INTERNATIONALIZATION PROCESS: STRATEGY AND MODES FOR ENTERING IN THE ITALIAN MARKET

Case: Metener Oy

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Abstract

The target of this Bachelors thesis developed on behalf of Metener Oy, is to make a clear point of view of the Italian Biogas market and to outline the better strategy to approach it. The company is a Finnish SME that operates as designer and developer of high tech biogas equipments. The basis of this research is the desire of the company to expand its presence out of the national boundary and in particular to see the possibilities that the Italian market offers. Important for the company is to gain information about the actual situation of the biogas market, regulations, trends, potential and future possible metamorphosis of it. Also important is the entry modes analysis, including as well as demand drivers and cultural perception that affect the entry modes itself. The entry modes and strategy advised, wants to help the company in the choice of the best strategy to pursue.

The data used in this research came from primary and secondary data, and qualitative and quantitative data. Secondary data derive mainly from Literature and Internet research. The quantitative data taken in consideration are drawn up by organizations and companies that collaborate with the Italian government, participate in European international projects and are recognized at international level. Qualitative data are also used and the main way to gather that information was the use of e-mails with expert and key person already acquainted of the Italian biogas market.

The results of the research showed the potential of the biogas market in Italy, as well as the strategy to follow in the short time to enter and get familiarity with it. Possible entry modes and advise about the desirable ones also were mentioned. The nature of the product makes this work usable also for other countries or markets than Italy.

Keywords
Entry mode, Entry strategy, Italian, Italy, Biogas, Exporting, SME, Market research, Internationalization.

Miscellaneous
Chapters 6, 7 and Appendix 4 are confidential until the 25.05.2015. They shall also not appear on the Table of Contents.

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1 INTRODUCTION

It is a well known fact that in the near future and during all the twenty-first century one of the most important issues that the society has to face concerns energy. (Randolph, 2008, p. xv.). The increase of the energy demand is pushed by different reasons: the constant growth and consequent energy request as well as the new economies like China and India above all, the high life style level reached by the first world countries during the past decades, the underestimated fact that fossil oil reserves and coal are not infinite in the time, are just the most evident and clear examples of why we need to take in consideration the energy as an issue and not as a need, any more.

Because of these macro reasons we can start to think more close to our reality and real life experience of needs. For several reasons, the price of the oil before the last crisis that literally stopped the economy in world wide scale, was running in an incredible rate. The historical maximum was touched on the 11th July 2008 when the price in the London market dedicated to the oil, registered the price of 147,25 USD. (Petrolio sopra 147 dollari, Borse a picco, http://www.corriere.it/economia/08_luglio_11/petrolio_record_2d18ea72-4f39-11dd-932f-00144f02aabc.shtml.). Since the last decade the price of gasoline and diesel started a never ending escalation in terms of price, and that maximum for the crude oil price was simply another reason to increase even more the final price dedicated to the consumer.

The car sales as a consequence have been registered the their lowest level.

I would like to put the attention on the importance that the natural gas for the automotive sector gained in recent years in Italy.

Metener Oy is the company interested and involved in this work. Its target is to reach a new market after the one in the home country (Finland) and the first step abroad (China). For sure the Italian market is one of the most attractive in this field but a lot of details have to be considered, from the strong presence of the bureaucracy in all levels to the European regulations which presence are impossible not to take in account.

2 ABOUT THE RESEARCH

Business research has the main task in giving answer and finding out things, it is not one discipline based tool but has to be considered multidisciplinary and include interaction of both theory and practice. (Saunders, Lewis, Thornhill, 2006, p.13.).
In almost the totality of cases it is an applied research, which means it is a problem oriented with the object to resolve specific business problems and give the inputs to make decisions. (Timm, Farr, 1994, p.6.).
In this circumstance the case study method helps in the research process for its nature to combine both qualitative and quantitative data resource (Yin, 1994, p.1.).

2.1 Research Objectives

This bachelor thesis has as final target to put light in the dark zone of the Italian market condition/prospective, permit Metener to have a better overview concerning the situation and give hints to make easy the strategy thinking process for an eventual internationalization in the near future.
Even if the research is conducted with the best intention I have to clarify that one bachelor thesis and its research can not be fully exhaustive to cover the complete procedural aspects of company internationalization. Many problems and contingency that according to the literatures present an easy theoretical solution, might face different complexity grade and have different destiny in real business life application.
The Metener business concern in different distinct but related activities:

- Biogas production
    - electricity production from combustion of biogas derived from the plant.
    - biogas used for fuel
- Design of biogas manufacturing plants
    - electricity production
    - filling station
- Consultancy

Analyse all the peculiarities for every business sector may require a wide study that covers all the aspects that the Company business mix presents. To have a realistic and well grounded result every one of that business sector has to be taken in account as a major topic in a dedicated research.

In this work I am going to focus on the feasibility of the filling station and upgrading market opportunities, as the company is requested, which finds that particular part of the business the most interesting for being offered abroad as suggested by the first project that Metener is running nowadays for the Chinese market.

2.2 Research Question

- How Metener Oy should carry out the internationalization process?
- What is the potential market for Metener Oy in Italy?
- What are the advisable entry modes for Metener Oy in Italy?
- How this internationalization process has to be led?

2.3 Research Methodologies

In the accomplishment of this document I got questions that required to be answered. Questions are on the base of every research. To find out valuable answers I get close to the case study method.

It is a really flexible research tool as it is applicable and can refer to several things, for instance a process, an organization, a group or individual, the case study method answers in particular to the question “how” and or “why”. (Yin, 1994, p.13.)

The single case study perfectly matches with the needs, that present the chance to give attention to a particular phenomenon, deep and consequent achievement of the answer (Yin, 1994, p.87.).

As mentioned in the beginning of this chapter, both qualitative and quantitative data resources are used, the same nomenclature is applied to distinguish both, data collection techniques and data analysis procedures (Saunders, Lewis, Thornhill, 2006, p.145.).

The two data categories are explained by the literature as follows:
Qualitative refer to any data collection or analysis that in the end will culminate in non numerical data. See an example interview and data categorization. (Saunders, Lewis, Thornhill, 2006, p.145.).
Quantitative refer to any collection of data or analysis procedure of it that will create or use numerical data. See an example questionnaire, graphs and or statistics. (Saunders, Lewis, Thornhill, 2006, p.145.). The authors gave also the simplistic differentiation definition, classifying them as numbers based and words based.

The secondary data, for Saunders, Lewis and Thornhill (2006) definition, are data already existing, collected for other purposes in the past, coming from different sources: internet researches, Literature and articles.
The main benefit in using the secondary data is that it is considerably more economical than collecting data in first person. Often are already skimmed and ready to be used. They can guide you to results that are not yet known and generally are stably available to be consulted. (Saunders, Lewis, Thornhill, 2006, p.259.).
Other relevant advantages are related to the speed how it is possible to interact with the data and the flexibility that provides wide variety. (Ruddick, Sherwood, Stevens R. E., Wrenn , 2006, p.98.).
Unfortunately the secondary data presents also some disadvantages. The most relevant and dangerous is because it can affect severely the result of the research concern the data quality. It is extremely important that the sources are totally reliable. Again, another problem may regard the effective matching with the researcher needs, specially if the data was collected for specific research they might not “fit” properly the necessary (Saunders, Lewis, Thornhill, 2006, p.260 - 262.).
It is also important to keep in consideration that some data was collected in different spans, which increase the risk to hit obsolete data; relevant as well is the level of the accuracy, that depends on the method used by the researcher. (Ruddick, Sherwood, Stevens R. E., Wrenn , 2006, p.98.).
Primary data is information not existing before, that is gathered during the research for a specific purpose following format that better fit the needs, considering certain sources and can be collected using different methods. (Ruddick, Sherwood, Stevens R. E., Wrenn , 2006, p.99.).

The Primary data used in this thesis came mostly form e-mail, telephone calls, interviews and personal meetings with the key persons. Most of them were conducted in Italian language and included interviews with direct and indirect competitors and regulation experts.

3 METENER OY

The company was settled in 2001, by his actual managing director Erkki Kalmari. The headquarter of the company is located in Leppävesi, in Laukaa area, in the north of Jyväskylä, Finland. Crucial in term of importance for the company was the collaboration between the founder and the University of Jyväskylä, collaboration that started before the company was established. Since the first moment of its existence, the company was characterized by a strong high tech attitude. Even if it can be considered a young company, it may benefit of strong experience, derived from the real practice of the founder who got close to the biogas sphere years before and had a chance to try first-hand experience the advantages of it.
The company has seven employees that are able to cover different crucial aspects of design, production and development of the biogas chain included construction, automation and electrical systems.

Although the company can provide different solutions to biogas related issues using already present material, the company patented its solution for the upgrading unit. This is the company's first patent and nowadays started the design of a new upgrading unit that covers different parameters regarding work characteristics.

Nowadays the company divides its business in services and products, that touch different areas of competence.
In the services Metener offer:

- Consulting
- Engineering
- Manufacturing

As products the Metener offer:

- Farm scale biogas plant
  - Design
  - Construction
- Biogas upgrading unit (for vehicle use).

The company at the moment already started the internationalization process thanks to the collaboration with Jyväskylä Regional Development Company Jykes Ltd. and FECC, the Finnish Environmental Cluster for China project.

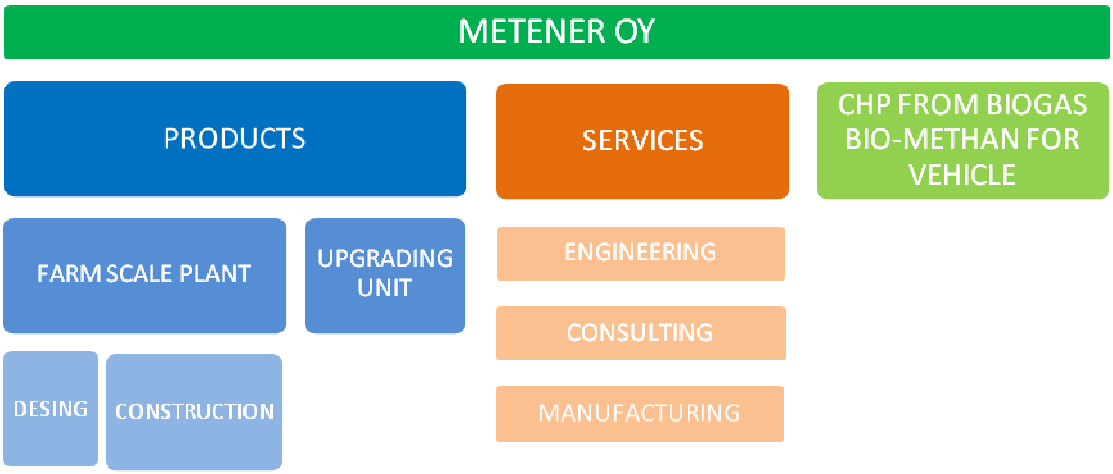

FIGURE 1: Metener Oy structure

3.1 Company history in brief

1998 Biogas power plant starts to operate.

2000 Beginning of the collaboration with the University of Jyväskylä.

2001 Foundation of the company.

2002 Upgrading unit invented and patented.

2002 Installation of methane refuelling station.

2009 Agreement with China, design and production of biogas plant equipment, with the collaboration of Jykes Ltd. and FECC.

2010 First delivery in China.

2010 New upgrading unit design and R&D started.

2010 Research of new business opportunities/markets.

3.2 Product description

The chain levels where Metener can offer its experiences can be considered quite wide, specially if it is counted as a resource of possible market opportunities, the consulting services that the company can provide.
For the nature of the Italian market this document will focus more in the biogas CHP[1] plant and the upgrading unit system for the vehicle use. This decision is taken considering the real potential of the products and needs, not only from the client's point of view but enlarging the prospective, including the market one as well.
The other aspects are not to be considered less important or not worthy of mention, but as specified before one bachelor thesis can not explain and touch in deep all the aspects in an exhaustive way.

Is important to mention that the two products are complementary to each other but not essential. Both can be an answer to different needs, and so, find an application also when considered separately.

About the **Farm scale biogas plant**, there is to denote that there is not a specific model, design or drawing. The parameters for the feasibility studies depends from the size of the farm, the nature of the farm business, the possibilities to reach valuable waste, like restaurant waste or alimentary production reject. Not all the farms do same things, there is a huge difference in a farm that is zootechnically based and another one that produces salad all year long.
In general, to give an idea who is not familiar with the topic, the minimum base to work on it is represented by a farm that can be supported by 100 cows and 100 land hectares (based on the Finnish conditions). This is a simple example of farm size that will be able to be self-sufficient under the waste and crop aspects. Possibility to work

[1] CHP stand for Combined Heat and Power

in a cooperative way between more farmers affect directly the requirement of land and livestock.

The general overview about this product shows that is possible to have a CHP with possibility to have excess in electricity production that may be sold to the electric operators. In particular it is possible to heat the farm, house, glasshouse and at the same time produce electricity for the total operational needs and be totally self-sufficient. With a minimal adjustment it is possible to extend the benefit also to have hot water and cooling system. One aspect that needs to be marked is the ability of the biogas plant to work in a prohibitive climate and weather conditions. Designed for the harsh Finnish climate, the units showed less dependency from the weather changes/conditions and permit to reduce in a consistent way the idle time caused by breakdowns.

The **Upgrading unit**, invented and patented, see appendix 1, by the managing director of the Metener, Erkki Kalmari, permits to have in exit bio methane after the biogas cleaning process. The peculiarity of this unit is the dimension, the unit itself can be stored in a sea container. The capacity is from 30 Nm^3/h to 100 Nm^3/h of raw biogas. Amongst the available types of technology used for this biogas depuration, this uses the water based one. The output of the unit is bio methane, in high pressure, ready to be filled in the vehicles tanks.

The timing required for the company to design and create the products, considering also the testing, is around five months. This time line is referred to basic project with simple CHP biogas plant and upgrading unit.

Considering that the biogas plant needs a mason's digester, Metener, in case of international project will provide the plan, consultancy and the upgrading equipment to be installed in a second moment.

3.3 International operations

In the 2010 Metener delivered the first device to China, result of years of collaboration with Jyväskylä Regional Development Company Jykes Ltd. and the Finnish Environmental Cluster for China project. For the fact that this negotiations were conducted with the intercession of the two subjects, it is possible to deduce that the managerial/strategical aspect of this entry mode was not in the sphere of the manager's competency. Or at least not totally. Some barriers were crashed by this cooperation and obviously some market research expenses avoided.
This is not to mean that the company will not have a strategy for the near future, on the contrary it is a greater point of start in the future strategy of keeping and enforce the presence in the Chinese markets.

In Europe, and in Italy in particular, the internationalization strategy have to be based on different context. The EU with its directive in ambit of environmental and emissions gave, and still do in the present, a strong input to invest in the renewable energy. Some benefits tariffs based are statutory in several countries, and create the conditions that make the investment desirable by a large number of farmers. In Italy with the Ministerial Decree of 18th December 2008, an important government document, the biogas entered in the renewable energy categories and so eligible to receive benefit and incentives. This represents a real "innovation" in the system that under the impulse of EU requirement in term of reducing CO_2[2] emissions, find in this, one mode to align the country with the European standards.

3.4 Metener Oy SWOT analysis

One of the most important tool in starting the strategy formulation is the SWOT analysis. The SWOT acronym stands for strengths, weaknesses, opportunities and threats; that act internally the company or organization and take into account the external influences from the environment. The best strategy is the one that maximise

[2] CO_2 stand for Carbon Dioxide

the positive aspects of the organization, strengths and opportunities and tries to minimize the influence of threats and to stultify the weaknesses. (Griffin, 2008, p.67.).

As all the organizations that operate in this business world and Metener as well, have to deal with SWOT. For the company can be presented as follows.

Strength

- Absolute pioneer position in the Finnish market.
- Metener's upgrading units is unique in the same field, thanks to its small capacity that permits to be more versatile.
- Small size of the company permits to be flexible and give a sure point of reference to the customer.
- Strong University and Organizations collaborations and networking.

Weaknesses

- Lack of ISO/EN[3] certification, might be a reason of impossibility to enter in the European markets, even though all the components came from European countries and should be made under the Community law.
- Lack of marketing and promotional plan.
- Presence of deep-rooted competitors in the Italian market.
- Lack of "physical" presence on the Italian (or any other target market) territory.

Opportunities

- Italy is the European country with the highest number of cars alimented by methane.
- Although Italy is an industrialized country it is rich of medium and big size farms especially concentrated in the centre/north of the country.
- A large number of restaurants and food industries are present on the territory, the last category often collected in restricted area as a cluster.

[3] ISO, International Organization for Standardization; EN, European Standard promulgated by European Committee for Standardization

- The characteristics of the Upgrading unit can make the product the missing ring in the Italian biogas and bio methane chain.
- The most recent policy in the renewable energy field, and subsequent inclusion of biogas within it create a new big potential for both products of Metener.

Threats

- Long and complicated purchase decision process from the buyer.
- High cost, in any case the cost have to be considered an investment and require business and payback analysis by the customers.
- The possibility that competitor will create upgrading units with the same versatility and flexibility.
- The lack of definitive and clear legislation about the bio methane as vehicle fuel referred to the farmer sphere of competence.

4 INTERNATIONALIZATION

At the simple question, why one company intends to undertake the way of internationalization, the spontaneous answer is make more money. It is the natural desire of any manager or owner of almost any company. (Hollensen, 2007, p.42.).

There are also non-profit oriented reasons, but it is clear that might be desired only subordinated at the certainty of the future profit income, regardless if in direct or indirect way. (Albaum, Duerr, Strandskov, 2005, p.62.).

In general the reasons can be classified under two categories: reactive (or defensive) and proactive (or aggressive). (Deresky, 1997, p.144.).
In the figure it is possible to see a scheme of both reasons.

PROACTIVE MOTIVES	REACTIVE MOTIVES
✓ Profit and growth goals	✓ Competitive pressure
✓ Managerial Urge	✓ Domestic market: small and saturated
✓ Technology competence/unique product	✓ Overproduction/ excess capacity
✓ Foreign market opportunity/market information	✓ Unsolicited foreign orders
✓ Economies of scale	✓ Extend sales of seasonal products
✓ Tax benefits	✓ Proximity to international customers/psychological distance

FIGURE 2. Proactive and reactive motives (adapted form Hollensen, 2007, p.42)

Of course not all the motives fit in the situation or needs of all the companies, LSEs have obviously a different way to start the internationalization way. At this point we can go through what are the Metener's motives.

4.1 Proactive motives

Profit and growth goals

The desire in the short term to reach new profit. This is one of the most important trigger for the SMEs. The target of growth is as well another motive to start the export procedure. In general, the good experience from one export experience can affect in positive the next strategy. It is important to consider that if the related profitability perception reach high level this is an enforcement for all the export future strategy. (Hollensen, 2007, p.43.)

Managerial urge

Is considered as the motivation and desire that the manager have to drive the company into an international context motivated by the enthusiasm of the management itself. (Hollensen, 2007, p.43.)

Also important to keep in mind that the fresh experience of Chinese exportation play a strong impulse to maintain this process of internationalization.

Technology competence/unique product

This is the case of the Upgrading unit. The characteristics of the unit give a potential key role in the foreign markets. Specially where small units are required and there is not an actual internal offer of them.

Of course nowadays the possibilities that this advantageous position will be threatened by competitors is real and increases day by day, but this is not a reason to be passive and stuck in the national market. On the contrary this is an incentives to run the process in an temporal effective way.

Foreign market opportunities/market information

The fact that the foreign market present opportunities, is one of the most important reason of going international.

On the other hand it is important to keep in mind that these opportunities are known if there is an active research of information about these market opportunities. Market knowledge includes finding information about competitors, customers and opportunities that in general are not easily shared by other players. (Hollensen, 2007. P.44.).

4.2 Reactive motives

Domestic market: small and saturated

If the internal market potential is small, the company may have the stimulus to go international. Specially for products that present few and easily identified customers the export is almost a must. (Hollensen, 2007. P.46.).

Another aspect to keep in mind is that Metener's products are not a non-durable, on the contrary required a deep analysis by the possible customer.

The One-off order is another reason why the SMEs want to start to export in a more systematic way. (Hollensen, 2007. P.47.).

What I have mentioned above, finds confirmation in the Metener preceding in China. As it was already referred to the managerial urge described in the proactive motives.

5 ITALY AS TARGET MARKET

Crucial point of internationalization process is the choice of the target market. Identify the market that in the end shows that it was the right one is important for several reason:

- Can be the driving force to fail or success in the process, in particular if it is the first step in the internationalization.
- The marketing strategy is affected by this decision.
- The foreign operations are influenced by the nature of the geographic location of the target market.

In general the SME tend to follow the “Low” criteria. Low “psychic” distance, low “cultural” distance, low geographic distance. But it is also true that young SMEs have the tendency to join distant markets earlier and faster than others. At the same time it is possible to say that in the real life there is not always a logical and sequential approaching procedures. (Hollensen, 2007, p.244-245.).

In this document we will analyze the Italian market, its potential and pitfalls. The clear objective is to give a real and effective resource that may be used and permit to save research expenses. One of the motive of the decision to take in consideration the Italian market is its known historical tradition in the field. Nowadays a lot of equipment for the natural gas treatment and how to handle the natural gas comes from Italy. This can of course increase the number of the competitors, but in the same time shows that the ampleness of the market permits the presence of a high number of players.

5.1 Natural gas vehicle fleet

In according with the statistics of the GVR Communications Group and NGVA Europe, Italy is the European country with the maximum number of vehicle alimented by methane with more than 580.000 units, referred to June 2009. (The.....GVR, Volume

9 #1 Number 98 March 2010, p.36, http://www.ngvgroup.com/pdf/gvr98-032010.pdf).

In general the trend of the sales is always in positive thanks to the fleet renewal incentives that the government allocates to encourage the sales of cars with "clean" fuels. These incentives are allocated mainly for two reasons:

- Renew the fleet of the cars in Italy, which is quite old.
- Pursue a environmental policy to cut the CO_2 emissions, in which Italy is quite in delay considering the EU standards.

For the year 2010 the government did not provide any incentives. Anyway in consideration of the economical crisis and the importance of the automotive industry under the employment aspect, effectively count more than 169 thousands employees (Economic Report Full Year 2009, 2010, http://www.acea.be/images/uploads/files/20100311_ER_1003_2010_I_Q1-4.pdf) including the induced car industry economic activity, is possible to guess that later on, a sort of similar incentives will be (re)introduced.

5.1.1 Last incentive policy

In general, in the past, incentive campaigns to purchase a new car were based on the main target to boost the demand and consequently help the automotive sector. The last incentive campaign, decree-law n.5 of 10/02/09, adopted to contrast the economical crisis, presents the welcome introduction of environmental aspect, with the purpose to encourage the sales of low CO_2 emissions and replacement of old cars in the fleet. In concrete the incentives are given under the form of discount on the sale price directly by the car dealer. (National Report on current status of biogas production – Italy, 2010, http://www.gashighway.net/default.asp?sivuID=25922&component=/modules/bbsView.asp&recID=16778).

The following table shows in detail the incentives concerning methane even though also LPG[4] was target of the same policy but with different allocation of resources.

Type	Scrapping (Euro 0,1,2)	Purchase of type-approved methane vehicle (Euro 4,5)	Extra incentive for CO_2 < 120g/Km	Tot €
Cars	✓ **€ 1500**	✓ **€ 1500**	✓ **€ 500**	**€ 3500**
Light Commercial Vehicle	✓ **€ 2500**	✓ **€ 4000**	**N/A**	**€ 6500**
After sale Methane conversion (Euro 0,1,2)	**N/A**	**N/A**	**N/A**	**€650**

TABLE 1. Italian Incentives Campaign 2009 (adapted form National Report on current status of biogas production - Italy, 2010, and Comparazione delle Misure Anti Crisi in Europa, Anfia, 2009)

5.2 Biogas plants presence

Actually in the territory it is possible to count several biogas production plants. This number changes quite rapidly and in any case to have a certain number is difficult or quite impossible. It is possible to state with certainty, independently for the numbers, that the phenomenon is in growing phase.

The CRPA, Italian company that operates in the zootechnical field including biogas, has surveyed till September 2009, 235 plants that produce biogas from livestock effluent, agricultural waste, agro-industrial waste and energy crops. Of the same type 59 are under construction. The number reach the 401 units, and 61 in construction if the one that use organic fraction of municipal solid wastes, agro-industrial wastewater and civil sewage sludge are also counted. As told before the number is steadily increasing, boosted from the incentives and the environmental policy in the last years. In any case it is important to specify that this is being moved by reactive motives as a response to the EU requirement and targets (specially in the

[4] LPG stand for Liquefied Petroleum Gas

CO_2 emission field and renewable energy production share), and almost never as a first initiative starter.

5.3 Electricity biogas related incentives

As told before Italy uses incentive policies to promote the diffusion and to use renewable energies. The biggest limit of the Italian system is represented by the fact that the only thing for what incentives are given is the electricity produced by using renewable energy. This means that the production itself of biogas, or the purification till has bio-methane is pointless for the scope to receive the incentive if the process is not completed with the generation of electricity. Also the related production of heat is not considered as a eligible resource. This represents a big delay respect the other EU members that for example allow to upgrade the biogas and pump it into the grid like already is done in Sweden, Germany, Austria, Denmark and Switzerland. (Deublein, Steinhauser, 2008, p.32, 391-394.).

In Italy at the moment after the Ministerial Decree of 18th December 2008 the electricity produced by biogas benefits of the following incentives:

- Green Certificates
- Feed-in tariff
- Exchange spot

All of the option are applicable only to plants that start to operate after 31st December 2007.

5.3.1 Green Certificates

The green certificates symbolize value of the electricity produced by renewable energy. The certificates are expected for plants with power bigger than 1 MW and are ensured for a period of 15 years. The number of correspondent certificates is based on coefficients determined by the source of renewable energy which may be revised every three years.

$$N° \, Green \, Certificate = \frac{Coefficient * Total \, production \, MWh}{1MWh}$$

The final value is given by the number of the certificates multiplied by the value coming for the subtraction of the value fixed law of 180€/MW and the one decided by the Authority of electric energy and gas.

$$Green \, Certificate \, Value = N° \, Green \, Certificate * (180 \, €/MWh - \, \mu \, €/MWh)$$

The following table shows the coefficient divided by biogas source.

Type of biogas by source	Coefficient
Biomass and biogas produced from agriculture, animal raising and forest on short supply lines	1.80
Biodegradable wastes and biomass different from the one above	1.30
Landfill gas and residual gas from water treatment processes	0.80

Table 2: Green certificate coefficient for the biogas source (adapted from National Report on current status of biogas Production – Italy, 2010)

The green certificate is also compatible with the "*Ritiro dedicato*", basically the sales of electricity to the national operator. The reason is in the fact that the sales are not an incentive but just a simplification of the procedure.

5.3.2 Feed-in Tariff

The feed-in tariff is adoptable in case of plants that have maximum capacity of 1MW. This is a monetary incentive dedicated mainly for the small size plant and permits to have an easy predictable income. In the light of the fact that is related to the kWh

feed in the grid and not to the quantity is produced, is important to feed the maximum amount. The tariff is ensured for 15 years from the day when the plant started to operate. Like the green certificates, also this present differences based on the source of biogas and the value may be revised every three years. The table 3 will shows the details. Assuming that 1m³ of biogas gives 10 kWh and the price of methane as vehicle fuel is around 1€/m³, in the light of the incentives it is in any case desirable to produce electricity instead to pursue the sales of biogas as vehicle fuel.

Type of biogas by source	Tariff
Biomass and biogas produced from agriculture, animal raising and forest on short supply lines	28 €ct/kWh
Biodegradable wastes and biomass different from the one above	22 €ct/kWh
Landfill gas and residual gas from water treatment processes	18 €ct/kWh

Table 3: Feed-in tariff by biogas source (adapted from National Report on current status of biogas Production – Italy, 2010)

5.3.3 Exchange spot

The exchange spot is the option for the small plant with power not more than 200 kW. After a revision process, now create a credit in favour of who produces energy and feeds in the grid if in the end of the year the value of his feed is bigger than the electricity taken from the grid. The value is calculated in base of the value of the market, so following price fluctuation, different tariffs related to day time and night time etc. If in the end of the year the balance shows credits the producer will ask the accreditation in money. (http://www.nextville.it/index/668).

5.4 Biogas potential

The biomass that are interesting for the production of biogas are mainly waste from the following categories:

- Zoo technical (liquid and solid animal dejection).

- Agro industrial (waste from transformation and processing of agricultural products).
- Agricultural production (residues from crops of fruits and sowable sector).

In addition to the resource mentioned above it is possible to use also waste in the end phase of the consumption (organic fraction of domestic waste) or others like sludge from water treatment.

Lately the interest of the government became close to the potential of the biogas production, specially in the light of the good result obtained by the rest of the European countries. In detail the Ministry of Economical Develop and ENEA, the entity for the new technology energy and environment drafted a study of the biogas potential considering biomass from waste of livestock sector in Italy.

The study has been conducted by analysing the different sources of useful waste, and in particular the main division was done by taking in to account:

- Estimation for the bovine and buffalos sector
- Estimation for the swine sector
- Estimation for the slaughter sector

5.4.1 Cattle and buffalos estimation

The sector in analysis for the characteristic of the dejection are one of the most interesting for the biogas production in anaerobic digestion.

Starting from the minimum number required from which is possible to consider economically interesting the investment, in this sector this value is fixed to 50 units. This is called dimensional threshold. Under this value it is not possible to think about one plant that is economically functional, on the contrary from this value, in presence of particular logistic condition and addition of other fermentable waste the technical-economical convenience can be reached.

The minimal dimensional threshold to have the economical sustainability in other hands is fixed to 100 units. After this value in presence of particular condition the plant can be totally self sufficient. Unfortunately the Italian structure is

characterized by a big number of small dimension farms and a small number of big dimension farms. The average dimension show a value of 43 units for farm.

The gross biogas potential without any sort of consideration between the size of the farm shows the amount of 1.500 millions Nm^3 of biogas. Taking this number out the blockage does not give the a real picture of the potential. Considering the size blockages this value decreases of 27% in the case of the 50 units blockage and of 45% in the case of 100 units. The table below shows better the numbers.

Biogas potential	**Nm^3 (in millions)**
Without blockage	1.500
Blockage set to 50 units	1.095
Blockage set to 100 units	825

Table 4: Biogas potential bovine and buffalos sector (adapted from La stima del potenziale di biogas da biomasse di scarto del settore zootecnico in Italia – Italy, 2009)

The study permits as well to focus in certain geographical area. In fact big size farms are collected like as a cluster in certain regions of Italy. In prevalence in the north: Lombardia, Friuli, Emilia-Romagna, Veneto with the exception of Puglia that is located in the south. The use of the blockage is necessary to give a real value to the estimation. It is not possible to consider valuable the potential of little farms located far from each other that makes it difficult or even impossible to concentrate in a common consortium. The realistic point of view requires to focus on the big size farms. Of course there is not to exclude the possibility for small medium farms that are located near each other to converge together and create one plant.
(La stima del potenziale di biogas da biomasse di scarto del settore zootecnico in Italia, Colonna, Alfano, Gaeta, 2009, p.13 – 39, http://www.enea.it/enea_paese/sistema_elettrico/Censimento_biomasse/RSE201.pdf).

5.4.2 Swine potential estimation

The swine sector is another important resource of biomass, even the result in terms of waste can vary considerably in according of the different way of breeding. In Italy the sector presents an anomalous trend. In fact the number of farms that are registered as producers are inversely proportional with the units of swine in it. In the south for example there is the major number of farms, with really small numbers of pigs in it. This is mainly a consequence of regional tradition, and the pigs are most of the time in the number of few units (less than 3units) destined to the domestic consumption.

The national average is 93 units for farm, but it is a mere statistical number. In real, between all the Italian regions only one reflects this number. The others are in the extreme, 87% of the farms have less than 10 units, and 2% of the farms have 85% of the total national breeding. The breeding is mainly concentrated in four regions: Veneto, Lombardia, Emilia Romagna and Piemonte, all located in the north.

Like it was for the cattle also the swine need a certain number to make the investment profitable. The minimum number required that permits the plant to work with the integration of other resources also coming from the agricultural sector is fixed in the number of 500. The number growth till to 2000 units to have a self sufficient plant to form the dejection. This number is also the start point for the EU directive 96/61/CE for the integrated reduction and prevention of the environmental pollution caused by breeding of swine and poultry.
Now considering all the units without any blockage the total amount of biogas predictable is 350 millions Nm^3 for a year. This value is obviously not truthful since it includes all the farms with few units. Considering the blockage of 500 units, the national potential decrease only of 6,5%, 32% if the other blockage of 2000 units is taken in account. The table below resume the numbers.

Biogas potential	Nm³ (in millions)
Without blockage	350
Blockage set to 500 units	327,25
Blockage set to 2000 units	238

Table 5: Biogas potential swine sector (adapted from La stima del potenziale di biogas da biomasse di scarto del settore zootecnico in Italia – Italy, 2009)
(La stima del potenziale di biogas da biomasse di scarto del settore zootecnico in Italia, Colonna, Alfano, Gaeta, 2009, p.40 – 65, http://www.enea.it/enea_paese/sistema_elettrico/Censimento_biomasse/RSE201.pdf).

5.4.3 Slaughter waste estimation

In Italy in the end of 2008 was possible to count 2930 slaughterhouses distributed as follows:

- 556 with CEE stamp[5].
- 2374 with limited capacity.

In the past, the solution to dispose of slaughter waste was to incinerate it and produce electricity and heat. This solution presents the main problem in the fact that the waste is quite humid. On the other hand this is a plus in the anaerobic digestion. Unfortunately not all the rest of the body of the animal can be used. Bones have to be chopped and before some part, after the BSE[6] explosion, has to be sterilized with temperatures up to 70° for at least an hour. In general the slaughter waste is quite profitable under the biogas potential.
The potential estimated is around 43 million Nm³ per year from half million tons of waste. Like the previous estimation, also this one has to be considered gross. It is more realistic that in concrete it is a bit less, otherwise it is still mentionable between the potential resource of biogas.
(La stima del potenziale di biogas da biomasse di scarto del settore zootecnico in Italia, Colonna, Alfano, Gaeta, 2009, p.66 – 94,

[5] The authorization is given by the national sanitary system and entitle to produce and sell meat inside the EU.
[6] BSE stand for Bovine Spongiform Encephalopathy

http://www.enea.it/enea_paese/sistema_elettrico/Censimento_biomasse/RSE201.pdf).

5.5 Upgrading potential

As mentioned before, the biogas production does not extinguish its using possibilities in the electricity and CHP production, but can be easily used in different ways after an appropriate upgrading cleaning process. In the most of the cases the possible use after this process are:

- Vehicle fuel
- Grid injection

At the moment in Italy no one of the mentioned uses are provided for this utilization. This, once again, represents the delay of the country in comparison with the rest of the Europe, specially if compared with countries with the same level of development. Fortunately in the light of the Ministerial Decree of 18th December 2008 which includes biogas as eligible source of renewable energy more attention to this field occurred. Stakeholders already started to press the government and together with the economical crisis it can just boost the procedure to a faster solution. Pilot project already run, see for instance Biogasmax project. This EU project involves five countries, Germany, Switzerland, Sweden, France plus Italy and concern the bio fuel and in particular the bio methane. (http://www.biogasmax.it/il-progetto/un-progetto-europeo-per-lo-sviluppo-sostenibile/).
It is important to mention that it already started to put bases for the next steps. Unfortunately a smaller deeply analysis, not considering France that is quite a total beginner in the filed, shows that Italy among the participants, is the country with less past experiences and participates in it with the landfill biogas. This solution can be seen probably like the easiest one, but for sure don't really gives any add value. Of course the focus must be in the positive part of it, which is the beginning of the interest in the procedures.

The upgrading process can be applied to all the biogas plants in construction or in study process. The size parameter must be analysed in a special session, because

the right plant size affects directly the cost of the upgrading unit, even if in general the prefeasibility study is already a good indicator about the effectiveness of the investment.
In addition of it, I believe that even the already existing plants (more than 10 years old), specially if they present a big size, can adopt the same technology that can be a resource once the relative electricity feed-in tariff will end.

Yet it is possible to state in the light of the analysis of the CNG car fleet exposed in the chapter 5.1 and its relative incentives that the potential of bio methane as vehicle fuel is wide. Specially considering bio methane as environmental friendly fuel thanks to its characteristics. (National Report on current status of biogas production – Italy, 2010, http://www.gashighway.net/default.asp?sivuID=25922&component=/modules/bbsView.asp&recID=16778).

5.5.1 Grid injection potential

Italy at the contrary as happens in the other countries has a really well developed natural gas pipeline. The pipeline covers regardless with its 31.500 km from the north to the south and from the east to the west. (Relazione Finanziaria Annuale 2009, 2010, p.17, http://www.snamretegas.it/it/investor_relations/pdf/bilancio_2009.pdf).

Excluding Sardinia island, all the rest of Italian territory is reached by the grid. The fact that all along the country it is possible to find different pressure pipelines give another big advantage for the upgrading potential. Excluding the local and urban grid that work in low pressure, the rest of the net can be used in any location with low expense in term of power and money to pump the gas into the grid.

FIGURE 3. Italian Natural Gas pipelines (from Relazione Finanziaria Annuale 2009, 2010, p.17, http://www.snamretegas.it/it/investor_relations/pdf/bilancio_2009.pdf Snam rete gas, 2010, p.17.).

5.5.1.1. Upgrading concerns

The EU guideline for the equalization between biogas and natural gas states that biogas can be injected in the natural gas network without preclusions, in the light that the injection is achievable without technical problems and safety. The biogas itself does not need to have special requirements, just the sufficient pressure is needed but one important step has to be done: the odorization. This is a safety procedure to make the gas traceable in case of leak. (Deublein, Steinhauser, 2008, p.161-392.).

At the moment no international technical standard about the injection of biogas is present. Some countries in Europe have decided to regulate this by national standard. (Biogas Upgrading to Vehicle Fuel Standards and Grid Injection, Persson, Jönsson and Wellinger, 2006, p.8, http://www.iea-biogas.net/Dokumente/upgrading_report_final.pdf).

To have an idea of the characteristics that the biogas must have, to be injected, the international standard can be used, in particular the EN ISO 13686 : Natural Gas – Quality Designation. (Deublein, Steinhauser, 2008, p.161).

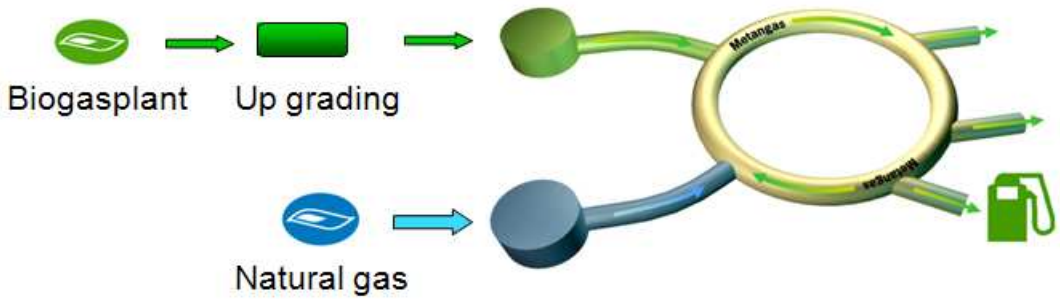

FIGURE 4. Integration bio-gas natural gas (from www.cleanaccessibletransport.com, 2010)

The rest of this document is confidential, the reader is invited after the expiry date of the confidential period to consult it.

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APPENDICES

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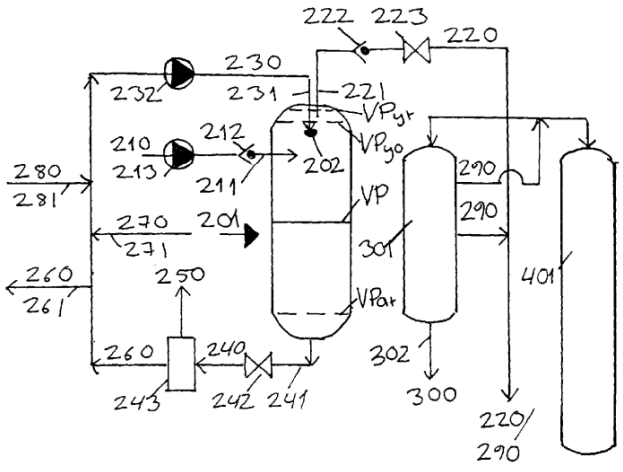

(57) Abstract: The invention relates to a pressurization apparatus (201) for biogas. Said pressurization apparatus (201) comprises a biogas inlet pipe (211) having at least a cut-off means (222, 223), a washing water inlet pipe (231) having at least a washing water pressurization device (232), a washing water outlet pipe (241) having at least a cut-off valve (242), said apparatus being controlled either manually or automatically.

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Apparatus and method for pressurising biogas in a gas washer

Background of the Invention

The invention relates to a pressurization apparatus for biogas.

Biogas may be produced for instance from agricultural and communal waste waters and sludges by means of separate biogas reactors. It may also be recovered e.g. from landfills where decomposing organic wastes are disposed of.

In general, biogas comprises from 30 to 50 % by volume of carbon dioxide, and accordingly, even a partial removal thereof significantly reduces for instance the space needed for storing the gas. Also the effectivity of biogas combustion is improved by lowering the carbon dioxide content thereof. Moreover, biogas commonly contains other compounds such as hydrogen sulphide complicating the use thereof, or causing e.g. corrosion.

One obstacle in the use of biogas is generally its low production or recovery pressure. It may be used on site for instance in boilers and aggregates, whereas its use in vehicles is often uneconomical due to high pressurization and storage costs.

Biogas is pressurized e.g. by means of high pressure compressors, such as water ring compressors. It is also possible to pressurize and purify biogas for instance with column washers that increase the pressure of biogas to about 10 to 40 at (gauge). Drawbacks of these apparatuses include the fact that they are either physically large or technically extremely complicated. Accordingly, such apparatuses are very expensive particularly in cases where pressures of 100 to 200 at (gauge) are sought.

General Description of the Invention

Now a pressurization apparatus for biogas has been found, said apparatus being technically particularly simple and compact.

To achieve this object, the invention is characterized by facts presented in the independent claims. The other claims disclose some preferable embodiments of the invention.

Biogas may not only be pressurized but also purified by means of the pressurization apparatus of the invention using for instance water as the washing liquid. If necessary, compounds or agents that intensify the purification may be added to said water.

The pressurization apparatus of the invention comprises at least a biogas inlet pipe provided with a pressurization device, a biogas outlet pipe, an inlet pipe for washing water provided with a pressurization device, as well as an outlet pipe for washing water. The pressurization apparatus is further equipped with cut-off valves and one-way valves necessary for the operation thereof. The operation of the pressurization apparatus is controlled for instance with a limit switch or a balance.

Preferably, a unit for removing carbon dioxide may be connected to said washing water outlet pipe.

The biogas inlet pipe may preferably be provided with a one-way valve preventing biogas from flowing out of the pressurization apparatus. This one-way valve is preferably placed as close to the pressurization apparatus as possible. Said one-way valve controls the biogas flow. If the pressure of the pressurization apparatus is lower than that of the inlet pipe, biogas will flow to the pressurization apparatus, whereas the biogas flow is stopped in situations where the pressure of the pressurization apparatus is higher than that of the inlet pipe.

The removal of biogas from the pressurization apparatus may for instance be carried out by providing the outlet pipe with a cut-off device such as a cut-off valve and/or one-way valve for biogas. The operation thereof is adjusted to and/or controlled according to the washing water and feed.

Pressurized washing water is preferably passed through a nebulizer into the pressurization apparatus containing biogas. As the water level rises, biogas washed in the pressurization apparatus starts to flow out of the pressurization apparatus under control of the cut-off device. As the water level reaches the upper limit in the container or outlet pipe, the washing water feed is stopped and the valve of the washing water outlet pipe is opened. As the water level is lowered, biogas is either fed or it flows through the one-way valve to the pressurization apparatus under control of the set values of said one-way valve. The valve of the washing water outlet pipe is closed as the water level reaches the set lower limit. The biogas feed to the pressurization apparatus is stopped, or biogas may flow to the pressurization apparatus under control of an optional one-way valve to reach the desired control value. Then the above cycle is repeated.

The nebulizer is preferably placed in the upper part of the pressurization apparatus to always pass the biogas to be purified through the spray of the nebulizer, thus assuring that only purified biogas is leaving the pressurization apparatus.

Biogas may preferably flow to the pressurization apparatus during the lowering of the water level. It may also flow to the pressurization apparatus after the lowering and/or rising of the water level has stopped, or as the water level is rising.

Washing water is preferably passed from the outlet pipe thereof to the pressurization device of the inlet pipe and to the nebulizer of the washing water. Washing water may be replaced partially or totally with fresh washing water. The washing water pipes may for instance be provided with a device for dispensing a detergent. In addition, the outlet pipe for washing water is preferably equipped with a unit for removing carbon dioxide.

The pressurized and purified biogas leaving the pressurization apparatus may be passed through one or several drying device(s) e.g. to pressurized tanks or biogas containers.

The apparatus used to purify and pressurize biogas is technically very simple, and moreover, the use thereof is economical and safe. It is preferable to feed biogas at a pressure of 1 to 100 at, such as 1 to 50 at, 1 to 10 at, 5 to 15 at, 5 to 50 at or 50 to 100 at (gauge) to the pressurization apparatus where it is pressurized to a pressure of 10 to 600 at, such as 10 to 50 at, 50 to 100 at, 100 to 300 at, 100 to 200 at, or 200 to 600 at (gauge).

The pressurization apparatus of the invention may only have two pumps. Both of them may preferably be serially produced gas compressors and water compressors that are already currently used in the industry or agriculture. This significantly contributes to the feasibility of the invention.

In the pressurization apparatus of the invention, preferably two water compressors may be used to feed said washing water. Relative to said washing water, one of the pumps may then be a powerful low pressure pump, the other pump being less powerful high pressure pump. Then, more than half of the pressure container may be quickly filled by means of the low pressure pump, and thereafter the rest of the container is filled against higher counterpressure with the higher pressure pump. This solution makes the use of the apparatus substantially quicker and more effective compared to an apparatus with a single water pump.

The maintenance of the apparatus of the invention is also favourable. The maintenance and repair costs of serially produced devices are usually low.

It is thus possible to pressurize biogas preferably to a pressure of 100 to 600 at (gauge) by means of an apparatus that is technically very simple, and simultaneously remove therefrom carbon dioxide, particles and hydrogen sulphide. Since the solubility of e.g.

carbon dioxide depends on the pressure of the washing water used, high carbon dioxide removal is attained with the apparatus of the invention due to high pressures used.

It is also preferable to use unpurified pressurized biogas in the pressurization apparatus to displace washing water, since this prevents the carbon dioxide of the washing water from being released in the pressurization apparatus. Carbon dioxide may be removed from washing water in the carbon dioxide removal unit connected to the outlet pipe where the pressure of the washing water is lowered to a value near the ambient pressure, that is to 0.5 to 1.5 at (gauge). Carbon dioxide is thus released quickly and effectively from the washing water. Preferably, carbon dioxide depleted washing water may again be recycled to the pressurization device of washing water.

The pressurization apparatus may be designed in different sizes. It may be built as small units for farms, or as large units for instance for waste water treatment plants. Also embodiments that may be transferred are possible, allowing for the pressurization of biogas from agricultural gas supplies, if necessary.

The apparatus of the invention may be controlled either with an automatic and/or manually operated control means to carry out the cycle necessary for the pressurization.

Detailed Description of the Invention

Some embodiments of the invention are now discussed in detail with reference to the appended drawings.

Figure 1 shows a pressurization apparatus used to pressurize biogas.

In Figure 1, a pressurization apparatus 201 used to purify biogas 210 comprises a biogas inlet pipe 211, a biogas outlet pipe 221, washing water inlet pipe 231 and washing water outlet pipe 241. The biogas inlet pipe 211 is provided with a one-way valve 212 and a biogas feeding means 213. The biogas outlet pipe 221 is provided with a one-way valve 222 and a cut-off valve 223 acting as the cut-off means of biogas, as well as a drying means 300 for biogas. The washing water inlet pipe 231 is connected to a water compressor 232 and a nebulized 202 placed inside the pressurization apparatus 201. The washing water outlet pipe 241 is equipped with a cut-off valve 242 and a carbon dioxide removal unit 243.

With the apparatus of Figure 1, biogas for instance from a biogas reactor and a biogas reservoir may be pressurized and purified according to the following cycle:

- pressurized washing water 230 is fed through the nebulizer 202 of the inlet pipe 231 to the pressurization apparatus 201 containing biogas 210
- the water level VP in the pressurization apparatus 201 having reached the upper control limit VP_{YO}, the cut-off valve 223 of the biogas outlet pipe 221 is opened thus causing purified biogas 220 to flow into the biogas outlet pipe 220
- the water level VP in the pressurization apparatus 201 having reached the upper limit VP_{YR}, the cut-off valve 242 of the washing water outlet pipe 241 is opened
- as the pressure is lowered, pressurized biogas 210 flows through the biogas inlet pipe 211
- the water level VP in the pressurization apparatus 201 having reached the lower limit VP_{AR}, the cut-off valve 242 of the washing water outlet pipe 241 is closed.

As the pressure in the pressurization apparatus 201 rises, the flow of biogas 210 from the biogas inlet pipe 211 stops. The one-way valve 212 of the biogas inlet pipe 211 controls the flow of biogas 210 during the cycle.

As the water level VP in the pressurization apparatus 201 has reached the upper limit VP_{YR}, the feed of said washing water may be stopped and the cut-off valve 233 of the biogas outlet pipe 211 is closed, and then the cut-off valve 242 of the washing water outlet pipe 241 is opened. Also, as the water level VP in the pressurization apparatus 201 has reached the upper limit VP_{YR}, it is also possible to continue with the feed of washing water 230, closing the cut-off valve 223 of the biogas outlet pipe 221, and thereafter opening the the cut-off valve 242 of the washing water outlet pipe 241. This procedure is possible for instance in situations where the outlet pipe 241 and the corresponding cut-off valve 242 are sufficiently large to remove the washing water 230 accumulated in the pressurization apparatus.

Washing water 240 from the outlet pipe 241 is removed and passed to the carbon dioxide removal unit 243 where carbon dioxide 250 contained in the washing water is released as the pressure is lowered. Then the purified, or fresh washing water 260 is passed to the pressurization compressor 231. On the other hand, the purified washing water 260 may be added with fresh washing water 270 through a pipe 271 and a detergent 280 through a pipe 281. The recycled washing water may also be replaced totally with fresh washing water 270.

Claims

1. A pressurization apparatus for biogas, **characterized** in that said pressurization apparatus (201) for pressurizing biogas (210) comprises:

- a biogas inlet pipe (211) having at least a biogas feeding means (213),
- a biogas outlet pipe (221) having at least a biogas cut-off means (222, 223),
- a washing water inlet pipe (231) having at least a washing water pressurization device (232),
- a washing water outlet pipe (241) having at least a cut-off valve (242),

and is operated according to the following cycle:

- pressurized washing water (230) is fed to the pressurization apparatus (201) containing biogas (210) using said washing water pressurization device (232) of said washing water inlet pipe (231),
- purified biogas (220) is passed through said cut-off means (222, 223) of said biogas outlet pipe (221),
- the water level (VP) in the pressurization apparatus (201) having reached the upper limit (VP_{YR}), the cut-off valve (242) of said washing water outlet pipe (241) is opened,
- pressurized biogas (210) is passed to said pressurization apparatus (201) through said biogas inlet pipe (211),
- the water level (VP) in the pressurization apparatus (201) having reached the lower limit (VP_{AR}), the cut-off valve (242) of said washing water outlet pipe (241) is closed.

2. Pressurization apparatus according to claim 1, **characterized** in that said biogas inlet pipe (221) comprises a one-way valve (212) to control the flow of said biogas (210).

3. Pressurization apparatus according to claim 1 or 2, **characterized** in that biogas (210) is fed with said biogas feeding means (213) at a pressure of 1 to 100 at (gauge).

4. Pressurization apparatus according to any of the preceding claims, **characterized** in that washing water (230) is fed with said washing water pressurization device (232) at a pressure of 10 to 600 at (gauge).

5. Pressurization apparatus according to any of the preceding claims, **characterized** in that a carbon dioxide removal unit (243) is connected to said pressurization apparatus (201).

6. Pressurization apparatus according to any of the preceding claims, **characterized** in that said pressurization apparatus (201) comprises one or more nebulizers (202) for washing water.

7. Pressurization apparatus according to any of the preceding claims, **characterized** in that said pressurization apparatus (201) comprises two or more washing water pressurization devices (232).

8. Pressurization apparatus according to any of the preceding claims, **characterized** in that one or more dryers (301) for pressurized biogas (220) is (are) connected to said pressurization apparatus (201).

9. Pressurization apparatus according to any of the preceding claims, **characterized** in that the biogas inlet pipe (211) comprises a one-way valve (212).

10. Pressurization apparatus according to any of the preceding claims, **characterized** in that one or more pressure tanks (401) for storage of said pressurized biogas (220) is (are) connected to said pressurization apparatus (201).

11. A method for pressurizing biogas, **characterized** in that biogas (210) is pressurized by means of a pressurization apparatus (201) comprising:

- a biogas inlet pipe (211) having at least a biogas feeding means (213),
- a biogas outlet pipe (221) having at least a cut-off means (222, 223),
- a washing water inlet pipe (231) having at least a washing water pressurization device (232),
- a washing water outlet pipe (241) having at least a cut-off valve (242),

said apparatus being operated according to the following cycle:

- pressurized washing water (230) is fed to the pressurization apparatus (201) containing biogas (210) using said washing water pressurization device (232),

- at least as the water level (VP) is lowered, purified biogas (220) is passed through said cut-off means (222, 223) of said biogas outlet pipe (221),
- the water level (VP) in the pressurization apparatus (201) having reached the upper limit (VP_{YR}), the cut-off valve (242) of said washing water outlet pipe (241) is opened,
- pressurized biogas (210) is passed to said pressurization apparatus (201) through said biogas inlet pipe (211),
- the water level (VP) in the pressurization apparatus (201) having reached the lower limit (VP_{AR}), the cut-off valve (242) of said washing water outlet pipe (241) is closed.

12. Method according to claim 11, **characterized** in that the feed of washing water is stopped as the water level (VP) has reached the upper limit (VP_{YR}),

13. Method according to claims 11–12, **characterized** in that washing water (230) is fed with said washing water pressurization device (232) at a pressure of 10 to 600 at (gauge).

14. Method for constructing a pressurization apparatus for biogas, **characterized** in that a pressurization apparatus (201) is provided with:

- a biogas inlet pipe (211) having at least a biogas feeding means (213),
- a biogas outlet pipe (221) having at least a biogas cut-off means (222, 223),
- a washing water inlet pipe (231) having at least a washing water pressurization device (232),
- a washing water outlet pipe (241) having at least a cut-off valve (242),
- manually operated and/or automatic control device to control said pressurization apparatus according to the methods of claims 11–13.

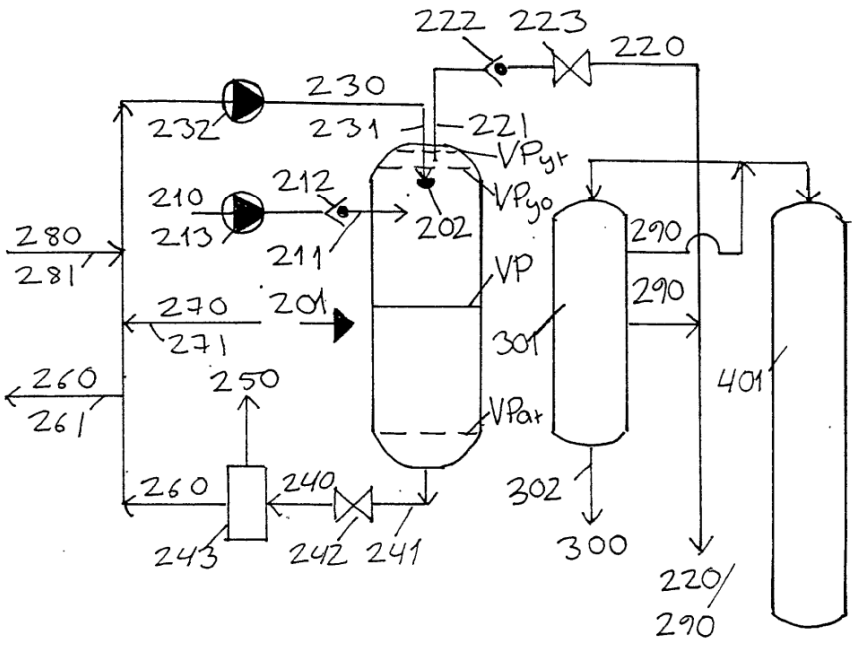
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FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/00701

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B01D 53/18, B01D 53/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0180670 A1 (CRYOTEC ENERGY SYSTEMS CO., LTD.), 14 May 1986 (14.05.86) --	1-14
A	GB 2207872 A (GREEN LAND RECLAMATION LIMITED), 15 February 1989 (15.02.89) --	1-14
A	US 4409102 A (MILTON R. TANNER), 11 October 1983 (11.10.83) --	1-14
A	FR 2534248 A1 (L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PROCEDES GEORGES CLAUDE), 13 April 1984 (13.04.84) --	1-14

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 March 2003	31-03-2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bertil Dahl/EÖ Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/00701

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 3109120 A1 (STEFFEN, HEINZ), 23 Sept 1982 (23.09.82) -- --------	1-14

INTERNATIONAL SEARCH REPORT
Information on patent family members

30/12/02

International application No.
PCT/FI 02/00701

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0180670 A1	14/05/86	NONE	
GB 2207872 A	15/02/89	GB 8719128 D	00/00/00
US 4409102 A	11/10/83	NONE	
FR 2534248 A1	13/04/84	BE 897917 A	05/04/84
DE 3109120 A1	23/09/82	NONE	

Appendix 2 Metener Oy Marketing Material

Novel small scale upgrading system for turning biogas into transport fuel

Metener Ltd is a SME based in Central Finland. The company has a vast experience in agricultural anaerobic digesters and small and medium sized units for upgrading biogas to vehicle fuel standards. The company's main activities are designing and providing turnkey anaerobic digestion plants and upgrading units. Important activities include also carrying out feasibility studies on biogas schemes and running biogas potential and process optimisation studies with two instrumented pilot scale anaerobic digesters with support of on-site analytical laboratory facility.

The company has strong emphasis in R&D, continuously improving biogas production and upgrading processes to find more cost-effective and reliable solutions. We have close co-operation with national universities and research bodies, and Metener has partnered several international universities and SMEs in EU funded research projects.

The patented Metener biogas upgrading technology is application of water scrubbing technology. The key difference to traditional scrubbers is the utilisation of high pressure water in batch absorbtion columns.

Raw biogas is compressed to buffer storage where it flows to fill upgrading column completely, and then the gas flow is cut out. Then column is filled with water by high pressure water pump and the carbon dioxide and sulfurous compounds are absorbed to water and simultaneous gas is pressurised to ~ 150 bar. After scrubbing cycle the water is recycled to process after regeneration in flash and water regeneration tanks, and column is filled again with raw biogas and cycle begins again. There are two paraller columns operating in different phases, one filling and other emptying.

Product gas is collected in pressure vessel and dehumified by absorbent, and is ready to be stored in intermediate pressure bottle banks or boostered by hydraulic compressor to high pressure bottle banks of refuelling station.

The advantages of technology is simplicity gained by combining the scrubbing and pressurisation phases and compact size of the plant. The technology is most suitable in range of 30 – 100 m^3 raw biogas per hour. Units are easily fitted and delivered in a container.

Recent delivery of biogas upgrading system is to rural China, where unit is installed on a pig farm and upgraded gas is, in addition to vehicle fuel, delivered in bottles to consumers and utilised as a cooking fuel. The installation will allow 1100 families to switch to renewable, clean burning and locally produced cooking fuel.

BKP Biogas Upgrading Unit

Metener Ltd
Biogas Technology

For biogas scrubbing.

BKP –Biogas Upgrading Unit is used to produce vehicle-grade fuel from biogas. BKP is designed to be built in a container. Therefore it is easy and fast to install, start production and if necessary, relocate.

Biogas is high quality form of energy. It is a clean burning renewable fuel and it can be generated from almost any organic material. Raw biogas is suitable for electricity and heat production, but best use for such a hi-octane fuel is vehicle use. Before utilisation in a vehicle biogas must be cleaned and compressed.

BKP uses water pistons for cleaning impurity from biogas. Process enriches methane content, removes trace compounds and compresses biogas simultaneously. Capacity is tailored to customer needs in the range of 30 – 100 m^3 raw biogas per hour.

Equipment

- heat insulated container
- compression of gas
- water treatment
- control unit
- electrification
- gas storage as an option
- measurement of methane percentage
- measurement of dew point as an option

Connection

Required in connections in the mounting site:

- foundation for container
- gas line
- water and drain connections
- electricity connection 32 -63 A depending on capacity

BIOGAS UPGRADING UNIT

BKP

Metener Ltd
Biogas Technology

TECHNICAL SPECIFICATIONS

Working Principle
Water piston cleaning

Capacity
Inflow 30-100 Nm^3/h *)

Power consumption
0,20 kWh / Nm^3 *)

Water consumption
6…30 l / Nm^3 *)

Cleaned gas

Volume	Depends of quality of raw biogas
Quality	95% CH_4 ±2%, (raw gas >60 % of methane)
Dew point	Ambient temperature reduced by 5°C
Pressure	150 or 250 bar

Mounting

Mounting to the customer's foundation. Ready for use when connected to gas, water, drain and electricity connections.

Dimensions

6100 mm (length) x 2500 mm (width) x 2400 mm (height)
Weight about 8400 kg

Delivery time

Delivery time for BKP -Biogas Upgrading Unit is about 6 months from the order.

*) Nm^3 = normal cubic meter inflow biogas

Material and energy flows in agricultural biogas system

Metener Oy
Ympäristö- ja energiateknologiaa

Raw materials
-Animal manure
-Energy crops
-Biological waste

Sales to natural gas grid

Digestate used as fertiliser
in agriculture

Biogas production facility

Biogas upgrading

Appendix 3 Commercial Organization Italy – Finland

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