Reinforcing investments in biogas technologies for small-scale RES applications in islands

ACTION PLAN FOR THE ISLAND OF SAMSO

DELIVERABLE D7.2

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Table of contents

Summary

This Biores report proposes measures to implement on the island for the promotion of biogas projects. The objective is to overcome the difficulties faced in the island regarding the construction of biogas plants. The report first identifies and analyses non-technical barriers for investors, then it proposes means to overcome the barriers. The result is a list of actions suitable for a municipal plan or policy. The report aims at the planning officers, which author or edit municipal plans.

1. Introduction

This report is a result of the EU project Biores[1] (2007 - 2010). Biores concerns biogas on islands, and furthermore Biores focuses especially on municipal waste. The report is one of the mandatory deliverables in the project contract, and it builds on more than two years of joint effort by nine partners, including six European islands: Porto Santo (Portugal), Samos (Greece), Samso (Denmark), Sardinia (Italy), Tremiti (Italy), and Western Isles (Scotland).

1.1. Background

Landfill is a problem in all six Biores islands, and the Biores project focuses especially on biogas derived from municipal waste in order to reduce the demand for landfill. The project duration is 30 months, and the present deliverable is one of the last deliverables.

The proposed action plan in this report thus draws on most of Biores. The following six reports (deliverables Dx.x) provide input to the action plan:

- D2.2 *Report on biogas exploitation potential and energy end-use needs of the selected islands* (PEPS 2008)
- D3.3 *Environmental leaflet* (Biores 2009)
- D4.2 *Report on non-technical barriers faced in selected islands* (Jantzen 2008)
- D4.4 *Report on the results of SWOT analysis in the selected islands* (Venetis, Mourtos and Skouras 2008a)
- D5.1 *Financial mechanisms and regulatory recommendations for technologies based on biogas from waste* (Venetis, Mourtos and Skouras 2008b)

[1] http://www.biores.eu

- D5.2 *Guidelines for developing an action plan for overcoming non-technical barriers* (Venetis, Mourtos and Skouras 2008c)

In summary the reports concern three main topics: biogas potential, non-technical barriers, and financing. All the reports are available and downloadable from the project website.

The project emphasizes the role of non-technical barriers (emotional, environmental, safety) to biogas plants, because they can jeopardize an economically viable project at a late stage of the development phase. The project concerns only *communal* (central) biogas plants as opposed to individual farm plants.

1.2. Objective

Biores aims to overcome barriers, and this report seeks relevant actions to meet that objective. In more detail, the presented action plan aims at the following objective from the description of the project (Biores 2007, Annex 1 p 3).

- *Objective:* to overcome non-technical barriers and financing obstacles that hinder investing in energy production from biogas derived from waste.

The idea is to propose individual action plans tailored to each Biores island, using the knowledge and experience gained throughout the project period of Biores. The specific target is to reduce or overcome the previously identified non-technical barriers in the island. Hopefully the municipality will then make a commitment in accordance with the action plan. An example of such a commitment is to adopt one or more of the proposed actions in the official plans or policies.

The report progresses in two stages: first an analysis, which secondly leads to recommended actions. All chapters start with general findings, then they present findings specific to the island.

1.3. Existing Policies on Samso

On its homepage the Samso municipality publishes current plans and policies (Maps and Plans[2]). The plans and policies relevant to the present action plan are: municipal zone plan, waste plan, waste water treatment plan, business development plan, and the job creation plan.

[2] http://www.samsoe.dk

There is some cross-coupling between plans with respect to biogas. First, the site of a future biogas plant will have to be adopted in the municipal zone plan. Second, the waste plan and the waste water plan must be consulted if waste and waste water sludge is to contribute to the supply of a biogas plant. Third, a biogas development project should be coordinated with the business development plan and the job creation plan.

Samso has already included a biogas extraction facility in the municipal waste plan (Samso Kommune 2009).

2. Biogas Potential

The economic viability of a communal biogas plant depends among others on the steady and sufficient supply of biomass — essentially its carbon content — as well as the size of the plant. Large plants have an economic advantage of large scale operation, especially with respect to personnel salaries. On the other hand the creation of new jobs could be a municipal policy.

In an early phase of the Biores project we collected data from the municipality concerning the amounts of waste and biomass on the island (deliverable D2.2) in order to assess the potential biogas production.

2.1. Standard Plant Sizes

The *size* (capacity) of an anaerobic digestion plant can be expressed in terms of its daily input rate, that is, cubic meters of treated biomass per day. The plant size of the 20 communal plants in operation in Denmark varies from 27 cubic metres per day to 444 cubic metres per day (Hjort-Gregersen 1999). A socio-economic study of communal plants used three standard sizes: 300 m^3, 550 m^3 and 800 m^3 (Nielsen, Hjort-Gregersen, Thygesen and Christensen 2002).

The gas yield depends on the quality and the carbon content of the biomass input, and it varies from animal slurry at 20 m^3 biogas per m^3 slurry to high quality biomass at 98 m^3 biogas per m^3 biomass (Hjort-Gregersen 1999 Table 5.1). We have thus created Table 1 as a reference for comparing anaerobic digestion plants.

Table 1. Plant size reference. Chosen efficiency: 30 m^3 gas / m^3 biomass.

	very small	medium	large	very large
Biomass in [m^3/day]	30	300	550	800
Biogas out [m^3/day]	810	9 000	16 500	24 000
Biogas out [m^3/year]	300 000	3 300 000	6 000 000	8 800 000

2.2. Biomass Potential on Samso

The biogas potential from organic industrial waste on Samso is small (Fig. 1). Even so, the amount of industrial waste is about five times more than the organic municipal waste, and both kinds of waste cause problems with rats. The island has a relatively large potential from energy crops in fallow fields, potato tops, and vegetables.

The biogas potential amounts to 6.1 million m^3 biogas annually (Planenergi 2002). If all were to be processed in one plant, it would be large (Table 1), in fact larger than any of the 20 Danish communal plants (in 1999). The energy output from such a plant would correspond to 30% of the total energy demand of the island (500 TJ per year). A single plant that covers the whole island is less likely, but the calculation does provide an idea of the magnitude of the potential, as well as an upper limit to what can be achieved.

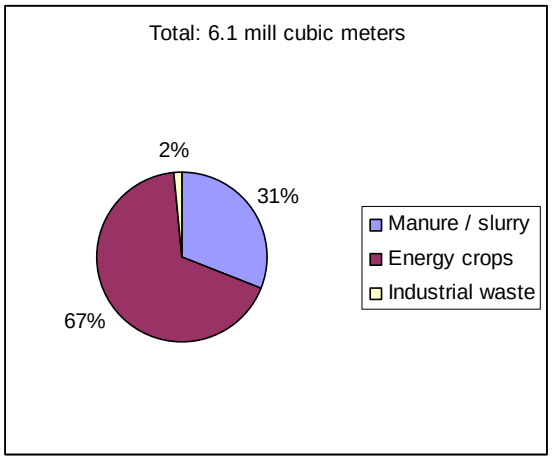

Figure 1. Biogas potential on Samso (Planenergi 2002).

3. Analysis of Non-Technical Barriers

If an investor expresses an opinion, which can be preceded by the sentence 'I am concerned that ...', then we regard it as a non-technical barrier. In order to convey the concept of a non-technical barrier to the stakeholders and between project partners, Biores defined it more succinctly as follows.

- A *non-technical barrier* (NTB) to a project is a hindrance due to human concern, as opposed to a technical hindrance. For example, 'I am concerned that the planned biogas plant will spoil the landscape' or 'I am concerned that it will be difficult to find enough local investors'.

Thus any concern, anxiety, or fear qualifies as an NTB. Biores performed a study of non-technical barriers (deliverable D4.2).

We composed a checklist that we presented to stakeholders on all six islands. It is not a statistical investigation; the aim is rather to check the presence or absence of the proposed barriers as sincerely as possible. We combined the checklist with a SWOT analysis (see below), and a scoring mechanism enables processing by computer. All six islands were analysed, and each island compared relative to the whole cluster of islands (deliverable D4.4).

3.1. Investigation Method

Appendix A shows just over 50 proposed barriers that we presented as a checklist to local experts. If the respondent answered *agree*, the barrier is present; if *disagree*, then it is not present, considering just the two options for simplicity. All items on the list are formulated in terms of a barrier, so they can be answered all in a uniform manner.

But we also wish to measure the strength of each barrier. Therefore each barrier had optionally seven answers, arranged on an ordered scale:

- (1.0) agree
- (0.8) more or less agree
- (0.6) slightly agree
- (0.5) maybe
- (0.4) slightly disagree
- (0.2) more or less disagree
- (0.0) disagree

The numbers in parentheses, invisible to the respondent, are *agreeability* scores similar to *fuzzy logic* truth values (Zadeh in for example Zimmermann 1993). We associate the scores with the answers in order to process the results by computer. The numerical score indicates the degree of presence of the tested barrier in the eyes of the responder. Thus a score of 1.0 indicates 'fully present', a score of 0.0 indicates 'not present', and an

intermediate score indicates present to a degree. Notice that a middle score of 0.5 indicates 'maybe present', and the numbers on the scale are unequally spaced.

We regard the score of 0.5 as neutral, and anything above 0.5 represents the presence of barrier to a degree. But we also regard scores below 0.5 as an incentive. This reflects our expectation that barriers are at least 'maybe present' in a project, and if a respondent answers that a barrier is *not* present to some degree, it is a relative incentive. With some scores indicating a barrier, and some scores indicating an incentive, we can average all respondent scores to deduce the overall level of barriers, a single number.

SWOT analysis is a method for analysing success factors of a business proposal, project, or any other objective for that matter. Factors which are *internal* are classified as either strengths (S) or weaknesses (W), and factors which are *external* are classified either as opportunities (O) or threats (T). For a brief introduction to the method, see Kneale and Aspinall (2003), and for an application to regional energy planning with respect to renewable energy, see Terrados, Almonacid and Hontoria (2007).

We performed a SWOT analysis on the non-technical barriers. We distinguish between barriers *internal* to the geographical boundary of the island, and *external* to the boundary of the island. Roughly speaking, internal NTBs are susceptible to our actions, while external NTBs are beyond our control. We group the barriers under the general categories:

- administrative barriers,
- regulatory barriers,
- economic/infrastructure barriers,
- financial barriers,
- product markets/competition/risk perception barriers,
- public awareness & acceptance barriers, and
- user defined barriers.

The categories are arbitrary, but we believe they cover the area well (deliverable D4.4). The last category is an open category that accommodates barriers that were not anticipated. The categories were identified, adjusted, and finally agreed upon in consensus by a group of experts, namely the members of the Biores project management group. Appendix A contains the checklist scores from all six islands, divided into internal and external barriers.

Figure 2 shows the average scores for each island. The plot indicates that all islands have an incentive toward biogas (level under 0.5), although Samos and Tremiti are close to being neutral. Sardinia has the largest incentive, and in fact Sardinia has already one biogas plant that exploits biogas from landfill (Serdiana, see EPTA, deliverable D2.3).

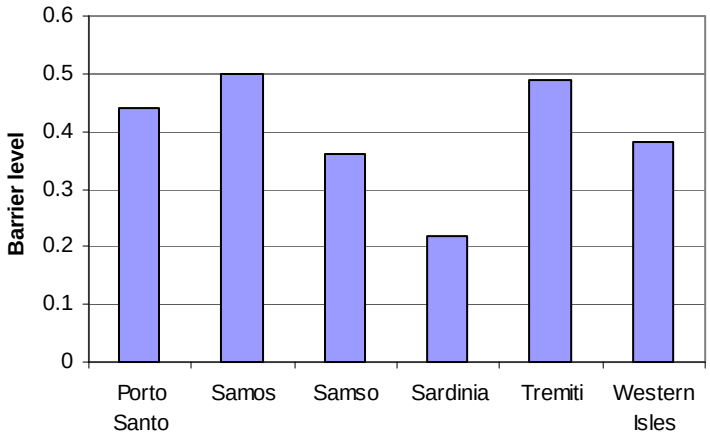

Figure 2. Average barrier levels. Level 0.5 is neutral, and levels below 0.5 indicate an incentive to a degree, the lower the better.

3.2. Barriers on Samso

We identified several barriers in Samso, but not an unusual amount compared to the cluster of six islands. Without subsidies a biogas plant is considered a risky investment, and in fact no new plants were built in Denmark after the subsidies ceased in 2002. On the other hand there are new subsidies starting from 2010.

We focus on the internal barriers, those that are susceptible to our own actions. Table 2 gives an overview of the strongest barriers we identified, those that scored 0.8 or higher. Samso has major internal NTBs in four categories: 1) economic / infrastructure, 2) financial, 3) product markets / competition / risk perception, and 4) user defined. There is one barrier lurking under the surface: location. If a controversial location is proposed, there will be public opposition, but since we have not had any location in mind yet, this barrier was not investigated.

The average level of internal barriers is 0.38 (Appendix, section A3), which indicates the internal barriers together do not represent a problem; there is rather a slight incentive compared with neutral at 0.5.

Table 2. Internal barriers at Samso.

Category	Barrier	Comments
Economic / infrastructure	There are restrictions and/or uncertainties in the supply of municipal organic waste to the biogas plant.	The amount of municipal organic waste is small, and there is no separation of organic waste from the rest. The municipality has no direct incentive to build a biogas plant, and waste is shipped to the mainland. If the organic fraction were separated and treated in a biogas plant instead, some shipping costs can be saved. There is an amount of biomass in the farm fields five times as large as the biomass potential in municipal waste. To protect the ground water and reduce the population of rats, the municipality may have a derived interest in a biogas plant. The farmers on the island will be able to supply a biogas plant, but there will likely be a seasonal variation. Manure from cows and pigs contribute the most to the biogas potential, and manure pipelines have earlier been proposed to supply a biogas plant (Planenergi 2002).
Financial	It is difficult to obtain financial support for items such as: operational costs, maintenance costs, creation of a consumer service office.	There will be government subsidies in the three years 2010 – 2012. They cover construction costs (20% subsidy + 60% loans with a municipal guarantee), not operation and maintenance. The operation of a plant could be hampered by variation in the input feed to the plant, and somewhat uncontrollable. If sludge wagons are required, there will be salary expenses to drivers, and maintenance of the vehicles. On the other hand there will be new jobs.
Product markets / competition / risk perception	We have technologies for treating municipal and industrial waste that can compete with a biogas plant. Local entrepreneurs consider the biogas plant as a high risk investment. We can get other biomass fuels (such as wood chip, straw, ethanol) that compete with biogas heat production (if heat option is available).	The municipal waste is compressed and shipped to the mainland, where it is incinerated, and the heat used for district heating. This solution prolongs the lifetime of the landfill, and the energy in the waste is exploited. It is thus a competitive solution to a biogas plant. There are 19 communal plants in Denmark, and their operation has become more stable, and profitable, over the years due to the experience of the plant operators. The investment is still considered risky, because the economic viability seems to be on the balance point. Large plants have better economy, but a plant on Samso would be medium size. For the district heating plants, we already have other biomass fuel than biogas.
User defined	Local bad experiences discourage landfill gas recovery.	There was an experiment with a privately owned biogas extraction plant in an abandoned landfill, but it turned out that the gas content in the landfill was too small. This may discourage private investors, but not the municipality (confer the waste plan).

4. Economic and Financial Issues

An earlier Biores deliverable provides a review of common financing models (Biores deliverable D5.1). These form a catalogue of standard models that we can pick from and adapt to the local island conditions.

4.1. Standard Financing Models

Figure 2 shows potential financing sources for a project. In the centre is the specially created company that will handle the financial development of the investment. All other boxes depict potential financing sources with the most important lying at the top left box, namely the local community contribution. The financial sources are not mutually exclusive.

Financial support mechanisms for renewable energy projects can be divided in two groups: a) governmental instruments and b) other market based financial instruments. The latter do not exclude public sector participation (for example Public-Private-Partnerships mostly for large scale investments).

Governmental instruments are grouped into price-support schemes, and compensation schemes. In the private sector *project finance* is a method for obtaining commercial debt financing for the construction of a facility. Project finance is paid back from the cash flow generated by the project. The project's assets, rights, and interests are held as secondary security or collateral.

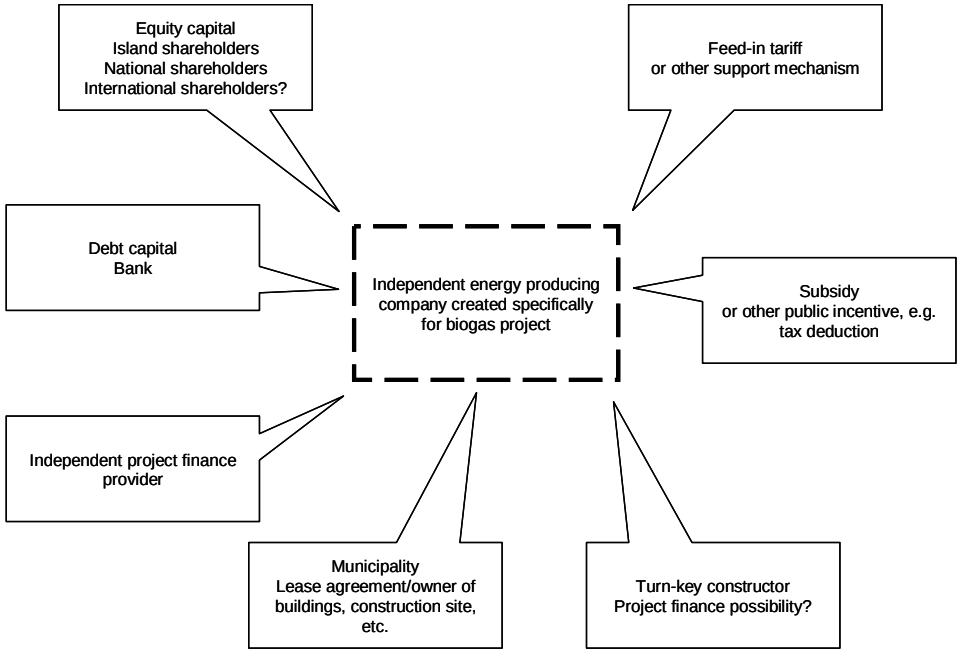

Figure 3. Financing sources (adopted from deliverable D5.1).

4.2. Financing Models Suitable for Samso

Samso has already implemented several of the standard financing schemes in previous renewable energy projects. The following is a list of financial sources that could be relevant for a biogas project at Samso.

- *Feed-in tariff*. This is to support the adoption of renewable energy through government legislation. The electric utility company is obliged to buy electricity from renewable sources at above market rates. The rates are set by the government. With the energy agreement in parliament in 2008, the feed-in tariff rose from 0.60 DKK to 0.745 DKK per kWh (0.08 to 0.10 EUR / kWh). For comparison, the feed-in tariff for wind turbines is 0.43 DKK (0.057 EUR/kWh) (if they are commissioned before January 2003 and for the first ten years of operation). It is an incentive, and as a consequence the national biogas production is expected to triple by the year 2020.
- *Subsidies*. In the coming period 2010 - 2012 the government intends to subsidise the construction of new biogas plants (Biogasbranchen 2009). There will be 85 million DKK per year (11.3 mill EUR) to support start-up costs by 20%. Communal biogas plants can further borrow 60% through loans guaranteed by the municipalities. Biogas will likely be treated financially as natural gas, in case the gas is sold for district heating. The municipalities will be obliged to include areas for biogas plants in the municipal zoning plans. The government will re-evaluate the plan in 2012, to decide if further action is necessary.
- *Municipal ownership*. Even though the Samso municipality is exceptionally small in Denmark, and its economy vulnerable, the municipality could still own a biogas plant. There is such an example in the case of the offshore wind turbines, where the municipality borrowed 125 million DKK (17 mill EUR) and bought five wind turbines. Each citizen is said to own a share of the plant, in this case 31,000 DKK (4,200 EUR). If there is a profit eventually, it must be paid back into energy projects, and not spent on the operation of the municipality itself.
- *Third-party financing*. Third party financers for renewable energy projects are referred to as Energy Service Companies, ESCOs. They are companies that finance, design, build, commission, operate, and maintain energy plants. We have such an example in the Nordby-Maarup district heating plant (wood chip plus solar), where the utility company NRGi is the ESCO. The consumer pays to NRGi a fixed subscription fee plus a payment proportional to his energy consumption. The larger Tranebjerg district heating plant is financed and owned the same way.
- *Project financing*. Long term financing of a new company (Special Purpose Company, SPC), that operates the plant; such that the assets are separate from those who propose the project, the *proponents*. The SPC is financed by equities. The amount could be 20% of the construction costs while

the remaining 80% are obtained through a loan (obligations). The proponents are more or less protected from a possible failure of the project.

- *A cooperative*. Farmers have always shared the cost of, say, machinery (harvesters) or buildings (ice houses), and the idea of sharing a biogas plant in a cooperative will be familiar. One example is a wind turbine (Paludans Flak I/S) sold in 7,765 shares, each corresponding to 1,000 kWh of the nominal annual energy production. The cost of the wind turbine was 25 million DKK (3.3 mill EUR), and one share costs 3,150 DKK (420 EUR). A Special Purpose Company (legally a partnership) distributes the annual income as untaxed dividend to the shareholders after deduction of the operating costs. The company does not pay tax, but the partners pay tax of the dividend. Another case is the Ballen-Brundby district heating plant, which is owned and controlled entirely by the consumers connected to the heating network (legally a partnership with limited liability).

4.3. Computer Results for Samso

The feasibility study by Planenergi (2002) proposed several plants, the largest of which covered the southernmost part of the island — the study named the plant *Samso South*. A total of 13 farms could supply the proposed *Samso South* through underground pipes, thus saving sludge wagons. The length of the transmission pipe is 13.8 kilometres. The size of the plant is 2 million m^3 biogas / year with a feedstock of 61% slurry plus solid manure, 34% solid biomass, and 3% organic waste. Thus its size corresponds roughly to 2/3 of a medium size plant (Table 1).

The study calculated the construction costs at 20 million DKK (2.6 million EUR) with a payback period of 8.4 years, using compound interest and with a 20% subsidy (Planenergi 2002, p 49).

The Biores decision support system DSS calculated a basic model with construction costs at 20 million DKK (2.6 million EUR) with a payback period of 2 years, using compound interest with a 20% subsidy. The detailed results are in the Appendix (A2), as well as the inputs that generated those results (A1).

The two results differ somewhat due to differences in the assumptions, since it was not possible to feed the DSS the exact same inputs. For example, Planenergi proposed to use underground twin pipes for the slurry, but this option is not available in the DSS. The study by Planenergi is much more detailed, and it is custom-made, therefore more precise.

The DSS also calculates the option of extracting gas from the landfill. In comparison it is a worse investment with respect to payback period (no profit), but the investment costs are lower: 1.3 million DKK (0.17 million EUR) versus 20 million DKK (2.6 million DKK) for the anaerobic digester. The DSS shows that the landfill extraction plant creates fewer jobs (3) than the anaerobic digester (9). With respect to odour reduction and sanitation the landfill is worse (score 1) than the anaerobic digester (score 6).

The results show that landfill gas extraction is the more risky option (long payback period). An anaerobic digester is the more expensive option, but with a better payback period, and it entails other benefits.

5. Willingness to Invest

Even if a project seems unprofitable, it might still be attractive due to its benefits. The situation is especially prevalent in public projects, where socio-economic benefits are weighted higher than in private projects. A cost-benefit analysis is generally laborious, and we have not made one, but instead tried to assess the willingness to invest in a biogas project by interviewing experts.

5.1. Investigation Method

We presented the following proposition to local experts: *If the investment is risky but there are no barriers, then invest*. If the answer is *agree*, it indicates a willingness to invest, despite the risk. It also indicates that the absence of barriers is an incentive that affects the willingness to invest positively. The selection of possible answers is the same seven point scale of agreeability as previously used for barriers. We formed a block of four similar propositions:

1. If the investment is risky and there are barriers, then invest.
2. If the investment is risky but there are no barriers, then invest.
3. If the investment is not risky but there are barriers, then invest.
4. If the investment is not risky and there are no barriers, then invest.

Here line 2 is the same as the proposition mentioned previously, and the remaining three are variations derived by negating two terms on the left hand side of the comma. Appendix A shows the scores from all the islands (Table 7). We also made a fifth proposition

5. A biogas plant is a risky investment

The answers vary significantly from island to island (Appendix, section A5). Figure 4 is a plot of the resulting score for each island. Three islands are willing to invest to a degree, two islands are undecided, and Samos is more or less unwilling to invest. Samos has a relatively high level of barriers compared to the other islands (Fig. 2), and Samos perceives the investment as risky.

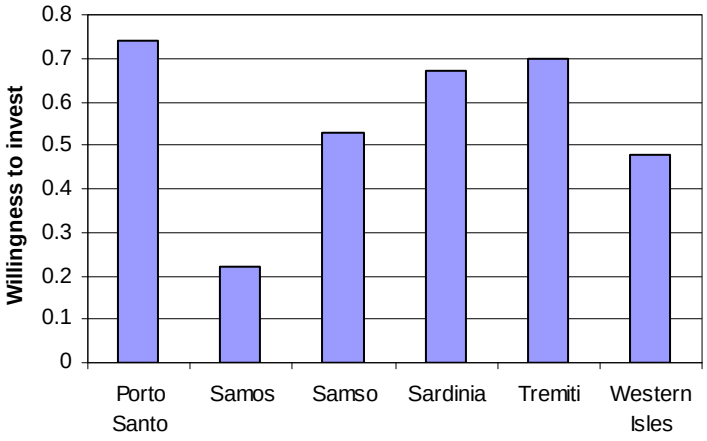

Figure 4. Willingness to invest. A score of 0.5 or higher indicates a willingness to invest, the higher the better. The result for each island is the combination of the scores from propositions 1 – 5.

5.2. Results from Samso

An overall assessment is that Samso is undecided toward investing in a biogas plant (in Fig. 4 the score is close to 0.5). This is mainly due to the lack of government subsidies, in other words the economic viability is uncertain.

The Samso scores to propositions 1 - 4 above are, in order: 0.0, 0.6, 0.2, and 1.0 (Appendix A). The first and the fourth answers are common sense and not surprising: if there is risk and barriers there is *no* willingness to invest, and if there is *no* risk and *no* barriers, there is a willingness to invest. We also found:

- Risk is *slightly* acceptable (0.6) from proposition 2, and
- barriers are *more or less* unacceptable (0.2) from proposition 3.

We deduce that barriers are more prohibitive than risk. Samso does have barriers, but only a medium amount compared to the other islands (Fig. 2).

Although the financial situation is tight with only 4 000 inhabitants, the Samso municipality has been supportive to renewable energy projects in the past (wind turbines, district heating plants, private installations). Clearly, the cost or viability of a project is just one of several factors affecting the decision to invest in a project. For example, the *Samso South* biogas plant requires almost the same investment as an offshore wind turbine, and these did find investors.

In case the government subsidizes a project, the risk decreases, and the willingness to invest will increase. If also the ownership shifts toward the farmers, so that the investment barriers related to municipal waste are diminished or disappear, the willingness to invest will also increase.

6. Short, Medium, and Long Term Guidelines

Biores deliverable D5.2 provides guidelines for an action plan. It classifies the actions into three groups characterized by their time-horizon, namely: short-term, medium-term, long-term. As the horizon increases the generality of the proposed actions necessarily increases. The document provides a catalogue of guidelines to pick from and it provides inspiration for proposing local guidelines.

6.1. General Guideline

A general guideline for overcoming the barriers is to focus the action plan on *internal* barriers, since they are by definition more susceptible to our actions than the *external* barriers.

The external barriers should be monitored nevertheless; should external events resolve those barriers, it will be an incentive, and we must be aware of it.

6.2. Guidelines for Samso

The tables below group actions according to time horizon: 1) short term, which can be done almost immediately (Table 3); 2) medium term, which can be done during planning and construction (Table 4), and 3) long term, to be done after a plant is built (Table 5). Each action is associated with an estimated time frame in years as an attempt to increase precision.

Each action is further associated with a barrier category. It is thus clear how the actions strive to overcome the barriers identified in Biores.

Of all the proposed actions, the most forceful concerns the municipal zoning plans. It is likely that the government will require that the municipalities reserve an area for biogas in the municipal plan.

Table 3. Short term guidelines.

Barriers addressed	Action	Time frame
Economic / infrastructure	*Exploit the vegetable waste*. Focus attention on the farmers. Inform the farmers through the farmers' association, for example by giving a course or a presentation during winter time, when the farmers are less busy. *Secure biomass supply*. Encourage farmers to deliver vegetable waste from their fields, by arguing that they will avoid the alternative gate fee at the waste facility. *Encourage the municipality*. Calculate the municipal savings from keeping organic waste on the island, instead of shipping it to the mainland for incineration. The savings could contribute to the cost of separating organic waste from the rest.	2010 - 2011
Financial	*Achieve joint ownership*. Propose a joint ownership between farmers and the municipality. Propose also a shareholding company, so that ordinary citizens get the opportunity to buy a share of the operation. Explain also other ownership models (see D5.1). *Exploit subsidies*. Inform about the government subsidies expected in 2010 - 2012 under the so-called Green Growth plan. *Municipal loans*. Biogas investments, and particularly small-scale ones, are traditionally considered as capital intensive since the equipment embodies the lifetime of fuel supply. Local stakeholders, in particular island authorities should help by offering coordination amongst involved parties (e.g. farmers and investors or local investors and banks). By capitalizing on local biogas plants, the authorities could advance low-risk investments that will pay themselves back directly in loan repayments and indirectly in the form of increased tax revenues and decreased state expenditures.	2010 - 2012
Public awareness & acceptance	*Improve public awareness*. Publicize all positive aspects of biogas plants (see D3.3). Publish an article in the local newspaper showing there are people working on the subject, and publish a contact point.	2010

Table 4. Medium term guidelines.

Barriers addressed	Action	Time frame
Product markets / competition / risk perception	*Provide guarantees*. Issue a guarantee to the farmers that they will not have to pay a gate fee to the biogas plant. *Secure supply*. Give farmers an incentive to secure the animal manure and vegetable supply. Give the waste water treatment plant an incentive to supply sludge to the biogas plant.	2010 – 2020
Regulatory	*Clarify legislation*. Clarify and facilitate legislative incentives to deliver agricultural, industrial and urban organic wastes to the biogas plant. *Zoning*. Biogas installations will be accelerated by pointing out the appropriate sites. The municipal plan should identify the areas where anaerobic digestion facilities would be, and provide zoning regulations. This guideline is already in the national Green Growth plan, and may become a requirement for the municipality.	2010 – 2012
Administrative	*Create directory*. Create an easily accessible EU directory of turn-key construction companies for biogas installations. Although a country categorization of these companies is immediately obvious, we should bear in mind that many companies are active internationally especially within the EU boundaries (and beyond of course). Such a directory will promote competition within the sector, thus forcing cost reductions. *Create a directory*. In a similar approach an EU directory of financial companies that ease or favour renewable energy projects by offering project finance alternatives, third party financing, and other financial support should be made publicly available and straightforwardly accessible. Such a development will provide a point of origin for investment efforts and a basis for the solution of financial problems linked to the difficulty of raising the necessary investment funds. *Collect data*. During the last 20 years there has been a large increase of biogas plants in Germany. Data from here can be exploited for further research on the economy, market and finance related barriers reaching statistically robust conclusions. As an example, a Biores partner has gathered, with difficulty, a European-wide (and technologically diverse) database for 80 biogas plants covering at least 25 years (the oldest plant construction took place in 1984 and the latest in 2008). A first econometric analysis of the investment cost data based on 2008 prices shows a steady decrease of around 2% per year (in real terms) in investment costs, with evidence of acceleration during the last decade as technology diffuses faster across Europe.	2011 – 2012
Economic / infrastructure	*Public transportation*. Local island authorities could make commitments to use upgraded biogas in public transport fleets.	2011 – 2021

Table 5. Long term guidelines.

Barriers addressed	Action	Time frame
Economic / infrastructure	*Research*. Direct attention to research programs that motivate recycling of organic waste, especially that of high energy potential.	2010 – 2025
Product markets / competition / risk perception	*Technology transfer*. Participate in the meetings of the national biogas association in order to receive and promote technology transfer.	2010 – 2020
Public awareness & acceptance	*Tourism*. Promote the participation of the tourist industry in biogas solid waste management solutions. Increased seasonal energy demand could be partially handled using excess waste generated by the tourist inflow. Hotel units could generate a critical mass of food wastes with high biogas potential.	2010 – 2025

7. Conclusions

This document eventually proposes actions to be incorporated in a municipal plan. The proposed actions are the result of more than two years of work by nine partners in the Biores project, and the result builds on quantitative and qualitative analyses of external and internal factors.

7.1. General Conclusions

At the outset, the objective was 'to overcome non-technical barriers and financing obstacles that hinder investing in energy production from biogas derived from waste'. Strictly speaking, the present action plan does not in itself overcome the barriers, because it is just a plan, and implementation work remains to be done to meet the objective. It is nevertheless an instrument, and the plan is mature enough for whole or partial implementation.

A final goal of the Biores project is to achieve a commitment from the local authorities to implement the action plan. It is not yet clear what form this commitment will take. It is unlikely that a municipality will commit themselves to implement this entire action plan, but on the other hand it seems feasible to include parts of the plan in future municipal policies. The willingness to consider this could be stated in a letter of intent from the municipality and thus provide documentation to the funding agencies of Biores.

7.2. Conclusions for Samso

The results indicate that the willingness to invest is undecided at Samso. But Samso is in a special situation: from now on the government will start subsidizing biogas plant construction. This will improve the economic viability of such a project. Barriers related to financing and risk will decrease in strength, and the remaining barriers seem possible to overcome.

Municipal waste contributes only little to the biogas potential, compared to vegetable and animal waste, but it will still be in the interest of the municipality to participate. The municipality could save expenses on shipping waste to the mainland, it could collaborate regarding the planned municipal landfill gas facility, its waste water sludge could be treated in a biogas plant, and problems with rats could be reduced. There is a derived benefit from the creation of new jobs and a new business. A biogas plant is a recycling component, and the resulting increase in sustainability may have a positive effect on tourism and the settling of new islanders. A biogas plant is certainly in agreement with the national government's long term planning.

A national plan may require that the municipality points to an area suitable for a biogas plant in the municipal plan. Samso had a biogas plant earlier, but it is no longer in operation; that site could be an option. Another option is perhaps a site next to the landfill; that would likely be acceptable by the public.

We thus predict that the willingness to invest will increase from 'maybe' to a level closer to 'yes'. We predict this will happen within the governmental support period 2010 – 2012, and possibly in 2011, and thus after the closing of Biores. This is good timing, because the Biores results will be complete and fresh.

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Appendix A: Data and Computer Results

A.1. Samso base model inputs to the decision support system DSS (www.biores.eu)

Variable	Value
Is there an existing AD plant?	no
Is there an existing Landfill?	yes
Is there space for an AD Plant next to the Landfill?	yes
Is there an existing WWTP?	yes
Is there space for an AD Plant next to the WWTP?	no
Is there space for an AD Plant somewhere else?	no
Project Location:	Harpesdal
Country:	Denmark
Which currency do you want to use?	Other
Please provide a 3-letter abbreviation for the currency:	DKK
Please provide the conversion rate (Euros to 1 unit of your currency, e.g 0.13):	0.1333
Municipal Solid Waste generated (kg/capita/day):	1.5
Year of Investment:	2011
Investment Lifetime:	20
Permanent Population:	4000
Additional Seasonal Population:	36000
Average number of **days** seasonal visitors / tourists stay on the island:	7
MSW Organic Matter (fraction in range [0..1]) :	0.2
Cost of Land to be bought for the new Plant (Currency/m2):	0
Fuel cost (Currency/lt) for feedstock transportation (e.g. MSW, manure etc):	9
Renewable Energy	100
Average Gross Monthly Cost per employee (Currency):	25000
Investment Capital Cost Subsidy (%):	20
Investment Discount Factor (discount rate %):	6.5
Estimated Annual Avg. Inflation Rate over the Investment lifetime (%):	3
Tax Rate on Profits (%):	0
Permanent Population served by Landfill (%):	100
Year landfill Opened:	1986
Last Year Landfill Used:	2026
Landfill Surface Area (m2):	10000
Landfill Average Height (m):	8
Is there an existing Collection System?	yes
Area to be bought next to Landfill (m2):	0
Would you like to apply Digestate Treatment?	no
MSW:	yes
Manure:	yes
Industrial:	yes
Solid Waste to be used (%):	100
What will be the separation method?	at source
Cattle	1100
Pig	1800
Vehicle Operation time to transport manure to the plant (hr/day):	7
Vehicle Power needed for the Manure transportation:	200 hp
Agricultural Information: Grass	125 ha
Vehicle Operation time to transport industrial waste to the plant (hr/day):	0
Vehicle Power needed for the industrial waste transportation:	0
Final usage type:	CHP
Type of Technology	Industrial
Electricity Selling Price (Currency/KWh):	0.745
Thermal energy selling price	0.115
Do you wish to specify a new NTB?	no
barriers	all blank
NPV weight	100
IRR weight	100
PP weight	100

A.2. Samso base model outputs from the decision support system DSS

Performance Matrix

ECONOMIC CRITERIA AND NTBS

Valid Options	NPV	IRR	PP	Investment Cost	Internal Barriers	External Barriers
Weight:	100	100	100	0	0	0
Option 3	259605932,2	89,94	2	20034922,8	0	0
Option 4	-3731158	-97	>20	1258973,7	0	0
Option 6	0	5	0	0	0	0

SOCIAL CRITERIA

Valid Options	Odour Reductions & Sanitation Improvement [0..10]	No of new jobs	Energy Coverage (%)
Weight:	0	0	0
Option 3	6	9	0,23
Option 4	1	3	0,07
Option 6	0	0	0

ENVIRONMENTAL CRITERIA

Valid Options	GHG Emission Reduction (1000m3/yr)	Fossil fuel savings (tn/yr)	Replaced tons of Chemical fertilizers (tn/yr)
Weight:	0	0	0
Option 3	79319,7	638	0
Option 4	25259,8	203,2	0
Option 6	0	0	0

Note on Options:

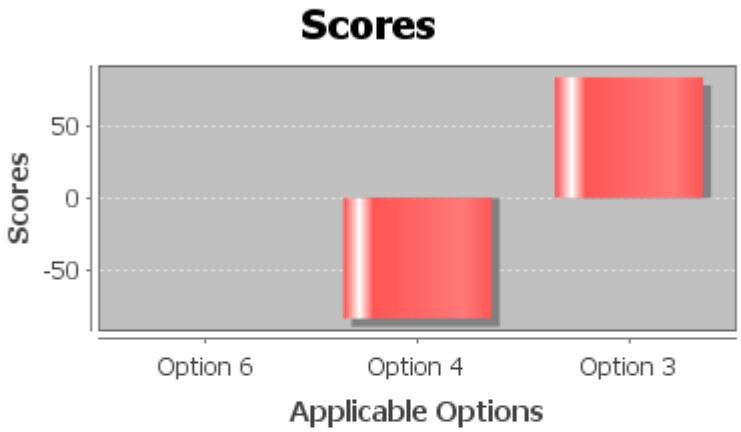
- *Option 1: Upgrade existing anaerobic digestion biogas plant*
- *Option 2: Anaerobic digestion biogas plant*
- *Option 3: Anaerobic digestion biogas plant next to landfill*
- *Option 4: Landfill biogas recovery plant*
- *Option 5: Anaerobic digestion biogas plant next to wastewater treatment plant*
- *Option 6: Do NOT invest*

Note on Criteria:

- *NPV: Net Present Value. General interest financial criterion. Widely used*
- *IRR: Internal rate of return (%). General interest financial criterion. Widely used along with NPV.*
- *PP: Payback period. It presents particular interest for project finance or third party finance initiatives*

MCDA Results

The chart below displays the overall scores of the applicable Options. View the chart in normal size.



Some important notes on the MCDA scores for the applicable Options:

- A positive score represents a preferred option when compared to the alternative options.
- If more than one options have a positive score, a higher value indicates a better (more preferred) investment option.
- *In general, the higher the better !*

Valid Options	Results
Option 3	83,3
Option 4	-83,3
Option 6	0

The Optimum investement Option is: Option 3. Some of its criterion results may be found in the table, below.

Criteria	Scores
Net Present Value	276765278,6
Investement Cost	20316129,1
Payback Period	2
External Non-Technical Barrier	0
Internal Non-Technical Barrier	0
Biogas Produced	1835706,64

What-If analysis based on different combination of Final Biogass Usage Types (eg. CHP, Electricity Production) and Technologies (eg. Industrial, Microturbines) has taken place for Option 3. The analysis focused on income and cost (%) difference with respect to your energy choices. The results are shown below:

Usage Type / Technology	Difference in expected income from energy (%)	Difference in required technology implementation cost (%)
EP / Turbine	-248,83	71,01
EP / Internal Combustion Engine	-248,83	71,01
CHP / Microturbines	30,77	52,07
EP / Microturbine	-298,66	62,13

Note on Options:

- *Option 1: Upgrade existing anaerobic digestion biogas plant*
- *Option 2: Anaerobic digestion biogas plant*
- *Option 3: Anaerobic digestion biogas plant next to landfill*
- *Option 4: Landfill biogas recovery plant*
- *Option 5: Anaerobic digestion biogas plant next to wastewater treatment plant*
- *Option 6: Do NOT invest*

A.3. Internal barriers, scores from all islands

No	Category	Barrier	Porto Santo	Samos	Samso	Sardinia	Tremiti	Western Isles
1	Administrative	Too many *internal* agencies and authorities take part in the authorization process (e.g licencing, environmental assessments, installation permit, operation permit)	0.6	0.8	0.0	0.4	1.0	0.4
2	Regulatory	Local regulations discourage the delivery of industrial waste to a biogas plant (e.g. gate fee)	0.0	0.2	0.6	0.0	0.8	0.0
3		Local regulations discourage the delivery of agricultural waste to a biogas plant (including manure and other animal waste products)	0.0	0.2	0.0	0.0	0.8	0.2
4		Local regulations discourage the delivery of sewage treatment waste in biogas production	0.0	0.2	0.0	0.0	0.5	0.8
5		Local regulations discourage landfill biogas recovery	0.5	0.0	0.0	0.0	0.0	0.4
6	Economic / infrastructure	It is difficult to distribute heat produced at the biogas plant	0.8	1.0	0.0	0.6	1.0	1.0
7		There are restrictions and/or uncertainties in the supply of municipal organic waste to the biogas plant	0.6	0.5	0.8	0.0	0.2	0.0
8		There are restrictions and/or uncertainties in the supply of industrial or agricultural organic waste to the biogas plant	1.0	0.0	0.0	0.0	0.8	0.2
9		The sale of biogas will be limited at times (by inadequate distribution network, storage capacity, demand)	0.2	1.0	0.0	0.5	0.5	0.5
10		The biogas plant will have a negative impact on tourism	0.0	0.6	0.0	0.0	0.0	0.5
11		There are serious land limitations for this type of investment (limited available land, next to tourism industry facilities, or other)	0.0	0.5	0.2	0.0	0.0	0.5
12	Financial	It is difficult to find enough local investors (local investment scheme will not be supported)	1.0	0.8	0.6	0.6	0.2	1.0
13		It is difficult to obtain financial support for items such as: operational costs, maintenance costs, creation of a consumer service office	1.0	0.8	1.0	0.2	0.2	0.0
14	Product markets / competition / risk perception	We have technologies for treating municipal and industrial waste that can compete with a biogas plant	0.0	0.0	1.0	0.4	0.0	0.0
15		We have commercial fertilizers at low cost that can compete with the digestate	0.0	0.5	0.6	0.4	1.0	0.0
16		Local entrepreneurs consider the biogas plant as a high risk investment	0.5	0.8	0.8	0.4	0.0	1.0
17		We can get other biomass fuels (such as wood chip, straw, ethanol) that compete with biogas heat production (if heat option is available)	0.0	0.0	1.0	0.0	0.6	1.0
18		We can grow energy crops, not intended for biogas, that compete with biogas crops	0.0	0.0	0.0	0.0	0.6	0.0
19	Public awareness & acceptance	There is lack of information and awareness regarding biogas plants among our residents (for example low awareness of benefits of biogas energy production)	1.0	1.0	0.6	0.6	1.0	0.8
20		There is lack of social acceptance and local participations towards implementation of renewable energy projects (this type of biogas investment in particular)	0.5	0.6	0.0	0.4	0.4	0.8
21		Our farmers have only limited knowledge about the agricultural by-products from biogas production	1.0	1.0	0.4	0.4	0.8	0.8
22		*Local* authorities or organisations (environmentalist organisation, or other) will oppose to this type of biogas investment	0.0	0.6	0.4	0.0	0.6	0.0
23		There will likely be opposition from the public on the island	0.2	0.8	0.6	0.0	0.5	0.0
24	User defined	Local bad experiences discourage landfill gas recovery			0.8			
25		Local bad experiences from previous projects discourage a biogas project			0.0			
26		8 provinces, 376 local communities, 1 central government can represent a barrier				0.5		
		Average	0.39	0.52	0.38	0.23	0.50	0.43

A.4. External barriers, scores from all islands

No	Category	Barrier	Porto Santo	Samos	Samso	Sardinia	Tremiti	Western Isles
1	Administrative	The authorization process is so slow, that investors may loose interest (for example more than 6 months)	1.0	0.8	0.8	0.5	0.8	1.0
2		Too many *external* agencies and authorities take part in the authorization process (e.g construction permit, location permit, licensing, environmental assessment, veterinary permit, operation permit)	0.5	0.8	0.6	0.5	1.0	0.0
3	Regulatory	The authorizing agencies are slow to coordinate due to overlap in roles, responsibilities and functions	0.6	0.6	0.2	0.4	1.0	0.5
4		External regulations restrict the supply of organic waste to a biogas plant	0.0	0.0	0.0	0.2	0.2	0.0
5		External regulations discourage cooperation with the private sector (industry, agriculture)	0.0	0.0	0.0	0.0	0.2	0.0
6		External regulations discourage cooperation with the municipality	0.0	0.2	0.0	0.0	0.2	0.0
7	Economic / infrastructure	Investors get limited and/or uncertain guarantees for sales amounts	0.5	0.5	0.4	0.2	0.0	0.0
8		The (selling) price support system for this type of biogas investment is inadequate (feed-in-tariff, quota based support system, or other)	0.5	0.0	0.2	0.0	0.2	0.0
9		Biogas is difficult to sell, because it is more expensive than other biofuel (wood chips, straw, etc.)	0.5	0.0	0.5	0.0	0.0	0.5
10		There is tax on biogas and heat generated from biogas (energy and CO2 taxes)	0.5	0.0	0.0	0.0	0.0	0.0
11	Financial	National support is inadequate (investment cost subsidy, interest rate subsidy, tax reduction or exemption, other)	0.2	0.2	0.6	0.0	0.4	0.0
12		National support through suitable loan mechanisms is weak (for example national funds for environmental protection, waste management, renewable energy development, loan guarantee, etc.)	0.2	0.8	0.5	0.2	1.0	0.0
13		Energy crop cultivation is not subsidised	0.5	1.0	0.6	0.0	0.2	0.5
14		Access to capital and financial products of commercial banks is limited for this type of biogas investment	0.8	0.8	0.2	0.5	0.8	1.0
15		Third party financing for this type of biogas plant investment is limited	1.0	0.6	0.8	0.0	0.8	1.0
16		Project financing for this type of biogas investment is limited	1.0	0.2	0.6	0.0	0.8	1.0
17	Product markets / competition / risk perception	The biogas plant market is immature (few or unavailable existing plants, few or unavailable turn-key construction companies, uncertain cash flows, etc) such that investment costs are high	1.0	1.0	0.2	0.6	0.2	1.0
18		It is difficult to obtain contracts with heat plants	0.6	1.0	0.0	0.2	0.5	0.0
19		It is difficult to obtain contracts with electricity distributors	0.0	0.0	0.0	0.0	0.0	0.0
20		It is difficult to consume all the digestate	0.5	0.5	0.2	0.2	0.8	0.0
21	Public awareness & acceptance	There is a lack of information and awareness among policy makers and regulators regarding biogas potential and benefits (economic, social, environmental, etc)	0.5	0.8	0.0	0.5	0.8	0.0
22		There is a lack of information and awareness among the touristic visitors (for example low awareness of benefits of biogas energy production)	0.0	1.0	1.0	0.5	0.8	0.5
23	User defined	Political strategic and priority resistance	0.6					
24		Contractual problems, competition for waste	0.6					
25		Transportation distances collecting material				0.6		
		Average	0.48	0.49	0.34	0.22	0.49	0.32

A.5. Willingness to invest, scores from all islands

No	Proposition	Porto Santo	Samos	Samso	Sardinia	Tremiti	Western Isles
1	If investment is risky and there are barriers, then invest	0.0	0.0	0.0	0.0	0.0	0.0
2	If the investment is risky but there are no barriers, then invest	0.2	0.2	0.6	0.4	0.5	0.8
3	If the investment is not risky but there are barriers, then invest	0.8	0.6	0.2	0.6	0.6	0.4
4	If the investment is not risky and there are no barriers, then invest	1.0	0.8	1.0	1.0	1.0	1.0
5	A biogas plant is a risky investment	0.2	0.8	0.6	0.4	0.2	0.8