Project: BiG>East
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Biogas Show Cases in the target region of Greece

Deliverable 6.4

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Table of Contents

Executive summary

The basic characteristics and a brief description of the two selected Show cases are given below. More details can be found in the next chapters.

Show case 1: «Schimatari»

Based on the mapping of the two Prefectures (Evia and Viotia) a promising site for biogas exploitation based mainly on pig manure can be located in the greater area between Evia island and the mainland. The planned biogas plant shall be operated with the input material of liquid manure from pigs, cows and chicken manure, fat, blood from slaughterhouse, dairy waste (Whey), katsigaros (waste of olive oil production) and food waste (total feadstock of about 200,000t/year). The input materials come from agricultural and industrial companies in the nearby area of the plant. The plant can be located to the mainland in the greater area of Schimatari - Inofyta.

The plant is based on co-digestion of different types of feedstock in a two step process – first step thermophilic digester made at silo digesters at approx. 50-52^{o}C, and secondary digesters made at storage tanks operated on lower temperature (in practice 40-45^{o}C). The total amount of CH_4 production is approx. 3.7 Mm^3 (approx. installed capacity 1.7 MWe). In this case it is assumed that the biogas is utilised in a gas engine for the production of electricity for sale to the grid (14 GWh/year) and for heat production (16 GWh/year). The heat is mainly used for the process (approximately 60%) and no external heat sale is assumed (an alternative is the excess heat to be used in the nearby area, e.g. for space heating or other uses of the military campus). The plant as proposed will require a site of approx. 2.6 ha.

The table below summarises the basic data and financial assumptions applied for the needs of the assessment and calculation of the economic forecast and the main results. The BIG>EAST calculation model was used, allowing the preliminary estimations (it is important to note that the results generated by the model should be only used as indicative and subject of change).

Technical data		
Scenarios	1: electricity revenues	2: electricity &compost revenue*
Feedstock	206,310t/year	206,310t/year
CH_4 production	3,742,897m_3/year	3,742,897m_3/year
Electricity for Sale	13.205.000kWh/year	13.205.000kWh/year
Heat for Sale	6,499,000kWh/year	6,499,000kWh/year
Liquid fertilizer/local use	188,801 t/year	188,801 t/year
Fibre	10,910 t/year	10,910 t/year
Financial structure		
Investment Costs	7,750,000€	7,750,000€
Electricity Price	0,08014€/kWh	0,08014€/kWh
Nominal Heat Price	0€/kWh	0€/kWh
Nominal Gate fee	0€/t	0€/t
Nominal Fibre Price	0€/t	20€/t
Nominal Waste Treatment Price	0€/t	0€/t
Results		
Earning before Interest	729,050€	960,988€
Internal Return Rate (IRR)	6.15%	11.26%
Capital Cost	697,044€/year	697,044€/year
Total Earnings	32,006€/year	263,945€/year

* In order to improve the revenue a scenario with nominal fertilizer price of 20€/t gives better results

Show case 2: «Agrinio»

Based on the mapping of the Prefecture of Aitoloakarnania a significant biogas potential in the region comes mainly from manure in the area of Agrinio and dairy waste (whey) with co-digestion of maize silage, thus a biogas plants can be located in the greater area of Agrinio city. The planned biogas plant shall be operated with the input material of liquid manure from pigs, dairy waste (whey), maize silage, katsigaros (waste of olive oil production) and fat, blood from slaughterhouses. The input materials come from agricultural and industrial companies in the vicinity of the plant. The farmers' harvest is directly brought to the place of the plant and discharged into the reception bunker (total feadstock of about 320,000t/year). The plant can be located in the nearby area of Agrinio city (eg. Spolaita or Stratos community at a distance of 10km approx. NW of Agrinio city).

The plant is based on co-digestion of different types of feedstock in a two step process – first step thermophilic digester made at silo digesters at approx. 50-52^{o}C, and secondary digesters made at storage tanks operated on lower temperature (in practice 40-45^{o}C). The total amount of CH_4 production is approx. 9.7 Mm^3 (approx. installed capacity 4.4 MWe). In this case it is assumed that the biogas is utilised in a gas engine for the production of electricity for sale to the grid (36.7 GWh/year) and for heat production (41.8 GWh/year heat production). The heat is mainly used for the process (approx. 36%) and no external heat sale is assumed (an alternative is the excess heat to be used in the greenhouses in the nearby area). The plant as proposed will require a site of approx. 3 ha.

The table below summarises the basic data and financial assumptions applied for the needs of the assessment and calculation of the economic forecast and the main results. The BIG>EAST calculation model was used, allowing the preliminary estimations (it is important to note that the results generated by the model should be only used as indicative and subject of change).

Technical data		
Semarios	1: electricity revenues	2: Electricity & compost revenue*
Feedstock	206,310t/year	206,310t/year
CH_4 production	3,742,897m_3/year	3,742,897m_3/year
Electricity for Sale	35,309,000kWh/year	35,309,000kWh/year
Heat for Sale	27,037,000kWh/year	27,037,000kWh/year
Liquid fertilizer/local use	281,892t/year	281,892t/year
Fibre	19,941t/year	19,941t/year
Financial structure		
Investment Costs	11,450,000€	11,450,000€
Electricity Price	0,08014€/kWh	0,08014€/kWh
Nominal Heat Price	0€/kWh	0€/kWh
Nominal Gate fee	0€/t	0€/t
Nominal Fibre Price	0€/t	20€/t
Nominal Waste Treatment Price	0€/t	0€/t
Results		
Earning before Interest	1,118,197€	1,578,634€
Internal Return Rate (IRR)	7.44%	13.54%
Capital Cost	1,133,436€/year	1,133,436€/year
Total Earnings	54,761€/year	445,198€/year

* In order to improve the revenue a scenario with nominal fertilizer price of 20€/t gives better results

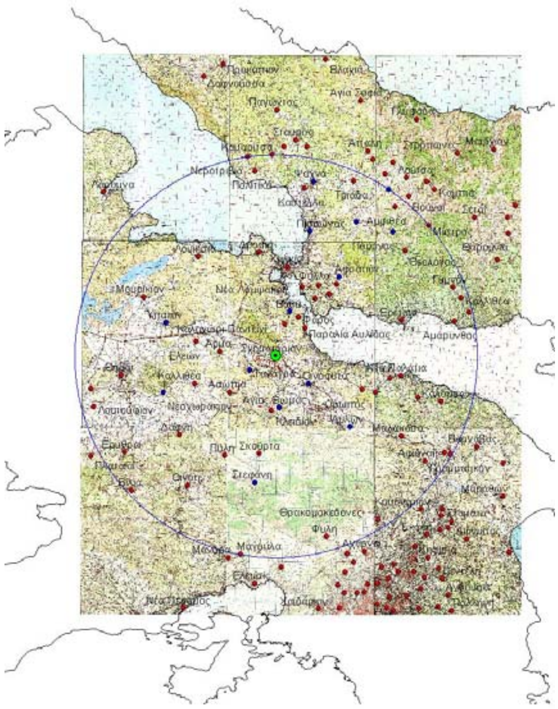
In all the case studies the solid fertiliser (the fibre fraction) will sold as solid fertilizer and the liquid fertiliser will be supplied to farms where it can be utilised. Furthermore, the owner of the plant can be a private investor, a consortium or even a Public Private Partnership (PPPs).

1. Biogas Show Case: «Schimatari»

The livestock-farming plays an important role in the economical activity of the Sterea Ellada Region but not the primary one. The main form of farming represents the extensive sheep breeding in the mountainous regions and mainly in Evia and Fthiotida Prefectures. The intensive livestock-farming is concentrated near the Metropolitan area of Athens namely the South East of Viotia and central Evia (near Chalkida) and it consists mainly by poultry and pig farms and secondary by cattle breading. The last years the intensive animal breading is rather stable. Viotia but mostly Evia is an interesting Prefecture concerning the number of pig farms, the maximum farm capacity (number of sow places), manure production and future biogas exploitation. Among the leader Prefectures in that prospective is Evia, Trikala and Preveza.

Based on the mapping of the two Prefectures (Evia and Viotia) a promising site for biogas exploitation based mainly on pig manure can be located in the greater area between Evia island and the mainland. Evia is the largest island of Greece too close to the mainland, separated by the Euboic sea. The electrical system of the island is connected to the mainland national grid. Viotia has a well established electrical system as it belongs to the mainland and is served by the mainland national grid.

The planned biogas plant shall be operated with the input material of liquid manure from pigs, cows and chicken manure, fat, blood from slaughterhouse, dairy waste (Whey), katsigaros (waste of olive oil production) and food waste. The input materials come from agricultural and industrial companies in the nearby area of the plant. The plant can be located to the mainland in the greater area of Schimatari – Inofyta (**see map**).



Map Source: Hellenic Military Geographical Service

1.1. Basic plant design

Biomass and biogas potential

It is assumed that more than 85% of the manure available in the area is transported to the biogas plant for digestion and separation. The plant is a co-digestion plant utilising besides the manure wastes residuals from nearby industries and nearby military campus (waste from larger kitchens). The amount of these biomasses used in the calculation is based on mapping made in the area.

The gas potential is calculated form Danish standard figures of potential gas yield from different biomasses as achieved in lab tests and on commercial operating plants. Based on the above estimations and other feedstock availability in the area the following biomasses and potential biogas production is calculated below.

Schimatari site	**Biogas production**					
Input	t input/y	% TS	VS/TS	t VS	GVS	m^3 CH_4/y
Pig manure Sows	65,000	5.6	80	2.912	290	844,480
Pig manure Fatteners	125,000	6.2	80	6.200	290	1,798,000
Cow manure	8,000	10	80	640	210	134,400
Chicken manure	2,400	50	80	960	290	278,400
Stomach content	512	22	85	96	460	44,042
Fat	323	12	95	37	650	23,934
Blood	845	8	95	64	350	22,477
Whey	2,100	5	95	100	330	32,917
Oil mill waste	1,400	25.4	58	205	700	143,500
Food waste	730	35	90	230	350	80,482
Total	206,310	7		11,443		3,402,633
Added storage	10%					340,263
Total production of methane						**3,742,896**

Other feedstock like fat, blood from slaughterhouse, dairy waste (Whey), katsigaros (waste of olive oil production) and food waste were added in small proportion in order to increase the biogas yield. The biogas generated by fermentation shall be utilised in a combined heat and power station and the generated power shall be supplied into the public network.

Utilisation of the biogas

The total amount of CH_4 production is approx. 3.7 Mm^3 (approx. installed capacity 1.7 MWe). In this case it is assumed that the biogas is utilised in a gas engine for the production of electricity for sale to the grid and for production of heat. The heat is mainly used for the process and no external heat sales are assumed (there is a possibility the excess heat to be used in the nearby area, eg for space heating or other uses of the military campus). The following energy production can be expected:

Energy production					
Gas produktion used on site	37.204.395	kWh/y	at	9,94	kWh/m3 CH4
equal to	4.247	kW			
Minmum engine capacity	1.695	kW electric	at		
Utilisation					
Electricity production engine	14.102.326	kWh/y	at	39,9%	efficiency
			and	5%	of the time out
Total electricity production	14.102.326	kWh/y			
Heat production	16.072.299	kWh/y	at	43,2%	efficiency
Used in the process	9.573.547	kWh/y	at	38	Deg C heated
For other use	6.498.751	kWh/y	equal to	742	kW
Utilised	-	kWh/y	equal to	0%	of heat

As it can be seen an electricity production of approx. 14.1 GWh per year can be expected. The plant uses some electricity for operation (separation equipment, pumps, mixers, blowers etc.). This is estimated to approx. 0.9 GWh (equal to approx. 6% of the total electricity production). This leaves approx. 13.2 GWh for sale to the grid.

It is expected that the engine is out for service in approx. 5% of the time of the year (equal to approx. 18 days). During service the gas is burned in a boiler for producing heat for the plant and possible surplus gas is flared off.

As it can be seen the process heat demand is relatively large (approx. 60% of the heat production from the engines). The reason is that the biomass has relative low energy content/high water content.

Biogas Digestate Utilisation

The raw manure supplied into the plant requires approx. 7,900 ha in relation to the nitrate directive. Even if the plant is supplied with nutrients in the organic waste the requirement after digestion and separation will be lower because nitrogen is removed in the fibre fraction. The requirement for land for using the liquid fertilizer after the process will be approx. 6,300 ha meaning a saving of approx. 1,600 ha spreading area. This will reduce pressure on land in the area and reduce costs for transport and spreading. The solid fertiliser (the fibre fraction) will be sold as solid fertiliser.

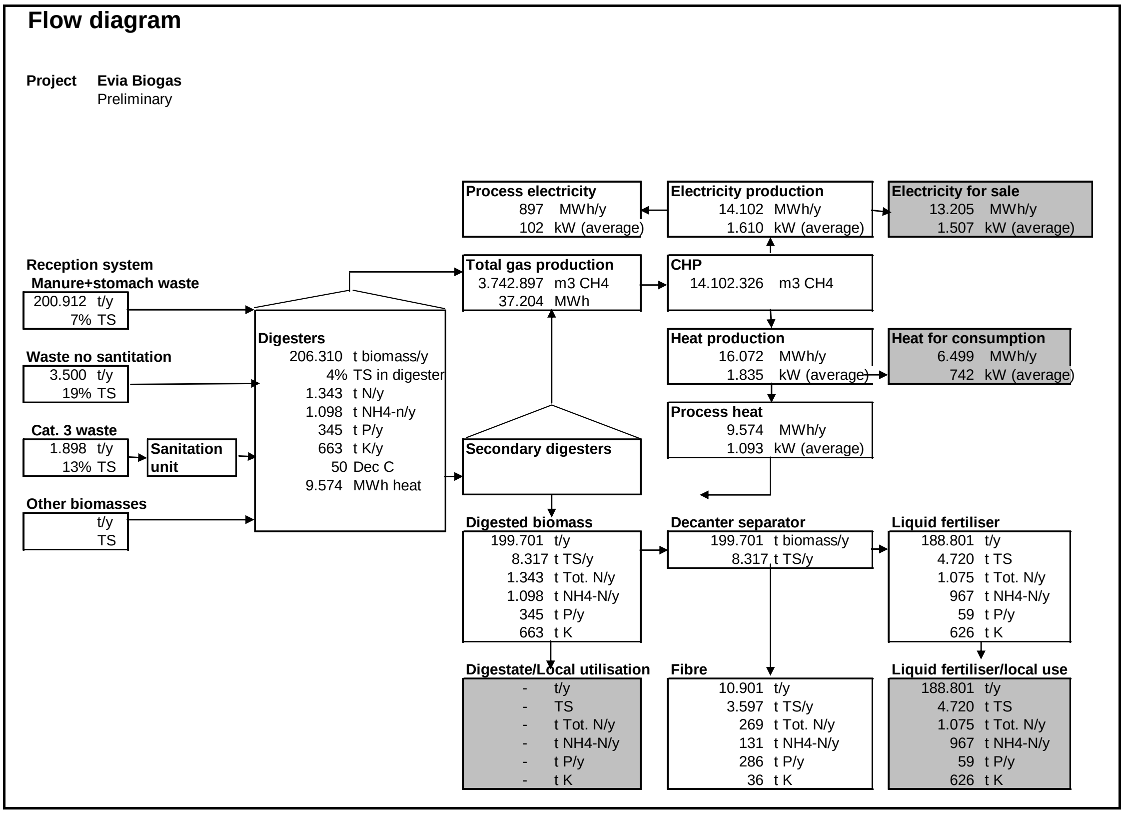
Flow chart

The mass balance of the biogas plant «Schimatari» has been calculated including the biomass, the energy and the nutrients in the biomass. It is assumed that the digestate is separated in a liquid fraction and a solid fraction to achieve a higher utilisation of the nutrients.

The input biomasses are divided in three types each supplied to an individual reception tank.

- Manure and stomach content
- Waste with no demand for sanitation (Whey and oil mill waste)
- Cat. 3 waste in relation to EU Regulation 1774/2002 (fat, blood and food waste).

The feedstock division is based on the demand for sanitation in relation to EU Regulation 1774/2002 and on the demand for optimising feed of biomasses in relation to how they digest. In relation to EU Regulation all Cat. 3 waste have to be sanitised at 70°C for on hour before treatment in the biogas plant. The manure and stomach content is in relation to EU Regulation 1774/2002 Cat. 2 waste with no demand for sanitation and the other waste types are not regulated in relation to this EU Regulation. By dividing the biomasses in different tanks it is possible to optimise the feeding of the digesters as well as it takes away dependency of regularity in the supply.



Because of the relative high content of water in the input biomass the amount of output biomass will not be much lower than the input (approx. 97% of the input – approx. 3% is taken out as biogas).

The fibre fraction can be composted and will then be reduced in volume because of evaporation of part of the water. This fraction is a perfect fertiliser for wine growing and for fruit plantations.

The liquid is a relative nitrogen rich fertiliser and has the right composition of the nutrients for normal agricultural crops as serials, maize and grass.

1.2. Technology Specifications

The biomass is mainly manure and based on the composition and the nitrogen content of the biomass (estimated to approx. 6.5 kg total nitrogen per t of biomass) the biomass is regarded as suitable for thermophilic digestion at 50-52°C and a retention time in the primary digester of approx. 16 days.

Overall plant set up

The manure is picked up from the farms and transported to the biogas plant. It is assumed that the industries supplied the waste products to the plant themselves or by contractors.

The plant is provided with the following reception tanks:

Reception tank for manure:	Approx. 2,000 m^3 covered concrete tank provided with mixers
Reception tank for Cat. 3 waste:	Approx. 100 m^3 covered concrete tank provided with mixers
Reception tank for waste where sanitation is not required (whey, vegetable waste etc.):	Approx 200 m^3 covered concrete tank provided with mixers.

By an estimated retention time of approx. 16 days in the primary digesters the volume of the primary digesters will be approx. 9,000 m^3. It is assumed that this is made in two times 4,500 m^3. Alternatively it can be made as three times 3,000 m^3. It is recommended to make the tanks as high silo tanks (a little higher than the diameter) to easy mixing and to save space and that they are provided with top mounted mixers.

The secondary digesters can be made as non insulated concrete manure tanks provided with a double membrane. It is recommended that the retention time is a little longer than in the primary digesters. Besides serving as a secondary digester the volume under the membrane serves as gas storage (approx. 1,000 m^3 gas storage capacities in each tank). It is assumed that all gas passes these three tanks and that a biological gas purification (removal of H_2S) is made under the membrane.

Furthermore, it is assumed that the digested liquid fertiliser is supplied to farms where it can be utilised. An approx. 3,500 m^3 buffer tank for this is included on the site.

The plant as proposed will require a site of approx. 150*175 m (approx. 2.6 ha). The size enables possible later expansion with one more digester and secondary digester.

1.3. Economical specifications

Investment

This section will focus on the development of a financial structure for a co-digestion plant using the input data as specified in the previous chapters and based on the plant design (inputs and outputs) and technological solution which are described above. It is well known that a biogas project demands high investment. Project financing is therefore a key element for the success implementation of a biogas plant. Based on the above mentioned facilities and plant design the investments costs for such a plant are as follows:

Investment Cost: Project No 1 «Schimatari»	**Euro**
Logistic (trucks, tanks)	940,000
Engineering, commissioning etc	500,000
Equipments (eg. pretreatment, digester, post treat-ment and storage)	3,160,000
CHP engine etc.	1,500,000
Buildings	930,000
Electric system/SCADA	150,000
Other coasts, unforeseeable etc.	570,000
Liquid assets	0
Total Financial Demand	**7,750,000**

* Included VAT and delivery

Profit and Loss

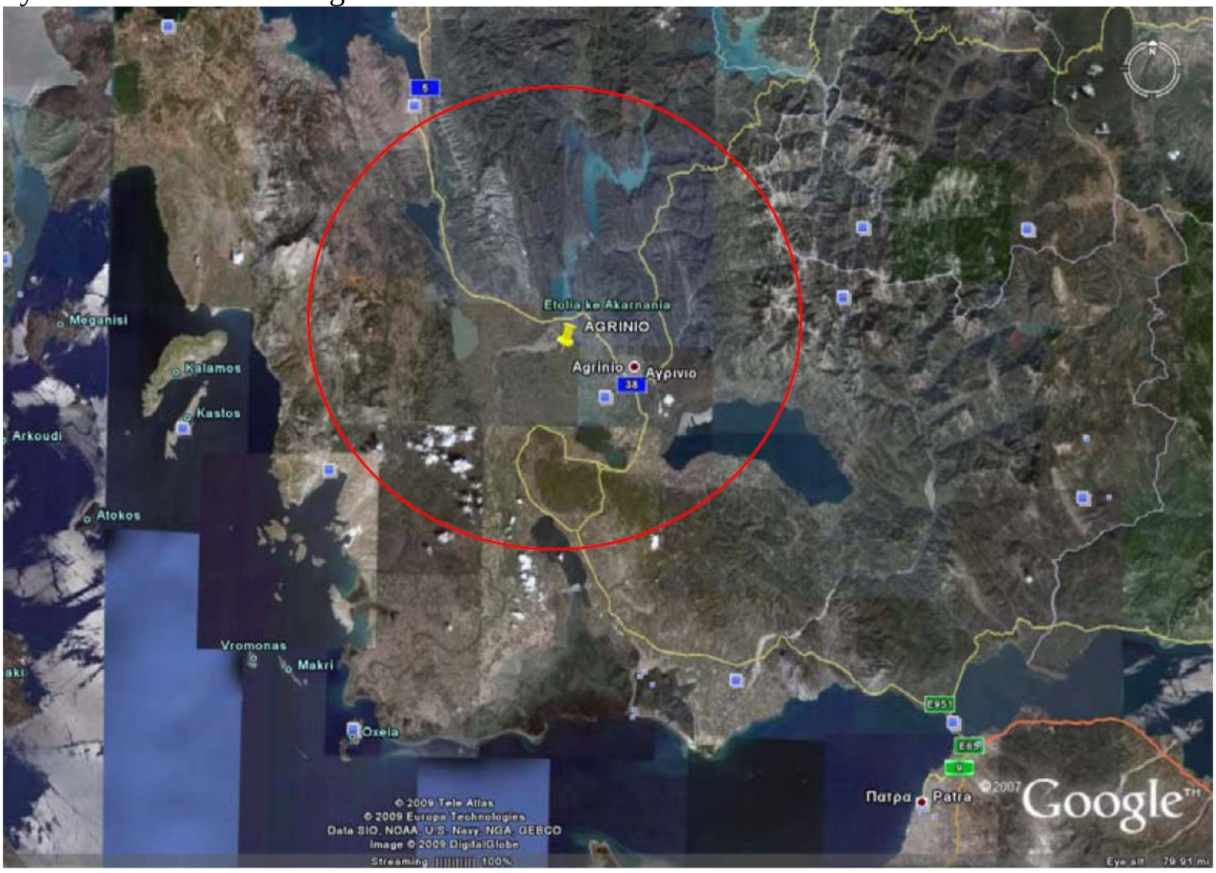
For the needs of the assessment and calculation of the economic forecast, the BIG>EAST calculation model was used, allowing the preliminary estimation of costs, plant size, dimensioning, technical outline etc. The calculation model as well as the guidelines for its utilisation are also available for free download at http://www.big-east.eu). The main results obtained for the specific show case "Schimatari" is summarized in the Table below for two basic scenarios:

Profit and Loss: Show Case No1 «Schimatari» Euro*	**Scenario 1**	**Scenario 2**
Economic Yield from Plant Operation		
Yield from electricity sale	1,082,063	1,082,063
Yield from heat sale	0	0
Yield from Compost sale	0	218,020
Plant working costs		
General Busines Cost	232,102	232,102
Biomass purchase	120,912	120,912
Purchase of electric energy	72,912	72,912
Discharge of sludge	0	0
Earnings before Interest	**729,050**	**960,988**
Internal Return Rate (IRR)	**6.15%**	**11.26%**
Capital Cost	**697,044**	**697,044**
Total Earnings	**32,006**	**263,945**

* Value from Year 1 of operation

2. Biogas Show Case: «Agrinio»

Aitoloakarnania is the largest Prefecture in the country and is a predominantly agricultural area. Agrinio is the biggest city of the Prefecture and is an important tobacco-producing centre. Based on a detailed mapping of the Prefecture a significant biogas potential in the region comes mainly from manure and wastes in the area of Agrinio with co-digestion of maize silage, thus a biogas plants can be located in the greater area of Agrinio city. The area is served by the mainland national grid.



Source: Google Earth

2.1. Basic plant design

Biomass and biogas potential

The planned biogas plant shall be operated with the input material liquid manure from pigs, dairy waste (whey), maize silage, katsigaros (waste of olive oil production) and fat, blood from slaughterhouse. The input materials come from agricultural and industrial companies in the vicinity of the plant. The farmers' harvest is directly brought to the place of the plant and discharged into the reception bunker. The plant can be located in the nearby area of Agrinio city (**see map above**).

It is assumed that approx. 80% of the manure and waste available in the area is transported to the biogas plant for digestion and separation. Besides this the plant is planned to utilise energy crops (mainly maize silage) produced by the local farmers and sold to the plant. The plant is a co-digestion plant utilising besides the manure residuals from nearby industries (dairies and slaughterhouses) and energy crops in a mixture too. The amount of these biomasses used in the calculation is based on mapping made in the area.

The gas potential is calculated form Danish standard figures of potential gas yield from different biomasses as achieved in lab tests and on commercial operating plants. Based on the above estimations and other feedstock availability in the area the following biomasses and potential biogas production is calculated:

Agrinio site	**Biogas production**					
Input	t input/y	% TS	VS/TS	t VS	GVS	m^3 CH4/y
Pig manure	124,000	6,5	80	6,448	290	1,869,920
Dairy waste	134,000	6	90	7,236	330	2,387,880
Energy crops	35,000	31	95	10,307	350	3,607,625
Stomach content cows/lamp/goat	137	20	80	22	400	8,768
Stomach waste pigs	200	22	90	40	460	18,216
Katsigaros	25,000	8.7	72	1,566	600	939,600
Fat	161	12	95	18	650	11,930
Blood	530	8	95	40	350	14,098
Total	319,028	9		25,678		8,858,037
Added storage	10%					885,803
Total production of CH_4						**9,743,841**

Other feedstock like wastes form slaughterhouse and energy crops were added in small proportion in order to increase the biogas yield. The biogas generated by fermentation shall be utilised in a combined heat and power station and the generated power shall be supplied into the public network.

Utilisation of the biogas

The total amount of CH_4 production is approx. 9.7 Mm^3 (approx. installed capacity 4.4 MWe). In this case it is assumed that the biogas is utilised in a gas engine for the production of electricity for sale to the grid and for production of heat. The heat is mainly used for the process and no external heat sales are assumed (an alternative is the excess heat to be used in greenhouses in the nearby area). The following energy production can be expected:

Energy production					
Gas produktion used on site	96.853.778	kWh/y	at	9,94	kWh/m3 CH4
equal to	11.056	kW			
Minmum engine capacity	4.411	kW electric			
Utilisation					
Electricity production engine	36.712.424	kWh/y	at	39,9%	efficiency
			and	5%	of the time out
Total electricity production	36.712.424	kWh/y			
Heat production	41.840.832	kWh/y	at	43,2%	efficiency
Used in the process	14.804.080	kWh/y	at	38	Deg C heated
For other use	27.036.752	kWh/y	equal to	3.086	kW
Utilised	-	kWh/y	equal to	0%	of heat

As it can be seen an electricity production of approx. 36.7 GWh per year can be expected. The plant uses some electricity for operation (separation equipment, pumps, mixers, blowers etc.). This is estimated to approx. 1.4 GWh (equal to approx. 5% of the total electricity production). This leaves approx. 35.0 GWh for sale to the grid.

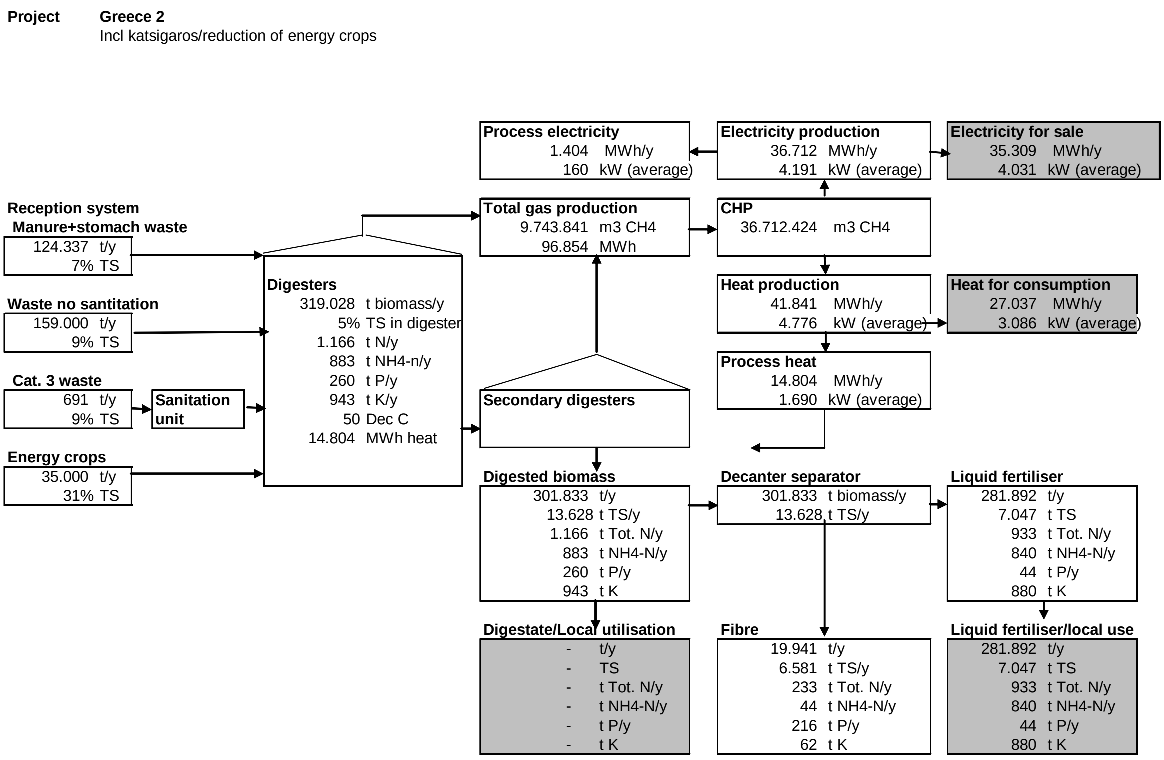
It is expected that the engines are out for service in approx. 5% of the time of the year (equal to approx. 18 days). During service the gas is burned in a boiler for producing heat for the plant and possible surplus gas is flared off. The process heat demands approx. 36% of the heat production from the engines.

Biogas Digestate Utilisation

The raw manure supplied into the plant requires approx. 6,900 ha in relation to the nitrate directive. After digestion the liquid is spread in relation to the nitrate directive now requiring approx the area of 5,500 ha which means a saving of approx. 1,300 ha spreading area. This will reduce pressure on land in the area and reduce costs for transport and spreading. On this area the total nutrient demand can be covered by using the separated digestate. It is obvious to utilise part of the nutrients for fertilising the crops supplied. The solid fertiliser (the fibre fraction) is sold as solid fertiliser.

Flow chart

The mass balance of the biogas plant «Agrinio» has been calculated including the biomass, the energy and the nutrients in the biomass. It is assumed that the digestate is separated in a liquid fraction and a solid fraction to achieve a higher utilisation of the nutrients.



The input biomasses are divided in four types each supplied to an individual reception tank.

- Manure and stomach content
- Waste with no demand for sanitation (Whey and oil mill waste)
- Cat. 3 waste in relation to EU Regulation 1774/2002 (fat, blood)
- Energy crops

The division is based on the demand for sanitation in relation to EU Regulation 1774/2002 and on the demand for optimising feed of biomasses in relation to how they digest. In relation to EU Regulation all Cat. 3 waste have to be sanitised at 70°C for on hour before treatment in the biogas plant. The manure and stomach content is in relation to EU Regulation 1774/2002 Cat. 2 waste with no demand for sanitation and the other waste types are not regulated in relation to this EU Regulation. By dividing the biomasses in different tanks it is possible to optimise the feeding of the digesters as well as it takes away dependency of regularity in the supply.

The fibre fraction can be composted and will then be reduced in volume because of evaporation of part of the water. This fraction is a perfect fertiliser for wine growing and for fruit plantations. The liquid is a relative nitrogen rich fertiliser and has the right composition of the nutrients for normal agricultural crops as serials, maize and grass.

2.2. Technology Specifications

The biomass is mainly manure and based on the composition and the nitrogen content of the biomass (estimated to approx. 3.7 kg total nitrogen per t of biomass) the biomass is regarded as suitable for thermophilic digestion at 50-52^{o}C and a retention time in the primary digester of approx. 14-16 days.

Overall plant set up

The manure is picked up from the farms and transported to the biogas plant. It is assumed that the industries supplied the waste products to the plant themselves or by contractors. Silage is produced on the farms and partly stored on the farms and on the biogas plant. The final set up of silage storage facilities can be made in parallel with the project negotiations' on the conditions for supply of silage (see estimation below). The silage supplied into the plant and stored on a plate. From here it is loaded by a front loader into a feeding device (quick mixer). If all silage must be stored at site this requires a plate of approx. 7-9 ha. If this can not be fitted into the site decentralised storage at the farms are required.

It is assumed that the plant is provided with the following reception tanks:

Reception tank for manure:	Approx. 1,000 m^3 covered concrete tank provided with mixers
Reception tank for Cat. 3 waste:	Approx. 100 m^3 covered concrete tank provided with mixers
Reception tank for waste where sanitation is not required (whey and katsigaros):	Approx 1,000 m^3 covered concrete tank provided with mixers.

By an estimated retention time of approx. 14 days in the primary digesters the volume of the primary digesters will be approx. 12,000 m^3. It is assumed that this is made in three times 4,000 m^3. It is recommended to make the tanks as high silo tanks (a little higher than the diameter) to easy mixing and to save space and that they are provided with top mounted mixers.

The secondary digesters can be made as non insulated concrete manure tanks provided with a double membrane. It is recommended that the retention time is a little longer than in the primary digesters. Besides serving as a secondary digester the volume under the membrane serves as gas storage (approx. 1,000 m^3 gas storage capacities in each tank). It is assumed that all gas passes these tanks and that a biological gas purification (removal of H_2S) is made under the membrane.

It is assumed that the digested liquid fertiliser is supplied to farms where it can be utilised. An approx. 3,500 m^3 buffer tank for this is included on the site.

The plant as proposed will require a site of approx. 150*200 m (approx. 3 ha) plus possible area for the silage storage (depending on the logistic in relation to supply of silage).

2.3. Economical specifications

Investment

This section will focus on the development of a financial structure for a co-digestion plant using the input data as specified in the previous chapters and based on the plant design (inputs and outputs) and technological solution which are described above. It is well known that a biogas project demands high investment. Project financing is therefore a key element for the success implementation of a biogas plant. Based on the above mentioned facilities and plant design the investments costs for such a plant are as follows:

Investment Cost: Project No 2 "Agrinio"	**Euro**
Logistic (trucks, tanks)	1,000,000
Engineering, commissioning etc	500,000
Equipments (eg. pretreatment, digester, post treat-ment and storage)	4,890,000
CHP engine etc.	2,770,000
Buildings	1,260,000
Electric system/SCADA	180,000
Other coasts, unforeseeable etc.	850,000
Liquid assets	0
Total Financial Demand	**11,450,000**

Profit and Loss

For the needs of the assessment and calculation of the economic forecast, the BIG>EAST calculation model was used, allowing the preliminary estimation of costs, plant size, dimensioning, technical outline etc. The calculation model as well as the guidelines for its utilisation are also available for free download at http://www.big-east.eu). The main results obtained for the specific show case "Schimatari" is summarized in the Table below for two basic scenarios:

Profit and Loss: Show Case No2 «Agrinio» Euro*	**Scenario 1**	**Scenario 2**
Economic Yield from Plant Operation		
Yield from electricity sale	2,831,248	2,831,248
Yield from heat sale	0	0
Yield from Compost sale	0	398,820
Plant working costs		
General Busines Cost	530,472	530,472
Biomass purchase	953,600	953,600
Purchase of electric energy	159,000	159,000
Discharge of sludge	0	0
Earnings before Interest	**1,188,197**	**1,578,634**
Internal Return Rate (IRR)	**7.44**	**13.54**
Capital Cost	**1,133,436**	**1,133,436**
Total Earnings	**54,761**	**445,198**

3. Organizational structure and Risk Management

The basic organizational structure and risk management are common for both the Shoe cases.

The owner of the plant can be either a private investor or consortium or even a Public Private Partnership (PPPs). Till now in Greece it seems that private investment with funds is a more flexible solution. The ownership has to be clarified and the structure of agreements between the plant owner and the ones dealing with the plant has to be structured. The important issue in setting up the organisation is that the ones that have an influence on normal operation also take the risk and gain the advantages.

3.1. Construction

It is assumed that the plant is constructed by local contractors in relation to an engineering project/specification and a split tender in more packages. The engineering can be based on commercial plants in Europe. The advantages of taking in local contractors are possible low prices, advantages for local economy and easier later service and possible rebuilding. To control construction a local site manager is recommended as well as to engage the future operation manager at least 3 month before technical completion of the plant.

3.2. Feedstock providers

As it is already noticed above:

- The manure is picked up from the farms and transported to the biogas plant in a tanker. It is important that the farms have best possible pick up facilities so that the connection and pumping time is minimised. In this study it is anticipated that each farm is equipped with a pre-tank containing approx. 60-80 m^3.
- The transport can be made in own tankers or the service can be purchased from an external contractor.
- It is assumed that the industries supplied the waste products to the plant themselves or by contractors.
- The logistics of silage (in Show Case No2) depends on the agreement between the plants owner and the farmers (eg. storage facilities in the biogas plant or partially storage to the farms).

3.3. Risk Management

The project will be positive for the local agriculture and the local environment as well as the overall environment. The project can also be a positive as a show case for development of commercial biogas plants in Greece.

To enable implementation of the plant it has to be made bankable. This requires that assumptions used in this show case have to be confirmed by contracts or Letters of Intent (LoI). Based on these confirmations the project economy can be reviewed. At least the following assumptions have to be “changed” into agreements/LoI or possible standard conditions:

Biomass:

- Supply of manure (including possible treatment fees and on amount to be returned and to be disposed to other farmers)
- Cost, supply and storage of the silage in Show Case No2 (including possible use of residues instead of energy crops).
- Supply of industrial residuals, food waste etc. including possible gate fees

- Area for spreading of the nutrients and liquid fertilizer storage facilities.
- Possible sales of fertilizer (fibre).

Energy:
- Sales of electricity
- Connection charges
- Possible sales/utilisation of heat (industrial purpose, fibre drying, cooling etc.)

Economy
- Finance – in particular possible grants

Location
- Possible site – planning issues and price
- Demand for planning approvals

Organisation
- Agreements from participant partners
- Possible organisation/ownership of the project
- Complex of agreements (principles) for operation the plant

Beside these the investor or the consortium has to agree on form of organisation, possible own finance and guarantees etc. In general all agreements and Letters of Intent will be made as depended agreements/LoI where they will be in operation when (if) the project is implemented.

As it can be seen the project can be feasible under the right conditions in relation to biomass input and finance (mostly if can be combined with compost sale and treatment fees). It is recommended that the principle agreement of finance and the overall organisation is made as the first step because it will give the best possible situation for the biogas company negotiating agreements on in particular supplies of waste.

When the finance and the overall organisation is agreed the overall clarifications can be made stepwise as well as a stepwise detailing of the project so that the biogas organisation can assess impacts of the agreements made and decision taken during the detailing and clarification in a detailed feasibility study/action plan.