Quick User Guide offline calculation tool

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CONTENT

Introduction

With this tool, you can determine if a small scale anaerobic digestion installation (or biogas installation) is profitable.

Try for yourself. With the Offline Expert Feasibility Calculator for Small scale Digestion, you can calculate if a biogas installation can make a profitable business case. With the tool, you can try different set-ups, scales, optimise your installation and generate financial data that can be used in a business plan.

This calculation tool covers a broad range of installations and options. The tool is intended for farm scale biogas installations. In effect, this means that installations up to a capacity of approximately 25.000 tonnes of biomass, or 150 kWe, are included in the tool.

The tool is meant for farmers experts and biogas experts. Where the online BioEnergy Farm scan (www.BioEnergyFarm.eu) is developed to be used by farmers and landowners, this Offline Expert Feasibility Calculator for Small scale Digestion is intended to be used by a trained consultant/experts. These trainings are provided within the BioEnergy Farm 2 project. With the help of these trainings and this guideline, a business plan for a small scale biogas installation can be made.

The tool covers a broad range of installations and options. The tool is intended for farm scale biogas installations. In effect, this means that installations up to a capacity of approximately 25.000 tonnes of biomass, or 150 kWe electrical capacity of a CHP (combined heat and power generation), are all covered by the tool. Furthermore, digestate treatment, heat delivery and biomethane production are all included in the tool.

This calculation tool has been build with the greatest care, but is no replacement for commercial offers. Although the financial data in the tool is based upon commercial offers and laws of physics, the outcome of the tool is no replacement for commercial offers. The maker of the tool, the project partners and the EACI can not be held responsible for the outcome of the tool.

1. Business case scenarios

1.1 Biogas

The main aim of the biogas scenario is to export the biogas, generated in the biogas plant, to a nearby energy user, using a biogas network. The biogas is then converted at the end user into heat using a biogas boiler. Because the biogas is exported, an additional boiler is needed on site, to generate heat for the biogas plant. This boiler can be fuelled with biogas or wood chips. Revenues are created by substituting fossil heat production with heat from the biogas boiler, and subsidies from the production of renewable heat.

1.2 Heat

In the heat scenario, the biogas generated in the biogas plant is converted into heat onsite, using a biogas boiler. The heat is then transported to the end user, using a heat network. Revenues are created by substituting fossil heat production with heat from the biogas boiler, and subsidies from the production of renewable heat. The main difference with the biogas scenario is that heat, instead of biogas, is transported. A small heat network (short distance to end user) can be cheaper than a biogas network and a separate boiler. However, a heat network suffers from heat losses with increasing distance.

1.3 CHP

In the CHP (Combined Heat and Power) scenario, the biogas produced in the biogas plant is converted into heat and electricity (power) onsite. The heat and electricity can then be used to compensate own energy use. Electricity that is not use internally, is fed in to the electricity grid. Revenues are generated by substituting electricity and fossil based heat, or by selling electricity to the grid. Exploitation subsidies can apply for both electricity and heat which is utilized at the farm.

1.4 Biomethane

The biomethane scenario covers the upgrading of biogas to natural gas grid standards, by removing CO_2 from the biogas. The biomethane is fed in to the natural gas grid and sold to the gas company. Depending on the upgrading technique used, electricity or heat is needed for the operation. Electricity will be bought from the grid, whereas heat can be supplied with biogas or wood chips.

1.5 Digestate treatment

The digestate treatment scenario intents to avoid expensive transport and disposal of manure, and instead produce fertilizers from the animal manure. Heat and electricity, necessary for the project, is supplied by a CHP.

2. Quick walkthrough

In the following chapters, each interface sheet is discussed. All the basic tools and options are used and described.

By clicking on the help-numbers in the interface or in the help-file, you can switch between the help-file and the interface sheet

2.1	Imprint	General information of the tool and disclaimer
2.2	Partners	Partners of the BioEnergy Farm 2 Project
2.3	Interface_1	Main interface, where the biogas plant can be designed
2.4	Interface_2	Digestate treatment interface (separator, mineral balance etc.)
2.5	Interface_INV	Investment overview
2.6	Interface_FIN	Financial results
2.7	Interface_CF	Cash flow overview
2.8	Interface_digester	Adapt digester parameters
2.9	Interface_sensitivity	Sensitivity analyses with escalation parameters
2.10	Substrates_manure	Manure substrate database
2.11	Substrates_cosubstrates	Cosubstrate database

2.1 General information of the tool and disclaimer (Imprint)

In the imprint you can find the relevant information on the maker of the tool and the BioEnergy Farm 2 project and the disclaimer. Also, the version number is located here.

2.2 Partners of the BioEnergy Farm 2 Project (Partners)

On the Partner sheet you can find detailed contact information for all the partners in the project.

2.3 Main interface, where the biogas plant can be designed (Interface_1)

Interface 1 is the main and most important interface sheet of the tool. This sheet contains nearly all input cells of the tool and allows you to design the biogas plant for the farm. It is also the sheet where you can change the Region of the biogas plant, the language and currency. Note that subsidy rules, energy prices, investments and digester lay-out may be region specific. Please enter the country and region first!

2.3.1 Business

At Business, you can enter the farm and client details. For region you have to select the country of the farm, because the country-specific parameters used, are based on that selected country. Language is only for the interface language. This has no further implications. Only when changing it later on, some inputs from the dropdown menus are no longer recognized!

The currency rate is default set for the project countries. The calculations are done in Euro, but when another currency is selected, the interface is recalculated in that currency. Changing the default currency can be important for comparison of cases between countries, or for example when presenting for a foreign bank with other currency.

For name, address and email, information about the farmer need to be filled in. This information is used in the report and also stored at the project database.

2.3.2 Livestock

The tool is focusing on farm-scale, manure based digestion. Most common farm species are presented. Those are (dairy) cows; bulls; pigs; poultry and other. The chosen species defines what will show up in the next column.

2.3.2.1 SPECIFY LIVESTOCK

Specify livestock	Specify	Type of manure	Day-fresh manure
[Species]	[type of animal]	[Solid or Liquid]	[yes or no]
Cows	Dairy cows	Liquid manure	Yes
Cows	Young dairy cows (calf <1 year)	Liquid manure	
Cows	Young dairy cows (yearling >1 yea	Liquid manure	
Pigs	Mature pigs for meat (porkers)	Liquid manure	
Make stable modifications to produce fresh manure?			No

For example: if you are scanning a dairy farm, you can select "Cows" in this first cell. After that we move on to the next column "Specify". We see that the dropdown menu only contains dairy animals: Dairy cows; Calves and; Yearlings. If you change the first cell to "Bulls" you see this second dropdown menu changes to: "Bulls for meat" and "Young bulls for meat".

Depending on the stable system one has solid or liquid manure (most common for dairy farms in, for example, the Netherlands is liquid manure). It is important to choose one of the options, because the properties of different type of manure are completely different. Therefore there is no default option chosen by the tool. You have to select one yourself!

The age of manure is important for the biogas potential. Older manure has a lower gas potential compared to daily-fresh manure. New generation stables have low-emission stable floors with scrapers. Only with these stables you can have daily fresh manure. In almost all other cases there is a cellar with a minimum quantity of manure, so the manure will never be daily fresh before it enters the digester.

2.3.2.2 SPECIFY NUMBER OF ANIMALS AND TIME IN BARN

Numbers of animals, here you can specify the correct number of animals.

No. animals	Grazing	
[#]	[days / year]	[hour / day]
120	120	8
50	120	12
40	0	

You may have noticed that also grazing time needs to be specified. Animals are not necessary 24/7 in the stables. If animals are never in the field, we fill in "0 days". If the animals are in the fields (part of) the day or year, this has to be filled in. This because manure produced in the field is not collected and pumped in the digester. If the grazing time cells are left empty, the default grazing time is selected for your country.

The number of animals is used to calculate the manure production. The manure production is programmed for the average amount of animals present of a year. Vacancy period(s) of the stable between rounds are not discounted for. Please specify the average number of occupied animal spaces for one year, taking vacancy into account.

2.3.2.3 SPECIFY SUPPLY OF MANURE

Manure supply. This can be used when for example manure from the neighbour is also brought to this digester. This is not farm-produced manure, so can be specified separately. Also costs for buying this manure can be specified, also negative costs.

Manure Supply	Costs
[ton/year]	[EUR/ton]
5.000	15
5.000	**75.000**

2.3.2.4 MANURE INPUT

Manure Input	
[ton/year]	[m³/year]
2.874	2.846
217	215
528	523
5.000	4.950
	-
	-
8.620	**8.534**

The brown cells are output cells that present the manure production of the farm. These numbers can for example be checked with the existing manure bookkeeping of the farmer.

2.3.2.5 NITROGEN ORGANIC ORIGIN

Organic input. For every substrate you can selected whether this is from organic origin or not. This input will then be used to track the organic nitrogen in the output of the digester.

2.3.3 Cofermentation

Besides manure there is also the option to feed some co-substrates. Note that this tool is for mainly manure with some adding of co-substrates. A calculation tool for co-digesters was developed in the former project BioEnergy Farm, and is still available at the project website www.bioenergyfarm.eu, as ADPC (Anaerobic Digestion Profit Calculator).

The process of adding of co-substrates to the tool is comparable to the process of adding manure substrates. There is a limited number of substrates in the database. You can select a maximum of 6 different cosubstrates for every case. After selecting the correct cosubstrate, you can provide the amount of added substrates per year, and the associated costs.

At the bottom of the input table for cofermentation, there are some extra outputs. First the share of co-substrates of the total mass. This is done because some countries have restrictions on this share related to the subsidy scheme. In the Netherlands for example this should be <5% to apply for the manure digestion subsidies.

Do you want cofermentation?	Yes	Costs	Price indication	2.3.2.5
Specify cosubstrates	Cosubstrate			Organic
[Category]	[ton/year]	[EUR/ton]	[EUR/ton]	[yes or no]
Glycerine	440	100	99 - 100	Sì
Total	**440**	**44.000**		
Share (mass) cosubstrates of total digester input		4,9	[%]	
Land use to produce cosubstrates		-	[ha]	

The other brown cell presents the needed land for the production of the co-substrates. This is only calculated for crops like maize, corn, CCM, grasses, etc. This number is indicative, and based on average production rates. This value is not used in further calculations.

2.3.4 Desulphurization with active carbon

Here you can specify if you want to add an active active carbon filter to the installation for the desulphurization of the biogas. This is additional desulphurization, if no biological desulphurization is present in the digester, or if additional desulphurization is required. You can also specify the expected sulphur contact of the biogas. If this is left empty, the default value is used.

Desulphurization with active carbon	Yes

2.3.5 Flare

If the standard utilization technique is out of order, due to maintenance or a breakdown, the biogas storage in the digester may not always be sufficient in size to cover the complete period. The ventilation of biogas (methane) to the atmosphere may be more hazardous and dangerous than ventilation of CO_2 from the burned biogas. Therefore, a flare is needed for long maintenance periods. In some countries, a flare can be contracted or leased for short periods, whereas other countries require in the installation of a flare as standard.
The brown output cell gives the default value for your country. If you to want change the default value, please select the correct option here.

	Default	Overwrite
Flare	No	

2.3.6 Main characteristics of the biogas plant

After you have selected the substrates, the main properties of the biogas plant are displayed on the right. Here you can find the main characteristics of the biogas plant, input substrates, digestate output and the capacity and production of the different utilization techniques for the biogas.

2.3.6.1 DIGESTER VOLUME

Digester size. The size of the digester (digester volume) is in principle based on the amount of substrates and the retention time in the digester. This means that for the digestion of 8000 m³ of manure, with a retention time of 25 days, a digester with a useful nett volume of 543 m³ is required. Added other substrates with higher retention times, will result in a larger digester; the retention time of all substrates is set to the highest retention time of the substrates.

However, to avoid a too high ODM load, the ODM load is capped at 3,5 kg/m³.day. This means that when the combined selected substrates exceed this load, the digester will be larger, so that the ODM load is 3,5 kg/m³.day.

You can manually overwrite the digester volume in the cell: override volume. Be advised that after you overwrite the volume, retention time and ODM load are no longer controlled by the tool. When you manually overwrite the digester size, resulting in a shorter retention time, the biogas yield will be tempered by the tool. To avoid this, add a new substrate with a shorter default retention time.

2.3.6	Main characteristics of the biogas plant	
Digester Volume	735	[m³] useful (nett) volume
Overwrite Volume		[m³] useful (nett) volume
Retention time	30	[days]
ODM load	3,50	[kg/m³.day]
Nitrogen load	3,15	[gr/liter]
DM input	11,99	[%]
ODM input	10,37	[%]
DM Digestate	5,24	[%]
ODM Digestate	3,49	[%]
Nitrogen organic origin	-	[%]
Based on your farm size you can produce per year:		
Biogas	496.708	[m³] of biogas
Methane content	54	[%]

More details on the installation can be found at the Interface_digester. Here you can change the dimensions of the digester, U-values of the walls, and get insight in the thermal losses of the installation.

2.3.6.2 UNIT

In the table with the main characteristics of the biogas plant, you can also change the heat unit (GJ, kWh or kW) and biomethane unit (m³, GJ, kWh or kW) to your preference, depending on the standards used in your country. For the biogas boiler, an efficiency of 0.85 is used. The efficiency of the CHP is based on the size of the engine.

Heat		Heat Unit	kWh
Biogas Boiler Capacity	281	[kW th]	
Heat Production	2.250.328	[kWh] Heat	
Nett Production	1.566.204	[kWh] Heat	
CHP			
CHP Capacity	138	[kWe] CHP	
Number of engines	1		
Electricity Production	1.006.029	[kWh] Electricity	
Nett Production	988.535	[kWh] Electricity	
Heat Production	1.244.299	[kWh] Heat	
Nett Production	789.436	[kWh] Heat	
Biomethane		Biomethane Unit	m^3
Biomethane Capacity	31,8	[m^3/hour] biomethane feed-in	
Biomethane Production	254.626	[m^3] biomethane (natural gas)	

2.3.7 First results, best case scenario

This table shows the results of the most optimal case, assuming that all energy generated by the biogas plant is used at the farm to replace fossil fuel. This table is meant for reference. If the scenario's in this case, with default energy prices and default investment layout, is not profitable, it is not likely that the case will be profitable at all.

Case [EUR]	Biogas	Heat	CHP	Biomethane	
Investments	501.700	647.900	448.400	748.300	[EUR/Year]
Ann. Benefits	237.300	207.000	282.300	289.700	[EUR/Year]
Ann. Costs	214.700	221.000	209.600	234.000	[EUR/Year]
Ann. Profit	22.500	-14.000	72.700	55.600	[EUR/Year]
Simple payback time	13	Not profitable	3	10	[Years]

2.3.8 Storage

With the tool, you can include storage facilities for cosubstrates and digestate in the business plan. Depending on the current storage facilities on the farm, you may want to include a different type of storage:

1	Additional digestate from added cosubstrates
2	Additional digestate from added cosubstrates and supplied manure
2	All digestate
3	No storage

The default option in the tool is option 1, only additional storage from adding cosubstrates.

You can then indicate storage period, and the available storage on your farm, after which the tool will automatically calculate the possible additional storage required. Please be advised that, when a separator is selected on the Interface_2 sheet, storage facilities for liquid fraction and solid fraction of the separated digestate will also be added to the digestate storage.

Storage type	Additional digestate from added cosubstrates	Default/Required	
How long do you need to store the digestate		7	[months/year]
Available separate storage capacity digestate		242	[m³]
		Default/Required	
How long do you want to store the cosubstrates		3	[months/year]
Available storage capacity liquid cosubstrates		85	[m³]
Available storage capacity solid cosubstrates		53	[m³]

The following storage types are used for the investments:

1	Foil basin for digestate and liquid fraction of separated manure. (When gas tide storage is required, this is automatically included in the tool, meaning a gas tide concrete storage is used for digestate storage)
2	Polyester silo for liquid cosubstrates
3	Trench silo for solid cosubstrates and solid fraction of separated manure

2.3.9 Energy use that can be substituted

In this part of the tool you can fill in the energy that can be substituted by the energy produced in the biogas plant. In the overview of "2.36 Main characteristics biogas plant and utilization techniques", the energy production that can be substituted is already shown. Please select the energy sources used on the farm or at a nearby energy user.

If the amount of electricity that can be substituted is lower than the electricity produced in the CHP, the remaining electricity is fed into the grid at feed-in tariff.

Energy Source	Specify amount	Unit	Price per unit		
			Default	Overwrite	Unit
Electricity	50.000	[kWh/year]	0,101		[EUR/kW
Natural Gas	550.000	[m³/year]	0,520		[EUR/m³
Heating Oil	2.000	[liter/year]	0,800		[EUR/lit

Note that you can only add substituted energy of one (1) consumer. This means you either add the farms own energy use, or the energy use of nearby energy consumers. Energy use of the digester is automatically calculated and distracted.

2.3.9.1 HEAT ALLOCATION

Heat and electricity allocation. In this table you can see which part of the produced heat and electricity for the boiler and CHP is allocated with the above provided energy use, and which part is still not used.

Heat allocation	Nett Production	Allocated	Unallocated heat	
Scenarios	[kWh]	[kWh]	[kWh]	[%]
Biogas scenario	1.795.465	1.795.465	0	0
Heat scenario	1.566.204	1.566.204	0	0
CHP Heat scenario	789.436	789.436	0	0
	[kWh]	[kWh]	[kWh]	[%]
CHP Electricity	988.535	50.000	938.535	95

2.3.10 Energy supply to end user

In this part of the tool you can indicate the distance to the end user of the energy that can be substituted. This means that piping to connect biogas plant and the end-user is automatically added to the investments.

Export of energy is to third parties. The installation of piping through public area's is more expensive then though private ground, due to permits and planning permissions. Indicating third party energy export, means including piping through public areas.

The complexity of the trajectory is an indication for the difficulty of the installation. The complexity of the trajectory is [0] for pipes through open fields, and [1] for urban areas. Please specify the complexity for the chosen trajectory. Default complexity is 0,5.

A heat network can operate at different temperatures. The delta T (difference between the incoming and outgoing temperature) is very dependent on the efficiency of the network. You can change the default value (20 degrees) if that better reflects your situation.

2.3.10	Default	Overwrite	Unit
Distance to heat/gas user	2,00	2,00	[km]
Complexity of traject	0,50		[0...1]
ΔT Heat network	20,00		[°C]
Include heat network in CHP case			
Energy export to third party?			

2.3.10.1 BIOMETHANE

To be able to connect to the gas grid, for the feed-in of biomethane, piping should be added and the gas had to be pressurized to the grid pressure. Please fill in the distance to the gas grid, the complexity of this trajectory (default 0,1) and the pressure in the gas grid.

Biomethane 2.3.10.1	Default	Overwrite	
Distance to gas grid	0,10		[km]
Complexity of traject	0,10		[0...1]
Pressure in gas grid	0,13		[bar (g)]

2.3.11 Exploitation subsidies

The tool shows the default values for the exploitation subsidies and the feed-in tariffs of electricity and heat, based on country specific information from the technical partners in the BioEnergy Farm 2 project. You have the possibility to overwrite the values, using the green cells. Please use the unit that is prescribed.

Exploitation subsidies	Default	Overwrite	Unit
Biogas subsidy	-		[EUR/kWh]
Heat subsidy	0,0730		[EUR/kWh]
CHP Electricity subsidy	0,0790		[EUR/kWh]
CHP Heat subsidy	0,0790		[EUR/kWh]
Biomethane subsidy	0,0930		[EUR/kWh]
	Default	Overwrite	Unit
Feed-in tariff Electricity	0,05		[EUR/kWh]
Feed-in tariff biomethane feed-in	0,32		[EUR/kWh]

2.3.12 Heat use digester

The digester needs heat to operate. In the CHP and Heat scenario, part of the heat generated by the biogas boiler or CHP, is used to heat the digester. In the Biogas and Biomethane scenario there is also heat required, and you can choose to generate this heat using biogas or wood chips. Using wood chips means that there is more biogas available to supply to the end user (biogas scenario) or to upgrade to natural gas and feed in to the grid (biomethane scenario), possibly increasing the profits of the installation. Further there is the possibility to overwrite the default wood chips price of your country.

Produce heat using	Biogas		
Price of wood chips	40		[EUR/ton]

2.3.13 Investment subsidy

Investment subsidies can be added to the tool in three (3) ways:

1	Adding a fixed subsidy on the investments
2	Adding a percentage of the total investments
3	Adding both a fixed subsidy and a percentage. With this option, the lowest number will be added, a fixed subsidy maximized by the percentage.

Specify maximum total investment subsidy available	200.000	200.000	[EUR]
AND/OR percentage of total investment	50	50	[% 0..100]

2.3.14 Financial parameters

Here you can change the financial parameters. The default value for your country is given in the brown cell, you can overwrite this value using the green cell next to it.

1	The amortization period (this is assumed to be equal to the subsidy period)

2	Interest rate on the bank loan. The interest rate on the loan is set equal to the discount rate.
3	Financing ratio, the financing ratio describes the share of foreign capital (bank loan) needed for the investment.
4	Labour costs. A biogas installation will demand time to operate, the labour costs describes the hourly rate of the farmer, when operating the biogas plant. The number of hours needed per week is defined based on the layout of the installation

Financial parameters	Default	Overwrite	
Amortization period	12,0		[Year]
Interest/Discount rate	5,0		[% 0..100]
Financing ratio	65		[% 0..100]
Labour costs	30		[EUR/hour]

2.3.15 Summary of the business case

This is the last table of this sheet, and gives a summary of the business case based on the input of all above. You can find detailed overviews of the investments at the Interface_INV, a detailed financial overview of the annual benefits and costs at Interface_FIN, and a cash flow overview at Interface_CF.

Case [EUR]	Biogas	Heat	CHP	Biomethane	
Investments	501.700	647.900	448.400	748.300	[EUR]
Investment subsidy	-200.000	-200.000	-200.000	-200.000	[EUR]
Subsidy percentage	40	31	45	27	[%]
Own contribution	301.700	447.900	248.400	548.300	[EUR]
Ann. Benefits	243.500	208.200	235.600	339.900	[EUR/Year]
Ann. Costs	214.700	221.000	209.600	234.000	[EUR/Year]
Ann. Profit	28.800	-12.800	26.000	105.900	[EUR/Year]
Simple payback time	10	Not profitable	10	5	[Years]

2.4 Digestate treatment (Interface_2)

Interface_2 is the interface sheet where you can select options for digestate treatment. With this sheet you can get a detailed insight in the composition of the fresh manure and digestate, and you can reveal what the compositions of the different fractions are if you where to use a separator.

2.4.1 Land use

In this table the correct placement possibility of Nitrogen and Phosphates can be filled in. This information is used to compare to the output of the digester, meaning that you can see if, with the nutrients from possible added cosubstrates, the digestate can still be placed on the farm fields or needs to be (partially) exported. If the export of manure does not need to be taken into account in the case, these cells can be left empty.

Placement Nitrogen	17.663	[kg N]
Placement Phosphate	7.026	[kg P2O5]
Processing obligations	0	[kg P2O5]

2.4.2 Manure composition

This table presents the input and output of the biogas installation and its nutrients. Further, this table also shows the composition of the separated fractions, if a separator is selected.
In the lower tables, the nutrient placement and nutrient output of the biogas installation is compared, showing if there is an excess of nutrients in the new situation. The excess of nutrients in displayed in terms of digestate, manure, solid and liquid fraction.

n	Manure Input	Cosubstrate Input	Digestate Output	
Mass	8.620	440	8.414	[ton]
Volume	8.534	338	8.064	[m³]
Nitrogen (N)	53.416	-	53.137	[kg N]
Mineralised Nitrogen (Nm)	28.218	-	32.129	[kg Nm]
Phosphate (P2O5)	24.391	-	24.391	[kg P2O5]

ɔn	Solid fraction	Liquid fraction	
Mass	1.430	6.983	[ton]
Volume	2.384	6.983	[m³]
Nitrogen (N)	10.627	42.510	[kg N]
Mineralised Nitrogen (Nm)	970	31.159	[kg Nm]
Phosphate (P2O5)	7.317	17.074	[kg P2O5]

Nitrogen Surplus	35.474	[kg N]
Phosphate Surplus	17.365	[kg P205]
This equals to		
Manure Surplus Nitrogen	5.617	[ton Manure]
Manure Surplus Phosphate	5.990	[ton Manure]
Solid fraction Surplus Nitrogen	4.774	[ton Solid fraction]
Solid fraction Surplus Phosphate	3.394	[ton Solid fraction]

2.4.3 Separator

In this menu, a separator can be selected. Each separator has different properties in terms of separation efficiency on mass, nitrogen and phosphate. The compositions of the solid and liquid fraction is shown above.

1	Centrifuge
2	Screwpress
3	Dissolved air flotation
4	Tumble

Separator	Screwpress

2.4.4 Export of digestate

When adding cosubstrates, more nutrients may be in the digestate then there where in the manure. This could lead to an excess of manure which need to be exported. Please select here if you want to include the export of digestate in the business case, and on what basis. The following scenario's can be selected:

1	Additional digestate from added cosubstrates	Default option: only additional mass, from adding cosubstrates, is exported.
2	Additional digestate from added cosubstrates and supplied manure	Additional mass, from the supply of manure and the addition of cosubstrates, is exported.
3	No	Export of digestate is not included
4	All digestate	All digestate is being exported
5	All surplus digestate	The mineral surplus is being exported, in the form of digestate
6	All surplus solid fraction	The nutrient surplus (phosphate & nitrogen) is being exported, in the from of solid fraction (only possible if a separator is selected)
7	Phosphate surplus digestate	The phosphate surplus is being exported, in the form of digestate
8	Phosphate surplus solid fraction	The phosphate surplus is being exported, in the form of solid fraction (only possible if a separator is selected)

9	Nitrogen surplus digestate	The nitrogen surplus is being exported, in the form of digestate
9	Nitrogen surplus solid fraction	The nitrogen surplus is being exported, in the form of solid fraction (only possible if a separator is selected)

Include export of digestate	Additional digestate from added cosubstrates and supplied manure

2.4.5 Costs of export

In this table, based on the input above, the amount of digestate/solid fraction that has to be exported is shown, with the associated costs. The standard costs of export of manure and solid fraction are shown, and can be overwritten with the green cells.

	Amount	Costs of export		
	[ton/year]	[EUR/ton]	[EUR/ton]	[EUR/Year]
Digestate	5.440	12		65.280
Solid fraction	-	15		-
		Default	Overwrite	

2.5 Investment overview (Interface_INV)

2.5.1 Investment overview

In the Interface_INV sheet, the investment overview is presented. For every component (or group of components) of the biogas installation, the capacity and investment costs are presented here.

2.5.2 Overwrite investments

In this overview, you have the possibility to overwrite the investment costs for each component. This can be used if for example during the process commercial offers for the different components are supplied by the suppliers. Further, additional investments can be added, if you want to include more investments than included in the tool.

2.5.3 Add investment

If you want to add an extra investment, you may do so with this table. Please add the investment in the appropriate scenario.

	Add investment				
2.5.3	Extra investment			15.000	20.000

2.6 Financial results (Interface_FIN)

Ann. Benefits	Biogas	Heat	CHP	Biomethane	Digestate treatment	Overwrite	2.6.3
Avoided purchase of fossil fuel purchase	120.000	120.000	120.000	120.000	120.000	120.000	[EUR/Year]
Sale of electricity	-	-	46.900	-	47.000		[EUR/Year]
Avoided purchase of electricity	-	-	5.100	-	5.100		[EUR/Year]
Sale of Biomethane	-	-	-	81.500	-		[EUR/Year]
Exploitation subsidies	131.100	114.300	135.700	208.200	138.700		[EUR/Year]
Add benefits							
Extra benefits	5.000					[EUR/Year]	
Total benefits	243.500	208.200	235.600	339.900	241.100		[EUR/Year]

Ann. Costs	Biogas	Heat	CHP	Biomethane	Digestate treatment	Overwrite	
Electricity purchase	1.900	1.800	-	7.200	-		[EUR/Year]
Wood chips purchase	-	-	-	-	-		[EUR/Year]
Active carbon	2.600	2.600	2.600	2.600	2.600		[EUR/Year]
Biomass purchase	119.000	119.000	119.000	119.000	119.000		[EUR/Year]
Export of digestate	65.300	65.300	65.300	65.300	65.300		[EUR/Year]
Personnel	9.000	9.000	10.500	10.500	10.500		[EUR/Year]
Maintenance	9.200	12.200	5.600	15.900	5.700		[EUR/Year]
Insurance	2.000	2.600	1.800	3.000	1.800		[EUR/Year]
Annuity	5.800	8.600	4.700	10.500	4.700		[EUR/Year]
Add costs							
						[EUR/Year]	
Total costs	214.700	221.000	209.600	234.000	209.600		[EUR/Year]

2.6.1 Benefits and Costs

The Interface_FIN sheet, shows the summarized financial result of the scan. Here you can find an overview of all the costs and benefits of the biogas plant, with the layout selected in the interface_1 and Interface_2 sheet. The results are mainly based on the first year of production. For some more extensive results, please check the exploitation overview.

2.6.2 Add benefits and costs

If you want to add costs or benefits to the exploitation, you may do so with this table.

Add benefits	
Extra benefits	5.000

2.6.3 Overwrite benefits and costs

In some cases, the user may want to overrule the tool calculations. All costs and benefits, generated by the tool, can be overwritten using these green cells on the right. Entering a value here, overwrites the benefits or costs calculated by the tool for all the scenario's. If the cell is cleared again, the tool will go back to use the original value.

Ann. Benefits	Biogas	Overwrite	2.6.3
Avoided purchase of fossil fuel purchase	120.000	120.000	[EUR/Year]

2.7 Cash flow (Interface_CF)

This sheet shows the cash flow overview, to show the movement of money in and out of the business. The cash flow is based on the summarized benefits and costs, shown in the Interfacen_FIN, enhanced with the interest and taxations.

2.7.1 Select scenario

The cash flow is only shown for one (1) scenario. Therefore one of the five scenarios in the tool need to be selected here. This selection will also apply for the business plan connection and sensitivity analysis.

2.7.1	Select scenario	CHP

2.7.2 Redemption

In the Interface_FIN sheet, the average interest over de full length of the project is calculated, based on annuity redemption. In the cash flow, a choice can be made between annuity or linear redemption.

2.7.2	Redemption	Annuity

2.8 Digester properties (Interface_Digester)

The Interface_digester gives the possibility to alter the digester properties related to the thermal energy use of the digester. There are possibilities to change the layout from a standard CSTR with membrane roof to a tower digester, and the standard dimensions, generated by the tool, can be adapted, as well as the insulation values.

2.8.1 Type of digester

In this menu the digester layout can be changed. The default option is a CSTR with a double membrane roof, and can be changed to a tower digester. The tower digester is characterized by full body insulation, where as membrane roof typically have high transmission losses.
Apart from the type of digester, the diameter of the tank can be overwritten. Changing the tank diameter will not change the volume of the tank, and therefore does change the height of the digester tank, subsequently changing the insulated and non insulated areas. The volume of the digester is determined by the retention time of the substrates, and can be changed at the Interface_1.

Type of digester	A CSTR digester liquid manure		
	Default	Overwrite	Unit
Diameter	16		[m]
Height	4		

2.8.2 Temperatures

In this table you can review and change the used temperatures for the calculations. The default values for the selected region are shown in brown, you can overrule these defaults in the green cells. Be aware that the energy losses of the installation, and thereby also the used temperatures, can have a significant impact on the case.

Temperatures			
Average ambient temperature	10	9,8	°C
Minimum ambient temperature	-10		°C
Temperature in digester	38		°C
Average temperature feed	10		°C

2.8.3 Thermal losses

The thermal losses of the digester are dependent on: temperatures, dimensions of the digester and the insulation of the digester. In this table, the size of the surfaces of the digester, generated by the tool, can be overwritten. Next to this, the U-values of the structures can be changed if necessary, to better represent the future situation.

Please note that the dimensions of the digester are connected to the thermal losses of the digester, not to the digester volume. The digester volume can be changed at Interface_1.

Thermal losses	Dimensions digester [m²]		U-value structure [W/(m².K)]		Thermal losses [kW]	
	Default	Overwrite	Default	Overwrite	Average	Maximal
Floor	210		0,260		1,5	1,5
Walls	206		0,253		1,5	2,5
Roof	252		2,273		16,2	27,5
			Total Thermal losses		19,2	31,5
			Losses biogas		1,2	1,2
			Heating substrates		31,6	31,6
			Total heat use installation [kW]		51,9	64,3
			Total heat use installation [GJ/yr]		1.638	

Please note: U-value, or thermal transmittance, is the overall heat transfer coefficient, the rate of transfer of heat (in watts) through one square metre of a structure divided by the difference in temperature across the structure. It is expressed in watts per metres squared kelvin, or W/m².K. Well-insulated parts of the digester have a low thermal transmittance whereas poorly insulated parts of the digester have a high thermal transmittance.

2.9 Manure substrate database (Substrates_manure)

The tool includes two (2) substrate sheets, the substrate_manure and the substrate_cosubstrate sheet. These sheets contain the specifications of the substrates which are included in the tool for manure and cosubstrates respectively. The substrate specifications are controlled by the technical partner of each country. However, every user has the possibility to add a new substrate in the green cells. Below you can find the tables with the substrate parameters, their unit, and a short explanation.

Manure substrates are divided in 5 categories/species: Cows, Bulls, Pigs, Poultry and other. Each species has several animal types, and every animal type can have liquid of solid manure. To add a manure substrate, select one of the species in the species column, and create a unique species/animal type name. Then add all the 15 substrate parameters. Only fully entered entries will appear in the interface.

Species	Manure substrates are divided in 5 categories/species: Cows, Bulls, Pigs, Poultry and other. Select one of the 5 species from the drop-down menu.
Species type	Create a unique species/animal type name. (E.g. "Productive Dairy cows")
Substrate type	The substrate type can be "solid" or "liquid". Each species/animal type name can have 1 solid, and 1 liquid substrate.
C1_Manure production	Manure production of the animals in [ton/year]. This is the average yearly manure production of an animal or animal place.
C2_Rel_dens	Relative density of the substrate, expressed in [ton/m³].
C3_Dry matter	Dry matter content of the substrate based on mass, in [%] (value between 0 and 100)
C4_ODM	Organic dry matter content of the substrate, based on mass, in [%] (value between 0 and 100)
C5_Biogas_pot_low	Biogas potential of the substrate, based on ODM, for non-fresh manure. Expressed in [m³/kg ODM]
C6_Biogas_pot_med	Biogas potential of the substrate, based on ODM, for day-fresh manure. Expressed in [m³/kg ODM]
C7_Methane_content	Methane content of the biogas from this substrate, based on volume of the biogas. Expressed in [%], value between 0 and 100.
C8_Carbon dioxide	Carbon dioxide content of the biogas from this substrate, based on volume of the biogas. Expressed in [%], value between 0 and 100. (typically, this is 100-1-C7_methane_content)
C9_Retention time	Retention time of the substrate, used to define the digester size. Expressed in [Days].
C10_Slib	Silb content (crude ash) of the substrate, based on mass, in [%] (value between 0 and 100)
C11_Potassium	Potassium content of the manure, based on mass, in [%] (value between 0 and 100)
C12_Phosphate	Phosphate content of the manure, based on mass, in [%] (value between 0 and 100)
C13_Organic bound nitrogen	Organic bound nitrogen content of the manure, based on total mass, in [%] (value between 0 and 100)
C14_Mineralised nitrogen	Mineralised nitrogen content of the manure, based on total mass, in [%] (value between 0 and 100)
C15_CO2 uptake	CO2 uptake of the substrate, expressed in [kg/ton]

2.10 Cosubstrate database (Substrates_cosubstrates)

The tool includes two (2) substrate sheets, the substrate_manure and the substrate_cosubstrate sheet. These sheets contain the specifications of the substrates which are included in the tool for manure and cosubstrates respectively. The substrate specifications are controlled by the technical partner of each country. However, every user has the possibility to add a new substrate in the green cells. Below you can find the tables with the substrate parameters, their unit, and a short explanation.

Cosubstrates are divided into two (2) types: Liquid and solid. Adding liquid cosubstrates to the digesters requires a different installation layout than adding solid cosubstrates to the digester. Every substrate has a unique name, and has the below defined substrate parameters. To add a cosubstrate, create a unique name for the substrate, and select the substrate type. Then add all the 16 substrate parameters. Only fully entered entries will appear in the interface.

Substrates	Cosubstrate name. Should be a unique name for the substrate to appear in the interface.
Substrate type	The substrate type can be "solid" or "liquid". Each substrate name can have 1 solid, and 1 liquid substrate.
C1_Production	In case of crops; indicate here the production of this crop, to give an indication on the required agricultural land.
C2_Rel_dens	Relative density of the substrate, expressed in [ton/m³].
C3_Dry matter	Dry matter content of the substrate based on mass, in [%] (value between 0 and 100)
C4_ODM	Organic dry matter content of the substrate, based on mass, in [%] (value between 0 and 100)
C5_Biogas_pot_default	Biogas potential of the substrate, based on ODM. Expressed in [m³/kg ODM]
C6_Methane_content	Methane content of the biogas from this substrate, based on volume of the biogas. Expressed in [%], value between 0 and 100.
C7_Carbon dioxide	Carbon dioxide content of the biogas from this substrate, based on volume of the biogas. Expressed in [%], value between 0 and 100. (typically, this is 100-1-C7_methane_content)
C8_Retention time	Retention time of the substrate, used to define the digester size. Expressed in [Days].
C9_Slib	Silb content (crude ash) of the substrate, based on mass, in [%] (value between 0 and 100)
C10_Potassium	Potassium content of the manure, based on mass, in [%] (value between 0 and 100)
C11_Phosphate	Phosphate content of the manure, based on mass, in [%] (value between 0 and 100)
C12_Organic bound nitrogen	Organic bound nitrogen content of the manure, based on total mass, in [%] (value between 0 and 100)
C13_Mineralised nitrogen	Mineralised nitrogen content of the manure, based on total mass, in [%] (value between 0 and 100)
C14_CO2 uptake	CO2 uptake of the substrate, expressed in [kg/ton]
C15_Cost estimation low	When selecting a substrate, a cost estimation for the substrate will appear. This estimation is a range of prices for which the substrate is available in your country. This is the lower limit of this price. [EUR/ton] (also when other currencies are selected)
C16_Cost estimation high	Higher limit of the cost estimation [EUR/ton] (also when other currencies are selected)

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