



## General data

Company

Universidad Politecnica de Cartagena

Date

20/12/2024

The aim of BIOGAS3 project is to promote the sustainable production of renewable energy from the biogas obtained of agricultural residues and food and beverage industry waste in small-scale concept for energy self-sufficiency. This project is co-funded by the Intelligent Energy Europe Programme of the European Union, Contract N°:IEE/13/SI2.675801.

smallBIOGAS is a software tool to develop economic and sustainability analysis in order to evaluate the viability of small-scale anaerobic digestion installations (ca. or less than 100 kWel; 372308 m<sup>3</sup>biogas/year, 65% CH<sub>4</sub>). The tool is adapted to the conditions of all participating countries of the project (France, Germany, Ireland, Italy, Poland, Spain and Sweden).

The results obtained from the use of this calculation tool are intended to provide the user with a guide about the viability of a small-scale biogas plant. The authors recommend further consultation with expert centres before investing in any biogas facility. The authors and promoters of this software tool accept no responsibility for any damages resulting from the use made of the tool smallBIOGAS.

Input from user

Output from smallBIOGAS tool

## Location data

Country	Spain	
Administrative division	Región de Murcia   Murcia	
Annual average temperature	17,1	°C
Percentage of wastes located at a distance equal or less than 10 km from the agro-food company	0	%
Percentage of wastes located at a distance higher than 10 km from the agro-food company	100	%

## Biogas production process data

Anaerobic digestion process	Wet	
Annual amount of waste introduced in the digester (fresh matter)	40.000,00	t/year
Annual amount of waste introduced in the digester (dry matter)	2.080,00	t/year
Annual amount of waste introduced in the digester (dry organic matter)	1.382,56	t/year
Annual amount of organic matter degraded	1.039,86	t/year
Needs of dilution water (only for wet digestion processes)	0	m3/year
Digestate recirculation rate	0	%
Needs of waste in terms of dry matter to concentrate (only for dry digestion)	0	t/year
Total amount of digestate produced (fresh matter)	38.987,70	t/year
Volume of anaerobic digester	2.391,03	m³
Hydraulic retention time	20,00	days
Thermal energy required for the heating of the anaerobic digester	1.216,77	MWh/year
Gross methane production (annual)	391.943,84	Nm3/year
Gross biogas production (annual)	645.318,99	Nm3/year
Gross biogas production (average per hour)	73,67	Nm3/h
Excessive digestate recirculation (if recirculation rate is >30%)	No	
Ammonia inhibition risk	Yes	
C/N ratio out of range	C/N too low (4)	

## Use of the biogas 1 (Boiler)

### Data of the biogas valorisation system

Use of biogas in	Boiler	
Use of produced electric energy	No	
Use of produced thermal energy	Self-consumption	
Use of produced biomethane	No	
Needs of thermal energy near to the biogas plant	3.750,00	MWh/year
Needs of electric energy near to the biogas plant	775,00	MWh/year
Recoverable thermal energy in boiler	3.314,87	MWh/year
Thermal power installed in boiler	435,08	kW
Unrecovered thermal energy in boiler	0,00	MWh/year
Investment in boiler system	24.076,09	€
Income or savings (sale or use of the thermal energy)	81.825,81	€/year

### Energy storage

Volume of the gasometer	--	m <sup>3</sup>
Self-consumed energy	Ne>Pe   Nt>Pt	%
Comments	--	

## Economic viability analysis. Investment project

<b>Investment</b>	939.148,64	€
Biogas plant	915.072,54	€
Biogas valorisation system	24.076,09	€
Other	0,00	€
<b>Income</b>	121.593,26	€/year
Sale of Thermal energy	0,00	€/year
Energy savings	81.825,81	€/year
Waste management	0,00	€/year
Other incomes	0,00	€/year
Sale or saving (sale or use) of digestate	39.767,45	€/year
Selling price of electric energy	0,00	c€/kWh
Selling price of thermal energy	0,00	c€/kWh
Selling price of biomethane	0,00	c€/kWh
<b>Expenses</b>	562.824,52	€/year
Operating and maintenance (O&M)	24.318,65	€/year
Staff	30.960,00	€/year
Transport and handling of waste	256.000,00	€/year
Cost of waste (co-substrates)	80.000,00	€
Transport of digestate	171.545,86	€
Other expenses	0,00	€/year
O&M as percentage of the sale of products and energy savings	20,00	%
Labour intensity	0,0002	h/t·d
Labour cost	15,00	€/h
Days worked per year	258,00	working day
Unit handling cost	2,00	€/t

## Economic viability analysis. Financial study of the investment project.

<b>Financing</b>	939.148,64	€
Subsidies	0,00	€
Own funding	281.744,59	€
Loans	657.404,05	€
Percentage of subsidies	0,00	%
Percentage of own funding	30,00	%
Percentage of loan	70,00	%
Interest rate of loan	4,70	%

### Financial indicators

Gross operating profit or earnings before interest, taxes, depreciation and amortization (EBITDA)	-441.231,26	€/year
Net present value (NPV)	-5.251.787,96	€
NPV/initial investment	-5,592	-
Internal return rate (IRR)	38,65	%
Payback period	>15	years
Weighted Average Cost of Capital (WACC)	5,90	%
Capital Recovery Factor (CRF)	10,23	%

## Environmental viability analysis

Primary energy obtained from the recovery of the biogas	3.314,87	MWh/year
Savings of CO2 emissions	921,53	t/year
Savings in artificial fertilizers	186000	kgN/year
Utilization of the digestate in	Vulnerable area	
Cultivation area required for application of digestate	1.094,12	ha

## Use of the biogas 2 (Co-generation)

### Data of the biogas valorisation system

Use of biogas in	Co-generation	
Use of produced electric energy	Self-consumption	
Use of produced thermal energy	Self-consumption	
Use of produced biomethane	No	
Needs of thermal energy near to the biogas plant	3.750,00	MWh/year
Needs of electric energy near to the biogas plant	775,00	MWh/year
Production of electricity in cogeneration	1.171,12	MWh/year
Electric power installed in cogeneration system (CHP)	153,71	kW
Thermal energy production in cogeneration	1.774,43	MWh/year
Unrecovered thermal energy in cogeneration system	0,00	MWh/year
Thermal recovery coefficient of the cogeneration system	0,162	
Energy efficiency coefficient of the cogeneration system	0,737	
Investment in cogeneration system	235.832,40	€
Income or savings (sale or use of the electricity)	116.250,00	€/year
Income or savings (sale or use of the thermal energy)	21.748,75	€/year

### Energy storage

Volume of the gasometer	--	m <sup>3</sup>
Self-consumed energy	66,18 e   Nt>Pt	%
Comments	--	

## Economic viability analysis. Investment project

<b>Investment</b>	1.150.904,94	€
Biogas plant	915.072,54	€
Biogas valorisation system	235.832,40	€
Other	0,00	€
<b>Income</b>	177.766,20	€/year
Sale of Electricity, Thermal energy	0,00	€/year
Energy savings	137.998,75	€/year
Waste management	0,00	€/year
Other incomes	0,00	€/year
Sale or saving (sale or use) of digestate	39.767,45	€/year
Selling price of electric energy	0,00	c€/kWh
Selling price of thermal energy	0,00	c€/kWh
Selling price of biomethane	0,00	c€/kWh
<b>Expenses</b>	574.059,10	€/year
Operating and maintenance (O&M)	35.553,24	€/year
Staff	30.960,00	€/year
Transport and handling of waste	256.000,00	€/year
Cost of waste (co-substrates)	80.000,00	€
Transport of digestate	171.545,86	€
Other expenses	0,00	€/year
O&M as percentage of the sale of products and energy savings	20,00	%
Labour intensity	0,0002	h/t·d
Labour cost	15,00	€/h
Days worked per year	258,00	working day
Unit handling cost	2,00	€/t

## Economic viability analysis. Financial study of the investment project.

<b>Financing</b>	1.150.904,94	€
Subsidies	0,00	€
Own funding	345.271,48	€
Loans	805.633,46	€
Percentage of subsidies	0,00	%
Percentage of own funding	30,00	%
Percentage of loan	70,00	%
Interest rate of loan	4,70	%

### Financial indicators

Gross operating profit or earnings before interest, taxes, depreciation and amortization (EBITDA)	-396.292,90	€/year
Net present value (NPV)	-5.024.312,18	€
NPV/initial investment	-4,366	-
Internal return rate (IRR)	26,54	%
Payback period	>15	years
Weighted Average Cost of Capital (WACC)	5,90	%
Capital Recovery Factor (CRF)	10,23	%

## Environmental viability analysis

Primary energy obtained from the recovery of the biogas	2.875,28	MWh/year
Savings of CO2 emissions	799,33	t/year
Savings in artificial fertilizers	186000	kgN/year
Utilization of the digestate in	Vulnerable area	
Cultivation area required for application of digestate	1.094,12	ha



## Use of the biogas 3 (Biomethane)

### Data of the biogas valorisation system

Use of biogas in	Biomethane	
Use of produced electric energy	No	
Use of produced thermal energy	No	
Use of produced biomethane	Injection into gas grid	
Needs of thermal energy near to the biogas plant	3.750,00	MWh/year
Needs of electric energy near to the biogas plant	775,00	MWh/year
Thermal energy in the biomethane obtained	4.334,90	MWh/year
Losses of energy in the purification process	628,56	MWh/year
Thermal output energy of the purifier	3.706,34	MWh/year
Biomethane output flow rate of the purifier	41,89	Nm <sup>3</sup> CH <sub>4</sub> /h
Installed capacity of the purifier	43,98	Nm <sup>3</sup> CH <sub>4</sub> /h
Higher heating power of the biomethane produced	3.632,21	MWh/year
Annual net amount of biomethane produced	328.409,74	Nm <sup>3</sup> /year
Flow rate of biomethane produced	41,05	Nm <sup>3</sup> CH <sub>4</sub> /h
Investment in biomethane system	339.724,26	€
Income due to biomethane sale	0,00	€/year

## Economic viability analysis. Investment project

<b>Investment</b>	1.254.796,80	€
Biogas plant	915.072,54	€
Biogas valorisation system	339.724,26	€
Other	0,00	€
<b>Income</b>	39.767,45	€/year
Sale of Biomethane	0,00	€/year
Energy savings	0,00	€/year
Waste management	0,00	€/year
Other incomes	0,00	€/year
Sale or saving (sale or use) of digestate	39.767,45	€/year
Selling price of electric energy	0,00	c€/kWh
Selling price of thermal energy	0,00	c€/kWh
Selling price of biomethane	0,00	c€/kWh
<b>Expenses</b>	546.459,35	€/year
Operating and maintenance (O&M)	7.953,49	€/year
Staff	30.960,00	€/year
Transport and handling of waste	256.000,00	€/year
Cost of waste (co-substrates)	80.000,00	€
Transport of digestate	171.545,86	€
Other expenses	0,00	€/year
O&M as percentage of the sale of products and energy savings	20,00	%
Labour intensity	0,0002	h/t·d
Labour cost	15,00	€/h
Days worked per year	258,00	working day
Unit handling cost	2,00	€/t

## Economic viability analysis. Financial study of the investment project.

<b>Financing</b>	1.254.796,80	€
Subsidies	0,00	€
Own funding	376.439,04	€
Loans	878.357,76	€
Percentage of subsidies	0,00	%
Percentage of own funding	30,00	%
Percentage of loan	70,00	%
Interest rate of loan	4,70	%

### Financial indicators

Gross operating profit or earnings before interest, taxes, depreciation and amortization (EBITDA)	-506.691,90	€/year
Net present value (NPV)	-6.207.255,13	€
NPV/initial investment	-4,947	-
Internal return rate (IRR)	32,31	%
Payback period	>15	years
Weighted Average Cost of Capital (WACC)	5,90	%
Capital Recovery Factor (CRF)	10,23	%

## Environmental viability analysis

Primary energy obtained from the recovery of the biogas	3.632,21	MWh/year
Savings of CO2 emissions	1.009,75	t/year
Savings in artificial fertilizers	186000	kgN/year
Utilization of the digestate in	Vulnerable area	
Cultivation area required for application of digestate	1.094,12	ha

## Use of the biogas 4 (Boiler)

### Data of the biogas valorisation system

Use of biogas in	Boiler	
Use of produced electric energy	No	
Use of produced thermal energy	Sale	
Use of produced biomethane	No	
Needs of thermal energy near to the biogas plant	3.750,00	MWh/year
Needs of electric energy near to the biogas plant	775,00	MWh/year
Recoverable thermal energy in boiler	3.314,87	MWh/year
Thermal power installed in boiler	435,08	kW
Unrecovered thermal energy in boiler	0,00	MWh/year
Investment in boiler system	24.076,09	€
Income or savings (sale or use of the thermal energy)	41.961,95	€/year

### Economic viability analysis. Investment project

<b>Investment</b>	939.148,64	€
Biogas plant	915.072,54	€
Biogas valorisation system	24.076,09	€
Other	0,00	€
<b>Income</b>	81.729,40	€/year
Sale of Thermal energy	41.961,95	€/year
Energy savings	0,00	€/year
Waste management	0,00	€/year
Other incomes	0,00	€/year
Sale or saving (sale or use) of digestate	39.767,45	€/year
Selling price of electric energy	0,00	c€/kWh
Selling price of thermal energy	2,00	c€/kWh
Selling price of biomethane	0,00	c€/kWh
<b>Expenses</b>	554.851,74	€/year
Operating and maintenance (O&M)	16.345,88	€/year
Staff	30.960,00	€/year
Transport and handling of waste	256.000,00	€/year
Cost of waste (co-substrates)	80.000,00	€
Transport of digestate	171.545,86	€
Other expenses	0,00	€/year
O&M as percentage of the sale of products and energy savings	20,00	%
Labour intensity	0,0002	h/t·d
Labour cost	15,00	€/h
Days worked per year	258,00	working day
Unit handling cost	2,00	€/t

## Economic viability analysis. Financial study of the investment project.

<b>Financing</b>	939.148,64	€
Subsidies	0,00	€
Own funding	281.744,59	€
Loans	657.404,05	€
Percentage of subsidies	0,00	%
Percentage of own funding	30,00	%
Percentage of loan	70,00	%
Interest rate of loan	4,70	%

### Financial indicators

Gross operating profit or earnings before interest, taxes, depreciation and amortization (EBITDA)	-473.122,34	€/year
Net present value (NPV)	-5.563.494,65	€
NPV/initial investment	-5,924	-
Internal return rate (IRR)	41,89	%
Payback period	>15	years
Weighted Average Cost of Capital (WACC)	5,90	%
Capital Recovery Factor (CRF)	10,23	%

## Environmental viability analysis

Primary energy obtained from the recovery of the biogas	3.314,87	MWh/year
Savings of CO2 emissions	921,53	t/year
Savings in artificial fertilizers	186000	kgN/year
Utilization of the digestate in	Vulnerable area	
Cultivation area required for application of digestate	1.094,12	ha

## Use of the biogas 5 (Co-generation)

### Data of the biogas valorisation system

Use of biogas in	Co-generation	
Use of produced electric energy	Sale	
Use of produced thermal energy	Sale	
Use of produced biomethane	No	
Needs of thermal energy near to the biogas plant	3.750,00	MWh/year
Needs of electric energy near to the biogas plant	775,00	MWh/year
Production of electricity in cogeneration	1.171,12	MWh/year
Electric power installed in cogeneration system (CHP)	153,71	kW
Thermal energy production in cogeneration	1.774,43	MWh/year
Unrecovered thermal energy in cogeneration system	0,00	MWh/year
Thermal recovery coefficient of the cogeneration system	0,162	
Energy efficiency coefficient of the cogeneration system	0,737	
Investment in cogeneration system	235.832,40	€
Income or savings (sale or use of the electricity)	58.556,12	€/year
Income or savings (sale or use of the thermal energy)	11.153,21	€/year

## Economic viability analysis. Investment project

<b>Investment</b>	1.150.904,94	€
Biogas plant	915.072,54	€
Biogas valorisation system	235.832,40	€
Other	0,00	€
<b>Income</b>	109.476,77	€/year
Sale of Electricity, Thermal energy	69.709,32	€/year
Energy savings	0,00	€/year
Waste management	0,00	€/year
Other incomes	0,00	€/year
Sale or saving (sale or use) of digestate	39.767,45	€/year
Selling price of electric energy	5,00	c€/kWh
Selling price of thermal energy	2,00	c€/kWh
Selling price of biomethane	0,00	c€/kWh
<b>Expenses</b>	560.401,22	€/year
Operating and maintenance (O&M)	21.895,35	€/year
Staff	30.960,00	€/year
Transport and handling of waste	256.000,00	€/year
Cost of waste (co-substrates)	80.000,00	€
Transport of digestate	171.545,86	€
Other expenses	0,00	€/year
O&M as percentage of the sale of products and energy savings	20,00	%
Labour intensity	0,0002	h/t·d
Labour cost	15,00	€/h
Days worked per year	258,00	working day
Unit handling cost	2,00	€/t

## Economic viability analysis. Financial study of the investment project.

<b>Financing</b>	1.150.904,94	€
Subsidies	0,00	€
Own funding	345.271,48	€
Loans	805.633,46	€
Percentage of subsidies	0,00	%
Percentage of own funding	30,00	%
Percentage of loan	70,00	%
Interest rate of loan	4,70	%

### Financial indicators

Gross operating profit or earnings before interest, taxes, depreciation and amortization (EBITDA)	-450.924,45	€/year
Net present value (NPV)	-5.558.286,46	€
NPV/initial investment	-4,829	-
Internal return rate (IRR)	31,15	%
Payback period	>15	years
Weighted Average Cost of Capital (WACC)	5,90	%
Capital Recovery Factor (CRF)	10,23	%

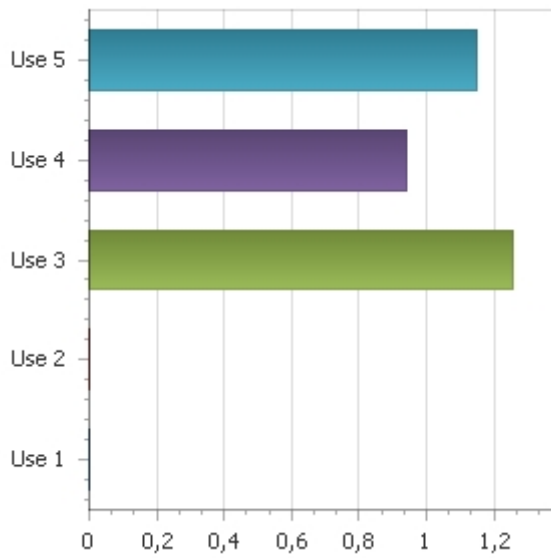
## Environmental viability analysis

Primary energy obtained from the recovery of the biogas	2.875,28	MWh/year
Savings of CO2 emissions	799,33	t/year
Savings in artificial fertilizers	186000	kgN/year
Utilization of the digestate in	Vulnerable area	
Cultivation area required for application of digestate	1.094,12	ha

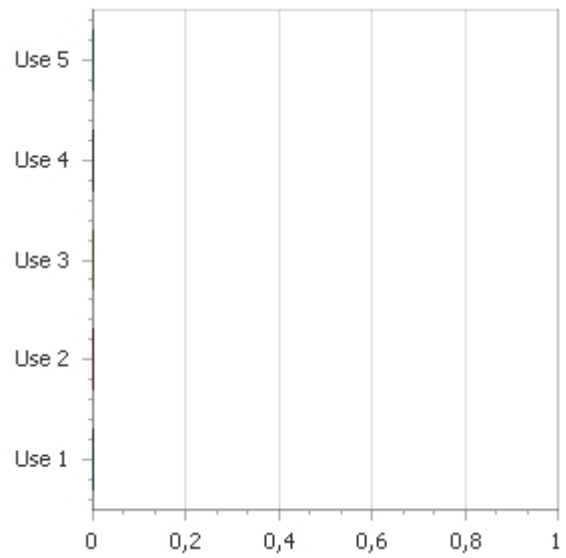


## Overview

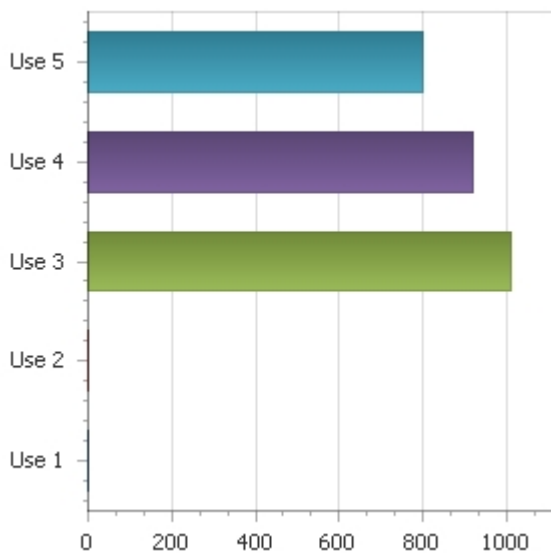
Investment (M€)



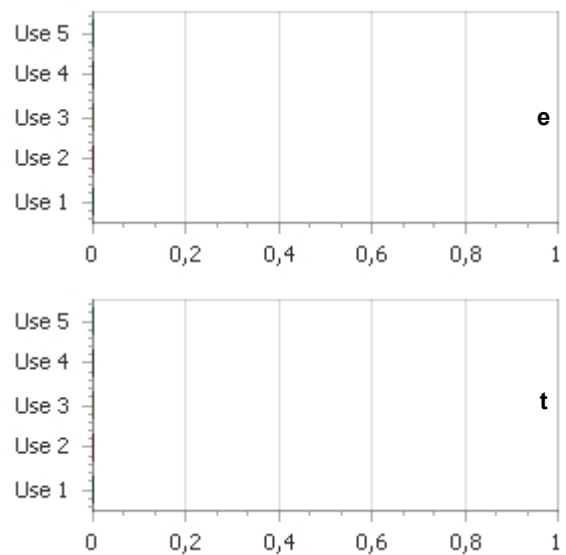
Payback period (years)



CO2-eq emissions savings (t/year)



Self-consumed energy (%)



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