



## General data

Company

Universidad de cantabria

Date

14/04/2021

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                                                                        | Cantabria   Cantabria |    |
| Annual average temperature                                                                     | 14,1                  | °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)              | 113.317,90       | t/year   |
| Annual amount of waste introduced in the digester (dry matter)                | 11.331,79        | t/year   |
| Annual amount of waste introduced in the digester (dry organic matter)        | 9.065,43         | t/year   |
| Annual amount of organic matter degraded                                      | 5.103,84         | 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)                             | 108.343,09       | t/year   |
| Volume of anaerobic digester                                                  | 11.379,77        | m³       |
| Hydraulic retention time                                                      | 35,14            | days     |
| Thermal energy required for the heating of the anaerobic digester             | 3.822,28         | MWh/year |
| Gross methane production (annual)                                             | 1.840.282,70     | Nm3/year |
| Gross biogas production (annual)                                              | 3.021.810,67     | Nm3/year |
| Gross biogas production (average per hour)                                    | 344,96           | Nm3/h    |
| Excessive digestate recirculation (if recirculation rate is >30%)             | No               |          |
| Ammonia inhibition risk                                                       | No               |          |
| C/N ratio out of range                                                        | C/N too low (11) |          |

## Use of the biogas 1 (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  | 0,00                    | MWh/year                           |
| Needs of electric energy near to the biogas plant | 0,00                    | MWh/year                           |
| Thermal energy in the biomethane obtained         | 20.353,53               | MWh/year                           |
| Losses of energy in the purification process      | 2.951,26                | MWh/year                           |
| Thermal output energy of the purifier             | 17.402,27               | MWh/year                           |
| Biomethane output flow rate of the purifier       | 196,68                  | Nm <sup>3</sup> CH <sub>4</sub> /h |
| Installed capacity of the purifier                | 206,51                  | Nm <sup>3</sup> CH <sub>4</sub> /h |
| Higher heating power of the biomethane produced   | 17.054,22               | MWh/year                           |
| Annual net amount of biomethane produced          | 1.541.972,87            | Nm <sup>3</sup> /year              |
| Flow rate of biomethane produced                  | 192,75                  | Nm <sup>3</sup> CH <sub>4</sub> /h |
| Investment in biomethane system                   | 736.134,05              | €                                  |
| Income due to biomethane sale                     | 0,00                    | €/year                             |

## Economic viability analysis. Investment project

|                                                              |              |             |
|--------------------------------------------------------------|--------------|-------------|
| <b>Investment</b>                                            | 3.335.496,70 | €           |
| Biogas plant                                                 | 2.599.362,64 | €           |
| Biogas valorisation system                                   | 736.134,05   | €           |
| Other                                                        | 0,00         | €           |
| <b>Income</b>                                                | 110.509,95   | €/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                    | 110.509,95   | €/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>                                              | 1.016.353,24 | €/year      |
| Operating and maintenance (O&M)                              | 22.101,99    | €/year      |
| Staff                                                        | 87.708,05    | €/year      |
| Transport and handling of waste                              | 906.543,20   | €/year      |
| Cost of waste (co-substrates)                                | 0,00         | €           |
| Transport of digestate                                       | 0,00         | €           |
| 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>          | 3.335.496,70 | € |
| Subsidies                 | 0,00         | € |
| Own funding               | 1.000.649,01 | € |
| Loans                     | 2.334.847,69 | € |
| 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) | -905.843,29    | €/year |
| Net present value (NPV)                                                                           | -12.189.301,40 | €      |
| NPV/initial investment                                                                            | -3,654         | -      |
| Internal return rate (IRR)                                                                        | 19,30          | %      |
| 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 | 17.054,22       | MWh/year |
| Savings of CO2 emissions                                | 4.741,07        | t/year   |
| Savings in artificial fertilizers                       | 430608,02       | kgN/year |
| Utilization of the digestate in                         | Vulnerable area |          |
| Cultivation area required for application of digestate  | 2.532,99        | ha       |

## Use of the biogas 2 (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                        | Fuel         |                                    |
| Needs of thermal energy near to the biogas plant  | 0,00         | MWh/year                           |
| Needs of electric energy near to the biogas plant | 0,00         | MWh/year                           |
| Thermal energy in the biomethane obtained         | 20.353,53    | MWh/year                           |
| Losses of energy in the purification process      | 2.951,26     | MWh/year                           |
| Thermal output energy of the purifier             | 17.402,27    | MWh/year                           |
| Biomethane output flow rate of the purifier       | 196,68       | Nm <sup>3</sup> CH <sub>4</sub> /h |
| Installed capacity of the purifier                | 206,51       | Nm <sup>3</sup> CH <sub>4</sub> /h |
| Higher heating power of the biomethane produced   | 17.054,22    | MWh/year                           |
| Annual net amount of biomethane produced          | 1.541.972,87 | Nm <sup>3</sup> /year              |
| Flow rate of biomethane produced                  | 192,75       | Nm <sup>3</sup> CH <sub>4</sub> /h |
| Investment in biomethane system                   | 736.134,05   | €                                  |
| Income due to biomethane sale                     | 0,00         | €/year                             |

## Economic viability analysis. Investment project

|                                                              |              |             |
|--------------------------------------------------------------|--------------|-------------|
| <b>Investment</b>                                            | 3.335.496,70 | €           |
| Biogas plant                                                 | 2.599.362,64 | €           |
| Biogas valorisation system                                   | 736.134,05   | €           |
| Other                                                        | 0,00         | €           |
| <b>Income</b>                                                | 110.509,95   | €/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                    | 110.509,95   | €/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>                                              | 1.016.353,24 | €/year      |
| Operating and maintenance (O&M)                              | 22.101,99    | €/year      |
| Staff                                                        | 87.708,05    | €/year      |
| Transport and handling of waste                              | 906.543,20   | €/year      |
| Cost of waste (co-substrates)                                | 0,00         | €           |
| Transport of digestate                                       | 0,00         | €           |
| 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>          | 3.335.496,70 | € |
| Subsidies                 | 0,00         | € |
| Own funding               | 1.000.649,01 | € |
| Loans                     | 2.334.847,69 | € |
| 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) | -905.843,29    | €/year |
| Net present value (NPV)                                                                           | -12.189.301,40 | €      |
| NPV/initial investment                                                                            | -3,654         | -      |
| Internal return rate (IRR)                                                                        | 19,30          | %      |
| 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 | 17.054,22       | MWh/year |
| Savings of CO2 emissions                                | 4.741,07        | t/year   |
| Savings in artificial fertilizers                       | 430608,02       | kgN/year |
| Utilization of the digestate in                         | Vulnerable area |          |
| Cultivation area required for application of digestate  | 2.532,99        | ha       |



## Use of the biogas 3 (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         | 0,00             | MWh/year |
| Needs of electric energy near to the biogas plant        | 0,00             | MWh/year |
| Production of electricity in cogeneration                | 5.498,74         | MWh/year |
| Electric power installed in cogeneration system (CHP)    | 721,71           | kW       |
| Thermal energy production in cogeneration                | 8.331,42         | MWh/year |
| Unrecovered thermal energy in cogeneration system        | 4.509,14         | MWh/year |
| Thermal recovery coefficient of the cogeneration system  | 0,279            |          |
| Energy efficiency coefficient of the cogeneration system | 0,491            |          |
| Investment in cogeneration system                        | 751.645,66       | €        |
| Income or savings (sale or use of the electricity)       | 0,00             | €/year   |
| Income or savings (sale or use of the thermal energy)    | 0,00             | €/year   |

### Energy storage

|                         |                                                                                                                                                                                                                      |    |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Volume of the gasometer | 4139,47                                                                                                                                                                                                              | m³ |
| Self-consumed energy    | 0 e   45,88 t                                                                                                                                                                                                        | %  |
| Comments                | Storage volume calculated to cover hours in which biogas is not utilized. There is unused biogas in self-consumption by the agro-food company (Pe>Ne y/o Pt>Nt) and which could be assigned to sale to third parties |    |

## Economic viability analysis. Investment project

|                                                              |              |             |
|--------------------------------------------------------------|--------------|-------------|
| <b>Investment</b>                                            | 3.351.008,31 | €           |
| Biogas plant                                                 | 2.599.362,64 | €           |
| Biogas valorisation system                                   | 751.645,66   | €           |
| Other                                                        | 0,00         | €           |
| <b>Income</b>                                                | 110.509,95   | €/year      |
| Sale of Electricity, Thermal energy                          | 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                    | 110.509,95   | €/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>                                              | 1.016.353,24 | €/year      |
| Operating and maintenance (O&M)                              | 22.101,99    | €/year      |
| Staff                                                        | 87.708,05    | €/year      |
| Transport and handling of waste                              | 906.543,20   | €/year      |
| Cost of waste (co-substrates)                                | 0,00         | €           |
| Transport of digestate                                       | 0,00         | €           |
| 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>          | 3.351.008,31 | € |
| Subsidies                 | 0,00         | € |
| Own funding               | 1.005.302,49 | € |
| Loans                     | 2.345.705,82 | € |
| Percentage of subsidies   | 0,00         | % |
| Percentage of own funding | 30,00        | % |
| Percentage of loan        | 70,00        | % |
| Interest rate of loan     | 4,70         | % |

### Financial indicators

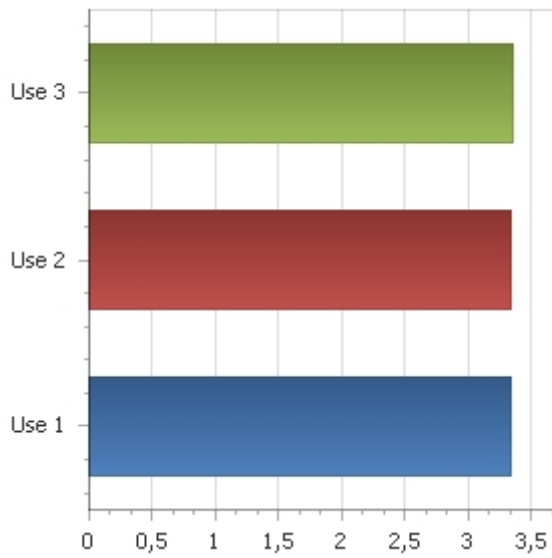
|                                                                                                   |                |        |
|---------------------------------------------------------------------------------------------------|----------------|--------|
| Gross operating profit or earnings before interest, taxes, depreciation and amortization (EBITDA) | -905.843,29    | €/year |
| Net present value (NPV)                                                                           | -12.204.813,01 | €      |
| NPV/initial investment                                                                            | -3,642         | -      |
| Internal return rate (IRR)                                                                        | 19,17          | %      |
| Payback period                                                                                    | >15            | years  |
| Weighted Average Cost of Capital (WACC)                                                           | 5,90           | %      |
| Capital Recovery Factor (CRF)                                                                     | 10,23          | %      |

## Environmental viability analysis

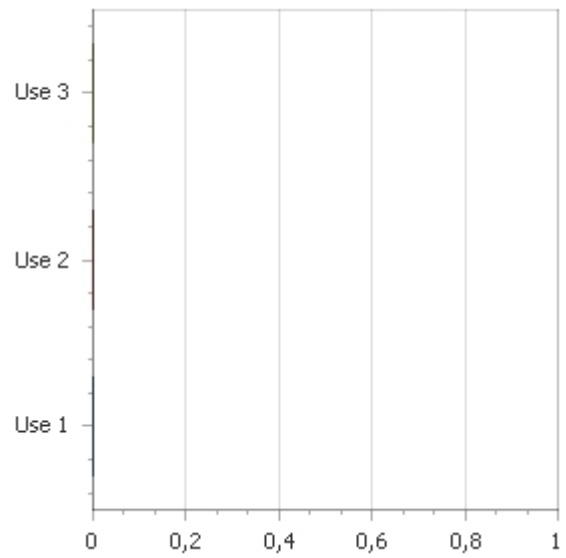
|                                                         |                 |          |
|---------------------------------------------------------|-----------------|----------|
| Primary energy obtained from the recovery of the biogas | 8.991,10        | MWh/year |
| Savings of CO2 emissions                                | 2.499,52        | t/year   |
| Savings in artificial fertilizers                       | 430608,02       | kgN/year |
| Utilization of the digestate in                         | Vulnerable area |          |
| Cultivation area required for application of digestate  | 2.532,99        | ha       |

## Overview

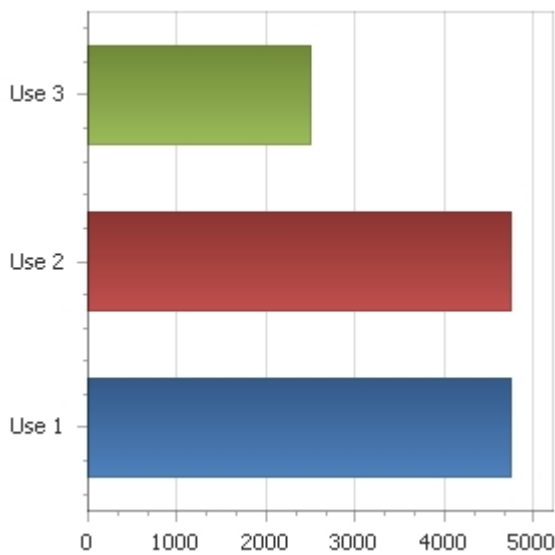
Investment (M€)



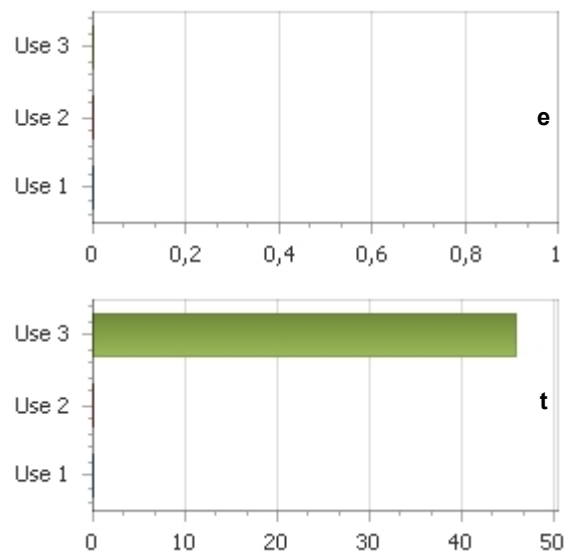
Payback period (years)



CO2-eq emissions savings (t/year)



Self-consumed energy (%)



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