biores

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

REPORT ON NON-TECHNICAL BARRIERS FACED IN THE SELECTED ISLANDS

DELIVERABLE (D4.2)

Intelligent Energy Europe

Partner Responsible: Samso Energy and Environmental Office (SEMK), Denmark

Jan Jantzen <jj@energiakademiet.dk>

August 2008

Table of contents

1. Summary

The six island communities of Porto Santo, Samos, Samso, Sardinia, Tremiti, and Western Isles are test islands, faced with non-technical barriers that hinder investments in a biogas plant. Non-technical barriers are generally poorly defined, and the problem in this study is how to uncover them. Samso designed a questionnaire consisting of 43 questions, and all island representatives presented it orally or via email to selected politicians, municipal officers, farmers, or environmental experts in each island. The questionnaire generated 15 responses that are processed and summarized in this report. A preliminary SWOT analysis indicates in a plot that Sardinia is somewhat different from the rest, and Porto Santo has more difficulties than the other islands. The questionnaire responses contained comments that identified additional non-technical barriers, all now collected in pick-lists summing up to 129 questions. The pick-lists are intended for the software decision support system to be designed in a later work package.

2. Introduction

Work package 4 of the BIORES project is an analysis of non-technical barriers hindering the promotion of technologies based on biogas in islands. The sooner such barriers are uncovered in a project the better. This report identifies and analyses non-technical barriers against biogas investments in the European islands which are participants of BIORES. The report is a first attempt to gather experience with non-technical barriers, and the results affect the specifications for a software decision support system to be designed in a later work package of BIORES.

The participating islands are rather dissimilar. Table 1 presents the islands, and it shows that the largest in terms of population is about 3 000 times larger than the smallest. In spite of the vast difference in size, every island produces within ½ - 1 ton of municipal waste per year per capita. That indicates that the potential yield from a biogas plant for municipal waste is small for a small island.

A companion report will present case studies for overcoming non-technical barriers (deliverable D4.3), and yet another report the result of a SWOT analysis in each island (deliverable D4.4).

The objective here is to survey the non-technical barriers in the six islands. This is easier said than done, because it can be difficult to recognize a non-technical barrier. There are obviously technical barriers in a biogas project, and these are easier to identify, because they are quantifiable. A non-technical barrier, on the other hand, is difficult to quantify.

Table 1: Overview of the islands. Sorted according to population, left to right
(Source: BIORES WP2 Questionnaire)

	Sardinia (IT)	Western Isles (GB)	Samos (GR)	Porto Santo (PT)	Samso (DK)	Tremiti (IT)
Population	1 660 000	26 500	13 900	4 470	4 130	500
Municipal waste [tons / year]	861 000	20 000	6 450	2 410	3 680	504

We propose the following working definition:

- A *non-technical barrier* (NTB) is a hindrance to a project, due to human concern as opposed to a technical hindrance.

It is not a precise definition, but it does provide guidance. Thus we immediately exclude barriers concerning the engineering design of the plant and its technical operation. Barriers characterized by anxiety or fear qualify as non-technical. Barriers concerning economy overlap the dividing line between technical and non-technical; thus we exclude technical-economic calculations, but we include personal judgement or intuition concerning a biogas project's economy. The following example illustrates the flavour of NTBs.

Example. The list below is a constructed sequence of events in a biogas project.

1. The municipality and a consulting company have identified a possible biogas plant location which is technically feasible and economically viable.
2. But a group of citizens protests and collects signatures, because the plant will *spoil the view*, and they are afraid it will *smell*.
3. A new location is searched, delaying the project, whereby the *financial plan becomes uncertain*.
4. The new location is accepted by most people, but there is still some *general scepticism*.

The sequence numbers refer to sequential project phases, and words in italics identify possible NTBs. *End of example*.

The literature provides several studies of NTBs similar to our objective. Concerning best practices and landfill gas, one report mentions the following list of NTBs (IEA 2000): awareness and perception, project economy, ownership and rights, access to markets, finance, planning, permitting, licensing, rules and bureaucracy. It even mentions some solutions to overcome the barriers from various countries.

Biogas in Sweden is rather advanced, and there is a recent study concerning incentives and barriers for expanding the use of biogas in Sweden (Lantz, Svensson, Bjornsson, Borjesson 2007). The authors organise the incentives and barriers according to sectors: municipal, industrial, agricultural, and the biogas plant. They do not distinguish between technical and non-technical barriers, but they mention several NTBs in tabular overviews. There is a similar kind of article concerning a whole country, namely Thailand (Prasertsan and Sajjakulnukit 2006).

A *good practice* guideline on anaerobic digestion (Warburton n.y.) specifies five major factors that affect a project:

- Project motivation (X)
- External consultation (X)
- Feedstock and products
- Project development (X)
- Plant construction and operations

In order to define the scope of NTBs generally, the (X) markers estimate where the NTBs affect a project (our estimate). The same reference lists a typical sequence of phases to achieve an authorization, summarized below.

1. *Prepare application*.
2. *Registration in the municipality*. Municipality checks to ensure correctness. Sends letter of acknowledgement.
3. *Publicise and consult*. Local press, WWW, library. Municipality sends to internal or external consultants.
4. *Case officer actions*. Officer inspects site, collects consulting results, writes and sends report to a committee. (X)

5. *Public release*. Municipality sends report and recommendation to the public. Public opposition. (X)
6. *Committee decision*. Permission or refusal. (X)
7. *Appeal.* (X)

Again the (X) markers are our estimate of NTB occurrence. Together the two lists above indicate a gap: NTBs appear early in a project plan, but public opposition arrives late in the project life cycle.

It is not our objective here to close that gap, but we would like to make it clear to investors what NTBs a biogas project might face, at an early stage of a project.

3. Methodology Adopted

Our approach is to identify some NTBs in the participating islands by means of a questionnaire, and then derive an overview that indicates how bad the situation is. We designed one questionnaire for all islands as a means to achieve some answers and opinions. With the future software decision support system in mind, the answers are quantified in order to be processed by a computer. Although the literature describes many NTBs, there is a lack of an organized approach that captures them.

A SWOT analysis on the other hand provides a two-dimensional, nested arrangement of S) *strengths*, W) *weaknesses*, O) *opportunities*, and T) *threats* (see for example University of Cambridge 2008). It seems the SWOT framework can also organise NTBs; intuitively a barrier is related to weaknesses and threats, rather than strengths and opportunities. We intend to perform a SWOT analysis anyway in the BIORES project (deliverable D4.4), and a common framework will thus link the questionnaire to the SWOT analysis.

The SWOT framework distinguishes on the top level between the *internal environment* and the *external environment* (Table 2). We choose to let the geographical boundary of an island discriminate between internal and external, because it is a well-defined criterion.

The list below describes each category of Table 2 in slightly more detail.

- *Strength*. A resource or capacity the organisation can use.
- *Weakness*. A limitation, fault, or defect in the organisation.
- *Opportunity*. Any favourable situation in the organisation's environment. A trend, a change, or a need that can be exploited.
- *Threat*. Any unfavourable situation in the organisation's environment. A barrier or a constraint that might cause problems, damage or injury.

It follows that the categories Strength and Weakness can be seen as two extremes on a scale regarding the internal environment, similar to a negative and a positive semi-axis. The categories Threat and Opportunity can be seen as a negative and a positive semi-axis on a scale regarding the external environment.

Table 2: SWOT table (University of Cambridge 2008)

		External environment	
		Threats	Opportunities
Internal environment	Strengths	Confront	Exploit
	Weaknesses	Avoid	Search

Example. From a project in Samso regarding renewable energy we have identified the following internal barriers:

- Municipality administration is slow
- Prices are uncertain
- Need for training and education
- Wind turbines spoil landscape
- Scarcity of suppliers and repair companies

These items are internal to the island. The second item 'Prices are uncertain' could be regarded as external, if the prices are given by a market or a supplier external to the island, for instance the cost of electricity. As the price is a matter of negotiation locally on the island, it is categorised as 'Internal'. The following are examples of external barriers:

- New government removed the subsidies
- National goals were lowered
- Tax even on RE energy (rape seed oil for instance)
- Electric car technology is immature

These barriers typically originate in the government, the EU, or an external market; they are given and cannot be affected by internal actions. *End of example*.

Table 3 lists the 43 questions in the questionnaire submitted to the participating islands. The questions are drawn from the literature, and the table defines whether we regard each question as external or internal. Linguistically they are not questions, but *propositions* that the respondent can evaluate quickly, but we prefer to call them *questions* anyway for convenience. The *subject* column groups the questions similar to groupings quoted in the literature, but here the subject also indicates the type of person that would be able to respond. Thus a politician, say, could reply to municipal questions together with a municipal officer; a farmer could reply to agriculture questions; economy related questions could be evaluated by an investor, which could be both a farmer and the municipality.

Example. To illustrate the layout of the questionnaire, question 1 is a proposition related to the municipality:

- There are too many agencies and authorities responsible for biogas.

The respondent then had to select one answer from the following list:

- ❑ I absolutely agree
- ❑ I more or less agree
- ❑ I slightly agree
- ❑ I slightly disagree
- ❑ I more or less disagree
- ❑ I absolutely disagree

The answer list is symmetrical, but there is no middle answer in order to enforce a decision from the respondent. If the respondent did not wish to answer, a blank answer was accepted. *End of example*.

To enable processing on a computer we associate each answer with a number, the *agreeability* of the question. Thus 'I absolutely agree' is equivalent to +3, 'I more or less agree' is equivalent to +2, and so on until 'I absolutely disagree' which is equivalent to -3. All responses have been encoded and collected in a spreadsheet file (D41Table1.xls).

Table 3: All questions in the questionnaire. Each question is classified as *external* (threat versus opportunity) or *internal* (weakness versus strength) to the island.

No	Question	Subject	Direction	SWOT
1	There are too many agencies and authorities responsible for biogas	municipal	negative	external
2	The agencies are slow to coordinate due to overlap in roles, responsibilities and functions	municipal	negative	external
3	The agencies' legislative framework of operation encourages cooperation with the private sector (industry, agriculture)	municipal	positive	external
4	The agencies' legislative framework of operation encourages cooperation with the municipality	municipal	positive	external
5	We have clear and well-established licensing procedures	municipal	positive	external
6	The average lead time to get an authorization is more than 6 months	municipal	negative	external
7	We have national environmental quality objectives	municipal	positive	external
8	We have a limit or a ban on land-filling	municipal	positive	internal
9	We have a legislative framework for municipal solid waste and sewage disposal	municipal	positive	external
10	We have legislative restrictions on the supply of organic waste to a biogas plant	municipal	negative	external
11	We have legislative incentives to deliver industrial waste to a biogas plant	municipal	positive	internal
12	We have a tax on waste incineration	municipal	positive	external
13	We have a tax on commercial nitrogen fertilizers	municipal	positive	external
14	There will be a gate fee at a centralised biogas plant	municipal	negative	internal
15	Biogas is exempted from energy and CO2 taxes	municipal	positive	external
16	It is feasible to supply industrial and municipal waste to the biogas plant	economy	positive	internal
17	The biogas distribution network and storage capacity will be limited	economy	negative	internal
18	Investors can get guarantees for selling prices, subsidies, and sales amounts	economy	positive	internal
19	Biofuel vehicles are more expensive than conventional, such that biofuel is difficult to sell	economy	negative	external
20	It is difficult to distribute and sell heat and electricity produced at the biogas plant	economy	negative	internal
21	Energy crop cultivation is subsidised	financing	positive	external
22	There are satisfactory subsidies for investing in biogas plants	financing	positive	external
23	There are subsidies for biofuel vehicles	financing	positive	external
24	We have technologies for treating municipal and industrial waste, that can compete with biogas	market	negative	internal
25	We have commercial fertilizers at low cost that can compete with the digestate	market	negative	internal
26	The biogas plant market is immature, such that investment costs are high	market	negative	external
27	A biogas plant is a risky investment	market	negative	internal
28	We would like a large number of small investors in the biogas plant	market	positive	internal
29	We would like a major private investor in the biogas plant	market	negative	internal
30	We would like to fund the biogas plant investment through a private bank loan	market	negative	internal
31	We can obtain financial support for *un*usual items, such as: operation, maintenance, creation of a consumer service office	market	positive	internal
32	We can get other biomass fuels, such as ethanol, that compete with biogas and its digestate for heat production	market	negative	internal
33	It is difficult to obtain contracts with heat plants and electricity distributors	market	negative	internal
34	Our farmers have only limited knowledge about the agricultural by-products from biogas production	agriculture	negative	internal
35	The digestate will improve the fertilisation of the fields	agriculture	positive	internal
36	It is feasible to supply agricultural waste to the biogas plant	agriculture	positive	internal
37	We can grow energy crops, not intended for biogas, that have a higher profitability than biogas crops	agriculture	negative	internal
38	I will only consider biogas, if it does not cost me extra money	agriculture	negative	internal
39	We have legislative incentives to deliver agricultural waste to a biogas plant	agriculture	positive	internal
40	Our general public is sceptical towards biogas plants	other	negative	internal
41	A biogas plant will improve sanitation	other	positive	internal
42	The reduction in odour from spreading digestate, instead of non-digested manure, will be appreciated	other	positive	internal
43	Excess biogas during the summer time will be a problem	other	negative	internal

The questions have a characteristic *direction*, and we associate a +1 with a positive direction and a -1 with a negative direction.

- *Positive direction:* higher agreeability is better.
  - Example Q5: We have clear and well-established licensing procedures

- *Negative direction:* lower agreeability is better.
  - Example Q1: There are too many agencies and authorities responsible for biogas

Using the definitions given so far, we can calculate a *score* s_k related to the kth question,

$$s_k = a_k d_k \quad (k = 1, 2, ..., Q)$$

Here a_k is the agreeability, d_k is the direction of the question (+1, -1), and Q is the total number of questions. The score is a convenient measure, because the higher the score the better.

4. Results From The Six Islands

We have received the following number of responses: Porto Santo 1, Samos 3, Samso 6, Sardinia 1, Tremiti 3, Western Isles 1.

For each island we have averaged the responses, if there were several, such that each island is associated with one (average) score profile. Appendix B shows for each island a plot of its score profile. It is important to remember that the score is adjusted for the direction of each question; therefore the higher score the better.

It is thus straight forward to find the questions that are problematic for a particular island, since these will likely be in the negative range. The barriers with the most negative scores are mentioned below for each island.

4.1. Porto Santo

Some facts about the island:

- Area: 47 Km2
- Population: 4 474
- Buildings: 2 409
- Municipal waste: 4 463 tons per year

The main industry is tourism. Its geography includes farmlands in the southern and central parts and further to the south a long shoreline with a few beaches, forests and grasslands to the west, rocky ledges and cliffs with a longer coastline to its north, forests to the northeast, drylands with grasses to the northern part, and mountains along the north-eastern part with about five to six main mountaintops with a few grasslands (Wikipedia). Agriculture is almost non-existent. All treated waste water is used for a golf course.

The island is among the three smallest of the six islands. Two thirds of the scores are negative, indicating relatively many non-technical barriers. The most severe barriers according to the questionnaire are: no clear licensing procedures (Q5), it takes a long time to get an authorization (Q6), legislation and taxes provide no incentives (Q11-14, Q21, Q23), investors cannot get guarantees (Q18, Q33), and there are other products that compete with biogas (Q32).

4.2. Samos

Some facts about the island:

- Area: 476 Km2

- Population: 13 858
- Buildings:
- Municipal waste: 6 454 tons per year

Samian economy depends mainly on the tourist industry which has been growing steadily since the early 1980s. The main agricultural products include grapes, honey, olives, olive oil, citrus fruit, dried figs, almonds and flowers. Samian wine, known primarily through a sweet Muscat wine, is also exported in several other appellations (Wikipedia).

The island is among the three largest of the six islands. About half of the scores are negative, which is better than Porto Santo, but still relatively many. The most severe barriers according to the questionnaire are: it takes a long time to get an authorization (Q6); there are taxes, fees and legislation barriers (Q12, Q14, Q39); it will be difficult to sell heat and electricity (Q20); investment costs are high (Q26); and farmers have only limited knowledge about biogas (Q34).

4.3. Samso

Some facts about the island:

- Area: 112 Km2
- Population: 4 130
- Buildings: 3 678
- Municipal waste: 6 448 tons per year

Agriculture is the primary business sector, and many products are exported from the island. Tourism is the second largest source of income, and half a million guests stay overnight every year. The renewable energy projects (windmills, district heating plants, renewable energy installations in private buildings) have also been an important source of jobs during the last ten years.

The island is among the three smaller islands. Samso returned 6 responses from 6 different persons, and the score profile is therefore an average. In several cases different persons answered differently to the same question. In those cases the truth is more or less undecided, especially if the answers are wide apart.

A little less than half of the scores are negative, which indicates a fair amount of barriers. The most severe barriers according to the questionnaire are: it takes a long time to get an authorization (Q6), legislation and subsidies are lacking (Q11, Q23), investing is deemed risky and financing is difficult (Q27, Q31, Q38), there is competition from energy crops (Q37), and the general public is sceptical (Q40).

4.4. Sardinia

Some facts about the island:

- Area: 24 000 Km2
- Population: 1 659 443
- Buildings: 1 031 648 house units
- Municipal waste: 860 966 tons per year

The Sardinian economy is focused on tourism, mining, commerce, services and information technology; an increasing income is coming from its wines and gastronomy. The island contains numerous extraordinary tourist areas. Several gold and silver mines operate on the island (Wikipedia).

The island is the largest of the six islands. Sardinia returned one questionnaire with 18 questions unanswered out of 43. Forty percent of the answered questions are negative. The most severe barriers according to the questionnaire are: there will be a gate fee (Q14), distribution and market will be limited (Q17, Q19, Q20), there is competition (Q24-25, Q32), investing is deemed risky (Q26), farmers have only limited knowledge (Q34), and the general public is sceptical (Q40).

4.5. Tremiti

Some facts about the Tremiti archipelago:

- Area: 3 Km2
- Population: 500
- Buildings: 323
- Municipal waste: 504 tons per year

Tremiti is an archipelago of the Adriatic Sea, and it forms part of the Gargano national park. The islands are an important tourist attraction (1600 inhabitants in the summer). There is no landfill in the island, but the garbage is stored on boats and brought to the landfills of the province of Foggia (Puglia region – in front of the island).

Tremiti is the smallest of the six islands (or archipelagos). The respondent commented that there is a natural reserve (protected area) and consequently there is concern about the social acceptance of a biogas plant. Lack of specific technical knowledge and social resistance are key elements considering the non-technical barriers in the biogas field in Tremiti Islands.

About half of the answers are negative. The most severe barriers according to the questionnaire are: it takes a long time to get an authorization (Q6), lack of legislative incentives (Q11, Q15, Q21, Q22, Q39), distribution of biogas will be limited (Q17), biofuel will be difficult to sell (Q19), investment costs seem high (Q26), farmers have only limited knowledge about biogas (Q34), farmers will only invest at no extra cost (Q38), and the general public is sceptical towards a biogas plant (Q40).

4.6. Western Isles

Some facts about the Western Isles archipelago:

- Area: 3 071 Km2
- Population: 26 502
- Buildings: 11 275
- Municipal waste: 20 000 tons per year

The economy depends on five sectors for employment: other services (private), construction, distribution (i.e. retailing and most wholesaling), health, and education. There has been a drop in agriculture, fishing and fish farming employment. (http://www.cne-siar.gov.uk/factfile/economy/).

The islands are among the three largest of the six islands (or archipelagos). Sixty percent of the answers are negative. The most severe barriers according to the questionnaire are: it takes a long time to get an authorization

(Q6), lack of legislative incentives (Q10 - Q14, Q22 - Q23, Q39), biogas distribution and storage will be limited (Q17), biofuel will be difficult to sell (Q19), there is competition (Q24 - Q25), investment costs seem high (Q26), farmers have limited knowledge of biogas (Q34), and investors will only invest at no extra cost (Q38).

4.7. Summary

Table 4 summarizes all the barriers mentioned above. The table shows 27 barriers that are problematic in the sense that they scored lowest (most negatively). They were selected from the score plots in Appendix B as the lowest scores, within a band relative to each island. Very roughly speaking most barriers are legislative or market related.

Table 4: Cross reference summary. Barriers with the most negative scores for each island.

	Porto Santo	Samos	Samso	Sardinia	Tremiti	Western Isles
5. We have clear and well-established licensing procedures	x					
6. The average lead time to get an authorization is more than 6 months	x	x	x		x	x
10. We have legislative restrictions on the supply of organic waste to a biogas plant						x
11. We have legislative incentives to deliver industrial waste to a biogas plant	x		x		x	x
12. We have a tax on waste incineration	x	x				x
13. We have a tax on commercial nitrogen fertilizers	x					x
14. There will be a gate fee at a centralised biogas plant	x	x		x		x
15. Biogas is exempted from energy and CO_2 taxes					x	
17. The biogas distribution network and storage capacity will be limited				x	x	x
18. Investors can get guarantees for selling prices, subsidies, and sales amounts	x					
19. Biofuel vehicles are more expensive than conventional, such that biofuel is difficult to sell				x	x	x
20. It is difficult to distribute and sell heat and electricity produced at the biogas plant		x		x		
21. Energy crop cultivation is subsidised	x				x	
22. There are satisfactory subsidies for investing in biogas plants					x	x
23. There are subsidies for biofuel vehicles	x		x			x
24. We have technologies for treating municipal and industrial waste, that can compete with biogas				x		x
25. We have commercial fertilizers at low cost that can compete with the digestate				x		x
26. The biogas plant market is immature, such that investment costs are high		x		x	x	x
27. A biogas plant is a risky investment			x			
31. We can obtain financial support for *un*usual items, such as: operation, maintenance, creation of a consumer service office			x			
32. We can get other biomass fuels, such as ethanol, that compete with biogas and its digestate for heat production	x			x		
33. It is difficult to obtain contracts with heat plants and electricity distributors	x					
34. Our farmers have only limited knowledge about the agricultural by-products from biogas production		x		x	x	x
37. We can grow energy crops, not intended for biogas, that have a higher profitability than biogas crops			x			
38. I will only consider biogas, if it does not cost me extra money			x		x	x
39. We have legislative incentives to deliver agricultural waste to a biogas plant		x			x	x
40. Our general public is sceptical towards biogas plants			x	x	x	

5. Assessment Of The Results

In many cases the islands returned comments to the questions, and these have generated new NTBs. The following six steps describe the procedure.

1. The initial set of NTBs was compiled from the literature.
2. Each NTB was rephrased into a proposition and entered in the questionnaire.
3. The NTBs were added to two pick-lists: one for external, one for internal.
4. The questionnaire generated comments.
5. Some comments were identified as new NTBs.
6. The new NTBs were rephrased and added to the two pick-lists

As a result we now have two pick-lists with 81 internal NTBs and 38 external NTBs (Appendix A). At first sight these appear unmanageable, but with a view to the future software decision support system, they can form basic material for tailor-made questionnaires.

The data collection activity revealed that some questions are unclear to some persons, but not to others. It is therefore natural to merge response profiles from several persons from the same island, such that the final single profile contains answers to all questions, and preferably answers that are the most accurate. The questionnaire is therefore not a statistical survey, but an inquiry into expert knowledge.

It takes perhaps one hour to interview one person through the full set of 43 questions. That is in many cases a large burden to put on a busy respondent, yet the set of questions cover only a subset of all NTBs. Furthermore some questions may seem irrelevant to one island, but not to other islands. The ideal situation is therefore a tailor-made set of questions that suits the particular island. The pick-lists will be useful for this purpose in the future.

5.1. Comparison Of All Islands

A preliminary SWOT analysis provides a summary of all islands relative to each other. We interpret the score of an internal question as a score on a scale from Weakness (-3) to Strength (+3), and the score of an external question on a scale from Threat (-3) to Opportunity (+3). Figure 1 shows each island as a point or a *centre*. If two islands are close, they face the same degree of resistance, although the barriers may be different.

The plot shows four islands in the lower left hand quadrant, which is to be expected since we are looking for barriers. A barrier is a negative factor, and if both the average external score and the average internal score is negative, the centre must lie in the lower left quadrant. Samso is in the upper right quadrant, which means a slight amount of opportunity and strength at the same time, according to the questionnaire. Sardinia is by itself in the lower right quadrant, which indicates opportunity, but also some weakness. That result may be unreliable, however, due to Sardinia's 18 unanswered questions.

The centre (x, y) for an island combines the average external and average internal scores,

$$x = \frac{1}{m}\sum_{i=1}^{m} s_i, \quad y = \frac{1}{n}\sum_{j=1}^{n} s_j$$

Here s_i is the ith external question score of m external questions, and s_j is the jth internal question score of n internal questions. The total number of questions is $Q = m + n$. Since we take averages, we can also calculate standard deviations within external questions and internal questions.

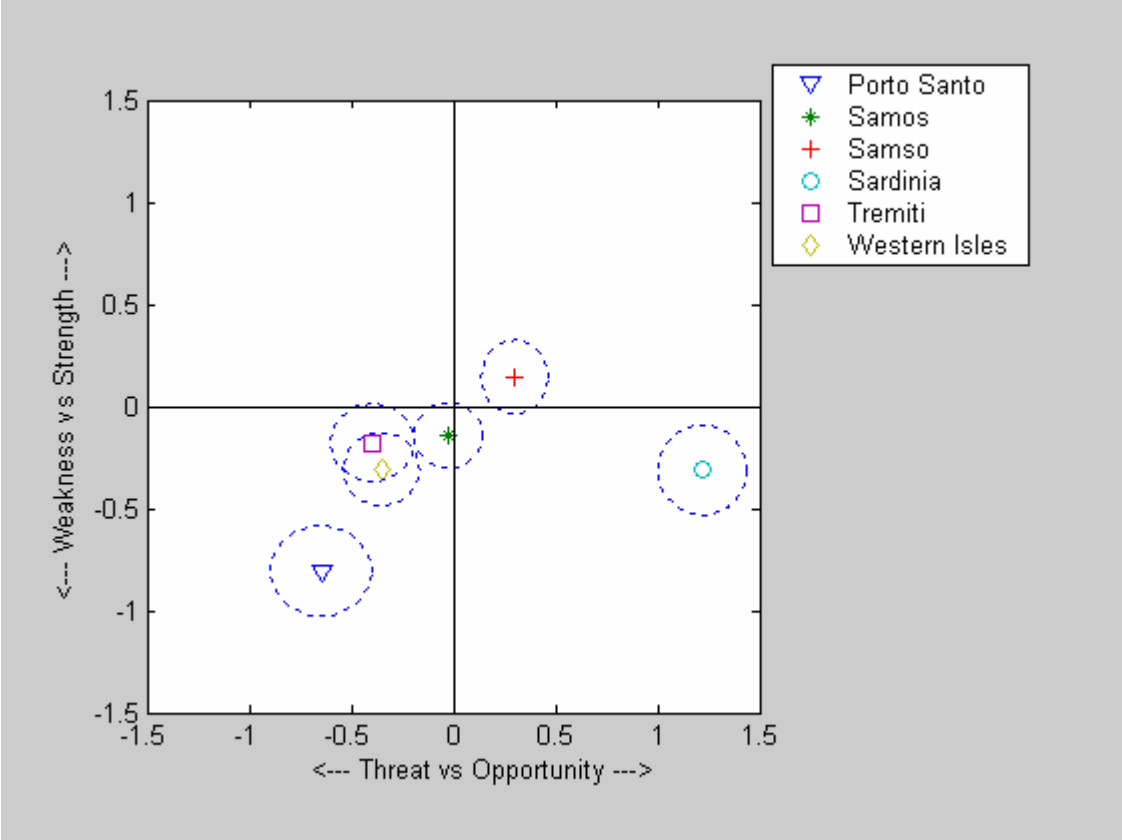


Figure 1. SWOT plot. Each island achieves an average external score *x* (horizontal) and an average internal score *y* (vertical). They map to a point (*x*, *y*). Ellipses indicate uncertainty along each axis (1/10 of the standard deviation along each axis).

Figure 1 includes ellipses showing the standard deviations, as a measure of the spread of the answers. We interpret a large spread as a large uncertainty in the location of the centre. The standard deviations are all relatively large numbers, and it was necessary to plot just 1/10 of the standard deviations to preserve the graphical overview. There is a standard deviation associated with each axis of the plot; therefore the curves around each centre are ellipses with semi-axes parallel to the coordinate axes.

The plot may be inaccurate, but it provides a quick overview. The accuracy increases with the accuracy of the questionnaire, and if the respondents within an island agree on the answers. The plot is a proposal for the upcoming deliverable on the SWOT analysis.

5.2. Summary Of Outcomes

The following list summarizes the material outcomes of the questionnaire task:

- WP4 questionnaire, deliverable D4.1 (43 questions, 1 PowerPoint file)
- Responses (15 PowerPoint files)
- Summary score sheet (1 Excel file)
- Pick-list of 81 internal factors (Appendix A)

- Pick-list of 38 external factors (Appendix A)
- Deliverable D4.2 (this report)

The WP4 questionnaire could perhaps be used in other projects with some modifications. All responses are summarized in a spreadsheet file, and can be processed on a computer. The two pick-lists are outcomes for future use in the planned software decision support system.

6. Conclusions

Have we now uncovered the NTBs in the six islands, as we set out to do? The answer is: only partially. It is a good initial attempt, but incomplete, because it turned out that one questionnaire does not fit all islands. The work is rather a manual prototype, which provides detailed specifications to the software system planned for a later work package. The importance lies more in the described approach, less in the calculated results. Once the approach is embedded in software, the whole analysis can be done over again in order to improve the accuracy of the results.

The questionnaire prompted comments from the islands, and these fed back into the pick-lists of questions, such that these grew during the activity. A recommendation is therefore to regard such pick-lists as a dynamic repository that can grow with time. Another recommendation is to use such a questionnaire, not for a statistical survey, but as an aid to interview experts and stakeholders.

The pick-lists and the SWOT organisation are inputs to the future software decision support system to be designed in a later work package of the BIORES project. The pick-lists can form the basis for a tailor-made questionnaire for each island, and thus help the islands to more precisely identify and overcome the local non-technical barriers.

References

1. IEA (2000): *International Perspective On Energy Recovery From Landfill Gas*. International Energy Agency, IEA CADDET Centre for Renewable Energy, ETSU, 168 Harwell, Oxfordshire OX11 0RA, UK [Retrieved from www.caddet-re.org on 9 Jul 2008]
2. P.J. Jorgensen, S. Hermansen, Aa. Johnsen and J.P. Nielsen (2007): *Samso – A Renewable Energy Island, 10 Years Of Development And Evaluation*. Planenergi and Samso Energy Academy. [Downloadable from http://www.energiakademiet.dk]
3. M. Lantz and M. Svensson and L. Björnsson and P. Börjesson (2007). The prospects for an expansion of biogas systems in Sweden: Incentives, barriers and potentials. *Energy Policy* 35 (2007) 1830 – 1843.
4. Prasertsan, S., and Sajjakulnukit, B., (2006). Biomass and biogas energy in Thailand: Potential, opportunity and barriers. *Renewable Energy* 31 (2006) 599-610.
5. University of Cambridge (2008): SWOT, http://www.ifm.eng.cam.ac.uk/dstools/paradigm/swot.html. [Retrieved 22 March 2008]
6. D. Warburton (ed.) (n.y.): *Anaerobic Digestion Of Farm And Food Processing Residues – Good Practice Guidelines*. Environmental Resolve, The Environment Council, 21 Elizabeth Street, London SW1W 9RP.

Appendix A: Pick-Lists Of Non-Technical Barriers

A.1. Internal Barriers

1. There are too many permits, inspections, administration, politics in the municipality
2. It is difficult to enter the island energy market
3. It is difficult to coordinate people, projects and finances altogether in agriculture, industry, service, tourism, and private households
4. The organisational structure is inadequate
5. There is a strong agricultural association, which may wish to control a biogas plant project
6. An agricultural association is missing, so that it is difficult to obtain support from the farmers
7. It is difficult to deliver adequate information and communication
8. It will be difficult to decide the ownership
9. The local economy is weak
10. The training and education of consumers, workers, businesses, or the municipality is inadequate
11. We are afraid that long term energy crop utilisation will cause soil erosion
12. Preservation of landscape, beauty, and environment prohibits a biogas plant
13. We cannot use the products from the digester (liquid fertiliser, fibre, better waste management), so the economy will not be viable
14. We cannot treat the emissions, so we think the plant will damage the environment
15. We do not want more traffic on the roads, and the roads will get dirty
16. We do not know how to make an energy balance calculation
17. We are afraid the noise from the plant will destroy our calm environment
18. We are afraid the lights will be on all night and create light pollution
19. We are afraid of human health risks from bacteria and organisms in the biogas reactor
20. We are afraid of fire and explosion in the biogas reactor
21. Cross contamination from vehicle movements between farms must be avoided, and that will be too costly
22. A biogas plant will destroy the landscape and spoil the view
23. There is a public concern that a biogas plant will affect animal welfare
24. The increase of marginal costs will not be outweighed by the created benefits and opportunities
25. We do not have trained operators, and it will be difficult to find some
26. I do not have the time, inclination and skills to consider a biogas plant project
27. We cannot utilise the produced energy within the island
28. We are unsure what price we will get for the energy if we sell it
29. We will only consider a biogas plant if there is an economic surplus in the project
30. We will only consider a small plant, because it is likely to be affected by fewer regulations and fewer anxieties
31. The timing is bad
32. Only a small plant will be acceptable to the general public
33. We have a nature preserve and we are afraid a biogas plant will create a conflict
34. We have a limit or a ban on land-filling
35. We have a legislative framework for municipal solid waste and sewage disposal
36. We have legislative restrictions on the supply of organic waste to a biogas plant
37. We have legislative incentives to deliver industrial waste to a biogas plant
38. There will be a gate fee at a centralised biogas plant
39. Biogas is exempted from energy and CO2 taxes
40. It is feasible to supply industrial and municipal waste to the biogas plant

41. The biogas distribution network and storage capacity will be limited
42. It is difficult to distribute and sell heat and electricity produced at the biogas plant
43. We have technologies for treating municipal and industrial waste, that can compete with biogas
44. We have commercial fertilizers at low cost that can compete with the digestate
45. We would not like a large number of small investors in the biogas plant
46. We would not like a major private investor in the biogas plant
47. We would not like to fund the biogas plant investment through a private bank loan
48. We can not obtain financial support for *un*usual items, such as: operation, maintenance, creation of a consumer service office
49. We can grow biomass for fuel, such as ethanol, that compete with biogas and its digestate for heat production
50. Our farmers have only limited knowledge about the agricultural by-products from biogas production
51. The digestate will not improve the fertilisation of the fields
52. It is not feasible to supply agricultural waste to the biogas plant
53. We can grow energy crops, not intended for biogas, that have a higher profitability than biogas crops
54. I will only consider biogas, if it does not cost me extra money
55. Our general public is sceptical towards biogas plants
56. A biogas plant will not improve sanitation
57. The reduction in odour from spreading digestate, instead of non-digested manure, will not be appreciated
58. Excess biogas during the summer time will be a problem
59. We have many micro-farms, so a centralised plant is not feasible
60. We do not have a tradition for cooperatives, therefore a coop will be difficult to establish
61. Our farmers are not used to thinking in terms of renewable energy, therefore interest will be low
62. Landfill is expensive, so there is an economic incentive to build a biogas plant
63. There is no landfill -- waste is sailed to the mainland -- therefore interest in a biogas plant is low
64. The island hosts a natural reserve, and the general public is afraid of the impact of a biogas plant to the nature
65. Agriculture is light or moderate
66. Water for irrigation is so scarce, that it limits the biomass production
67. It is difficult to find new areas for land filling
68. The farmers are concerned about cadmium and heavy metals on the fields
69. We ship waste to the mainland for incineration
70. Biogas digestate will help to reduce our quota of nitrogen on the fields
71. We must separate household waste more in order to make a biogas plant feasible
72. Farms that supply slurry are distributed over a large area, so transportation will be expensive
73. I will stop growing energy crops, if the wheat price is high
74. It will be necessary to create organised collection sites throughout the island
75. We already have a gas distribution network
76. We have no market for biofuel
77. We do not have district heating or cooling
78. It will be easy to sell electricity to the grid
79. We burn waste in power plants or cement plants
80. The cost & benefit ratio of a biogas plant is good
81. We have a sugar factory which can be seen as a competition to a biogas plant

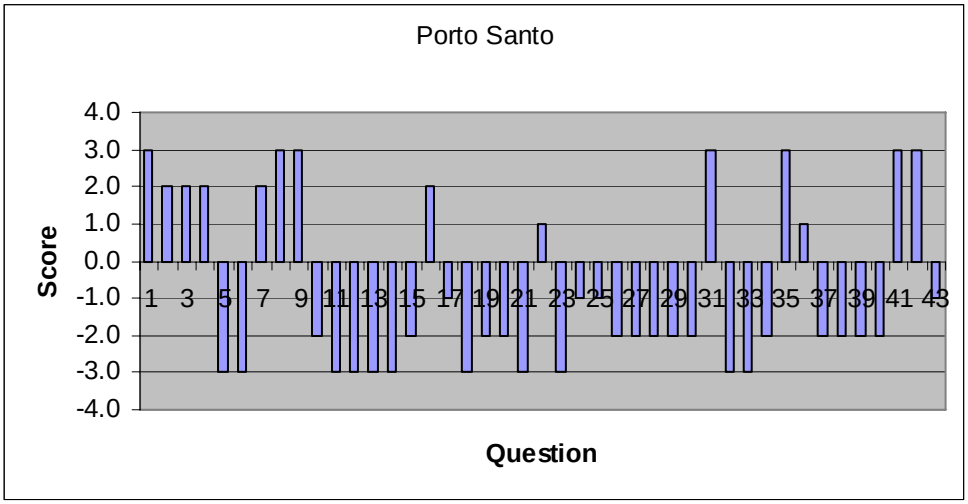
A.2. External Barriers

1. There are too many regional, national, and EU rules and too much bureaucracy
2. There are too many agencies and authorities responsible for biogas

3. The agencies are slow to coordinate due to overlap in roles, responsibilities and functions
4. The agencies' legislative framework of operation do not encourage cooperation with the private sector (industry, agriculture)
5. The agencies' legislative framework of operation do not encourage cooperation with the municipality
6. There are no national goals
7. We do not have clear and well-established licensing procedures
8. The average lead time to get an authorization is more than 6 months
9. The national environmental quality objectives are difficult or expensive to meet
10. It is difficult to get access to external investors
11. There are no subsidies
12. Taxes and fees make the economy unfeasible
13. There are competing technologies
14. The existing technologies are immature
15. There are transportation bottlenecks, such as ferry capacity
16. Construction companies and suppliers are lacking
17. Part time residents will not participate, because they have less opportunity to participate
18. The national energy market fluctuates, so that prices are uncertain
19. We have strong restrictions on environmental emissions: CO2, carbon particles, NOx, odour, nutrients to sea, ammonia evaporation
20. Tourism will be negatively affected
21. The island is isolated, so it is difficult to get access to outside knowledge
22. The islanders will resist outside help
23. We have a tax on waste incineration
24. We have a tax on commercial nitrogen fertilizers
25. Investors cannot get guarantees for selling prices, subsidies, and sales amounts
26. Biofuel vehicles are more expensive than conventional, such that biofuel is difficult to sell
27. Energy crop cultivation is not subsidised
28. There are no satisfactory subsidies for investing in biogas plants
29. There are no subsidies for biofuel vehicles
30. The biogas plant market is immature, such that investment costs are high
31. A biogas plant is a risky investment
32. It is difficult to obtain contracts with heat plants and electricity distributors
33. We do not have legislative incentives to deliver agricultural waste to a biogas plant
34. The environmental approval enforces collaboration between authorities
35. It is difficult to say how many approvals are necessary
36. There may be some new EU rules coming that are more restrictive
37. Commercial fertilizer may become a shortage, or the price may become very high
38. The takers of the digestate will be very sceptical concerning contaminants

Appendix B: Responses From The Six Islands

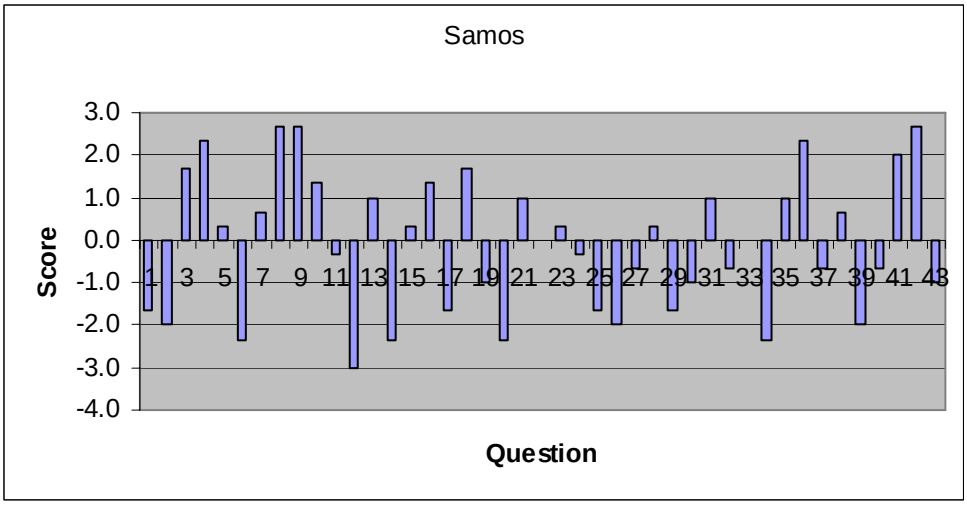
B.1. Porto Santo



Comments from Porto Santo

- Agricultural practice in Porto Santo Inland since its discovery has been moderate. The water variation and the scarcity for irrigation, in some years, did not favoured cereals crops which were insufficient to supply enough food for local living people, which suffered food scarcity in dry years. Conventional crops were grape production, some kind of cereals, fruit trees. Actually in Porto Santo the agricultural activity is almost inexistent and must be reactivated. Some potentiality exists but must be reactivated. The water availability comes from desalination plant. The treated Wastewater is completely used in Golf Park. The model of development of the island was directed to tourism. Young people leaved the island. In recent time the increase in touristy activity is creating more jobs. The creation of agricultural association and cooperation must be promoted.

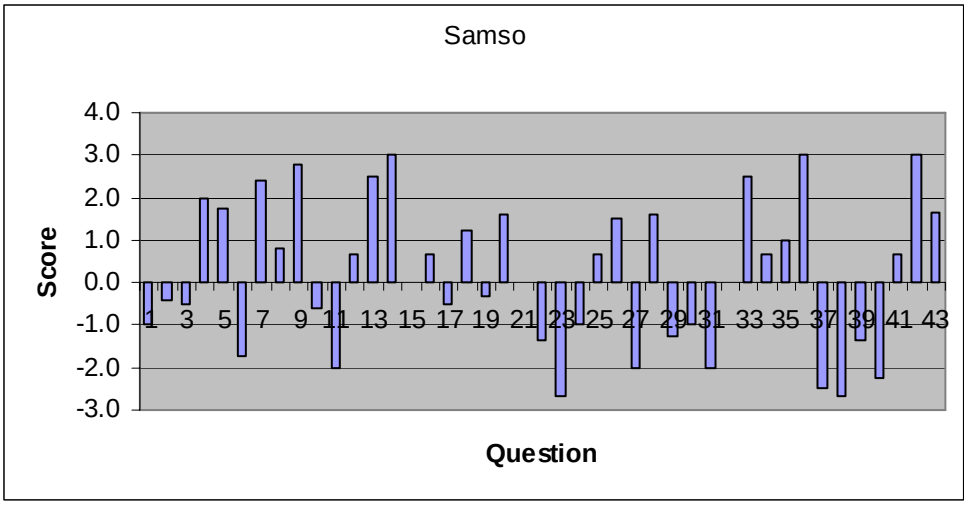
B.2. Samos



Comments from Samos

- None

B.3. Samso

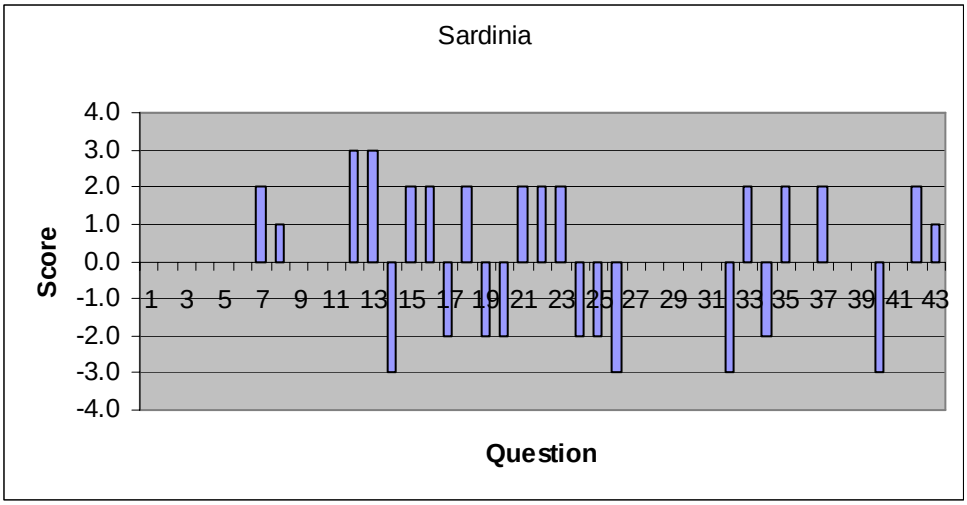


Comments from Samso

- 1. There are too many agencies and authorities responsible for biogas. *Environmental license (VVM), the municipality, and the region.*
- 4. The agencies' legislative framework of operation encourages cooperation with the municipality. *The Danish Environmental Agency sets goals for RE, they are transferred to the municipalities. We are obliged to collaborate with Aarhus municipality.*
- 5. We have clear and well-established licensing procedures. *Environmental approval enforces cooperation and mandatory cooperation between municipality and region. How many approvals are necessary is difficult to say.*
- 6. The average lead time to get an authorization is more than 6 months. *Maybe, it ought to be faster than now*.
- 7. We have national environmental quality objectives. *EU rules and goals; more coming*.
- 8. We have a limit or a ban on land-filling. *Problem to find areas*.
- 9. We have a legislative framework for municipal solid waste and sewage disposal. *Waste directive; waste water slurry allowed in the landfill; rules for cadmium and heavy metals on fields*.
- 10. We have legislative restrictions on the supply of organic waste to a biogas plant. *Rules against dead animals, waste water slurry; ecological areas are sensitive*.
- 11. We have legislative incentives to deliver industrial waste to a biogas plant. *Goals concerning waste products from industry: recycling, recuperation. 25 percent of daily waste is bio (food). Separation required. Total waste is 6500 tons/year, deposited 5500 tons, recycled 1000 tons (year 2004). We have begun to ship waste to the mainland for incineration.*
- *12.* We have a tax on waste incineration. *Fees on waste are 330 DKK per ton, 375 DKK per ton for depositing, 0 DKK for recyclable, 0 DKK at farm plants and common plants*.
- 13. We have a tax on commercial nitrogen fertilizers. *There are limits on buying. There is a nitrogen quota: fines if quota is overstepped*.
- 14. There will be a gate fee at a centralised biogas plant. *There is a gate fee at the municipal landfill*.
- 17. The biogas distribution network and storage capacity will be limited. *There have been plans for a pipe network. Could it be connected to the water purification plant? Samso has an exemption, so that we separate household waste less and less. Pig farms are distributed over a wide area*.

- 18. Investors can get guarantees for selling prices, subsidies, and sales amounts. *Perhaps there is something in the very recent energy agreement in the parliament*.
- 19. Biofuel vehicles are more expensive than conventional, such that biofuel is difficult to sell. *It is difficult to find biomass for fuel here*.
- 20. It is difficult to distribute and sell heat and electricity produced at the biogas plant. *The previous plan placed the biogas plant close to the district heating plant. Not the electricity, but the heat is more difficult*.
- 21. Energy crop cultivation is subsidised. *If there are subsidies, they will probably disappear*.
- 23. There are subsidies for biofuel vehicles. *Electric vehicles and hydrogen vehicles are exempt from registration fees*.
- 24. We have technologies for treating municipal and industrial waste, that can compete with biogas. *We should minimise the waste amount, and use compost. Biogas is better than deposit.*
- 25. We have commercial fertilizers at low cost that can compete with the digestate. *Biomass has wider spectrum of fertiliser, better. Prices have gone up 100 percent. It is sold to China and Eastern Europe. Fertilizer may become unavailable.*
- *28.* We would like a large number of small investors in the biogas plant.. *Any investor is welcome*.
- 30. We would like to fund the biogas plant investment through a private bank loan. *Does not matter. We will use 'Kommunekredit' (municipal loan fund)*.
- 31. We can obtain financial support for *un*usual items, such as: operation, maintenance, creation of a consumer service office. *Information about digestate content is important . Perhaps EU support?*
- *32.* We can get other biomass fuels, such as ethanol, that compete with biogas and its digestate for heat production. *There is a contract, that straw suppliers must yield to biogas*.
- 33. It is difficult to obtain contracts with heat plants and electricity distributors. *Legal rules oblige grid to receive. Not the electricity, but the heating plant yes*.
- 34. Our farmers have only limited knowledge about the agricultural by-products from biogas production. *Not a barrier, they will quickly obtain the knowledge if necessary*.
- 37. We can grow energy crops, not intended for biogas, that have a higher profitability than biogas crops. *Wheat prices have doubled last year*.
- 39. We have legislative incentives to deliver agricultural waste to a biogas plant. *There are restrictions on what can be spread on the fields*.
- 40. Our general public is sceptical towards biogas plants. *Information is important*.
- 41. A biogas plant will improve sanitation. *Fat from food waste will improve the yield of gas. Salt will decrease the yield. In Aarhus they add calcium to get the right pH value. They tried to mix agricultural waste and household waste, but household waste had impurities (plastic), so the attempt was abandoned. The takers of the digestate were very sceptical. Absolutely no plastic, medicine, weed contamination must be guaranteed. Improving sanitation is not necessary. Consider rats and Creutzfelt. Biogas plant may extend the landfill life time*.
- 42. The reduction in odour from spreading digestate, instead of non-digested manure, will be appreciated. *This is an incentive. Waste water slurry is not spread onto the fields anymore*.

B.4. Sardinia

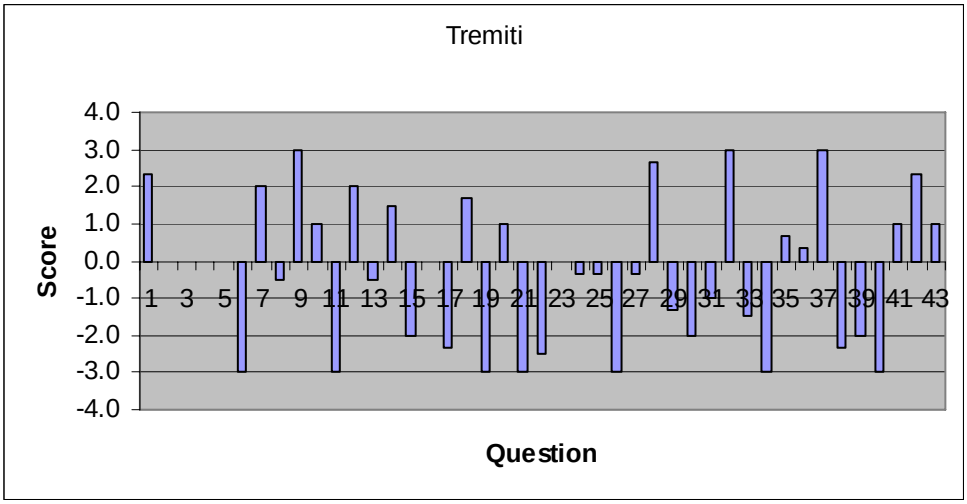


Comments from Sardinia

- 7. We have national environmental quality objectives. *Regional Energy Plan. Financial 2008*.
- 8. We have a limit or a ban on land-filling. *There are limits imposed in Regional Landscape Plan*.
- 12. We have a tax on waste incineration. *The costs of disposal of municipal waste by incineration are supported by: CIP 6 and green certificates*.
- 16. It is feasible to supply industrial and municipal waste to the biogas plant. *Yes, however, it would be necessary to create organized sites distributed throughout Sardinia*.
- 17. The biogas distribution network and storage capacity will be limited. *Storage capacity is limited, but the main city in Sardinia have a gas network, capable of distributing gas*.
- 18. Investors can get guarantees for selling prices, subsidies, and sales amounts. *The new financial provides guarantees both all-inclusive rates (300 € / MWh) (Plants under 1 MW), Green Certificates (circa 1.20 € x 1.8= 216€ MWh). It also permits, for the construction of installations within 250 kW of power, just a declaration of activities beginning (DIA)*.
- 19. Biofuel vehicles are more expensive than conventional, such that biofuel is difficult to sell. *If cars have a double-fuel alimentation system, the cost is not very different. If not, the change of the fuel alimentation system will cost around € 2000-2500*.
- 20. It is difficult to distribute and sell heat and electricity produced at the biogas plant. *Yes, for distribution and selling of heat: because there aren't infrastructures and this implies still uncertainty. It is possible only for use in site. Easy sell electricity to the grid*.
- 21. Energy crop cultivation is subsidised. *The European Agricultural Fund for Rural Development (FEASR) subsidises agricultural production for energy. Rural Development Program of Sardinia 2007-2013. Priority I: improving the competitiveness of agriculture and forestry in compliance with environmental sustainability and preservation of the countryside*.
- 22. There are satisfactory subsidies for investing in biogas plants. *National subsidies come from the green certificates. Cost benefits ratio is convenient*.
- 23. There are subsidies for biofuel vehicles. *From 1 January 2008 incentives for the processing of vehicles are: 1) 350 € for the installation of systems with LPG. 2) 500 € for the installation of systems to methane. There is also a reduction on taxation of biofuels, with reduction or elimination of excise (GU L 283 del 31/10/2003)*.

- 24. We have technologies for treating municipal and industrial waste, that can compete with biogas. *There are power plants in: Cagliari (9.4 MWe, 34 GWh/year), Macomer (2 MWe, 6.5 GWh/year*.
- 25. We have commercial fertilizers at low cost that can compete with the digestate. *Compost produced by power plants (by-product) is given free but it not compete with the digested sludge (compost) from biogas*.
- 26. The biogas plant market is immature, such that investment costs are high. *The market is just rising. Some plants are operating. The cost-benefit ratio is very convenient*.
- 32. We can get other biomass fuels, such as ethanol, that compete with biogas and its digestate for heat production. *Currently no. Will be built a plant in Sardinia, in a factory (SADAM) which produced sugar, will produce energy (50 MW) from beet*.
- 33. It is difficult to obtain contracts with heat plants and electricity distributors. *Not particularly for electricity distributors. It is difficult to obtain contracts with heat users o distributors*.
- 40. Our general public is sceptical towards biogas plants. *Biogas plants are accepted because they are small plants and environmentally sustainable*.

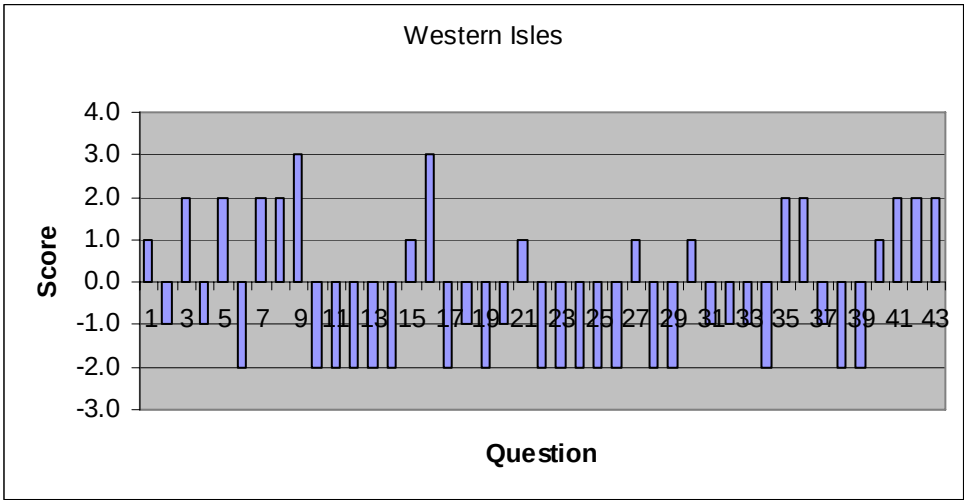
B.5. Tremiti



Comments from Tremiti

- An important element to be taken in consideration is related to the presence in the Tremiti Area of natural reserve (protected area) and there is concern about the social acceptance of a biogas plant.
- Lack of specific technical knowledge and social resistance are key elements considering the non-technical barriers in the biogas field in Tremiti Islands.

B.6. Western Isles



Comments from Western Isles

- This questionnaire has been completed from the perspective of a Public Sector Municipal Waste Anaerobic Digester operator. We are a local authority with landfill diversion targets and fiscal disincentives such as Landfill Tax as the key drivers to adopt alternative waste management technologies.