the challenges section.
- Once the potential investors have all been contacted, a financing plan should be established. It needs to be decided how large a loan to take, to apply for subsidies, and to sign contracts with the various investors.
- Based on the financing plan, an ownership structure should be established.

Future

Once the size of the plant is known:

- **Regulations and permits:** The relevant permits should be obtained, and legislation should be consulted to ensure that the plan obey by applicable regulations.
- **Substrates:** Long-term contracts for securing substrates should be signed with farmers and other suppliers.
- **Biogas:** Medium-term contracts for securing demand should be signed with potential procurers to ensure that demand exists in the first 2-3 years.
- **Advertising:** Through HINKU and using relevant outlets, the biogas plant and biogas in general should be advertised to potential customers.

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The International Institute for Industrial Environmental Economics

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