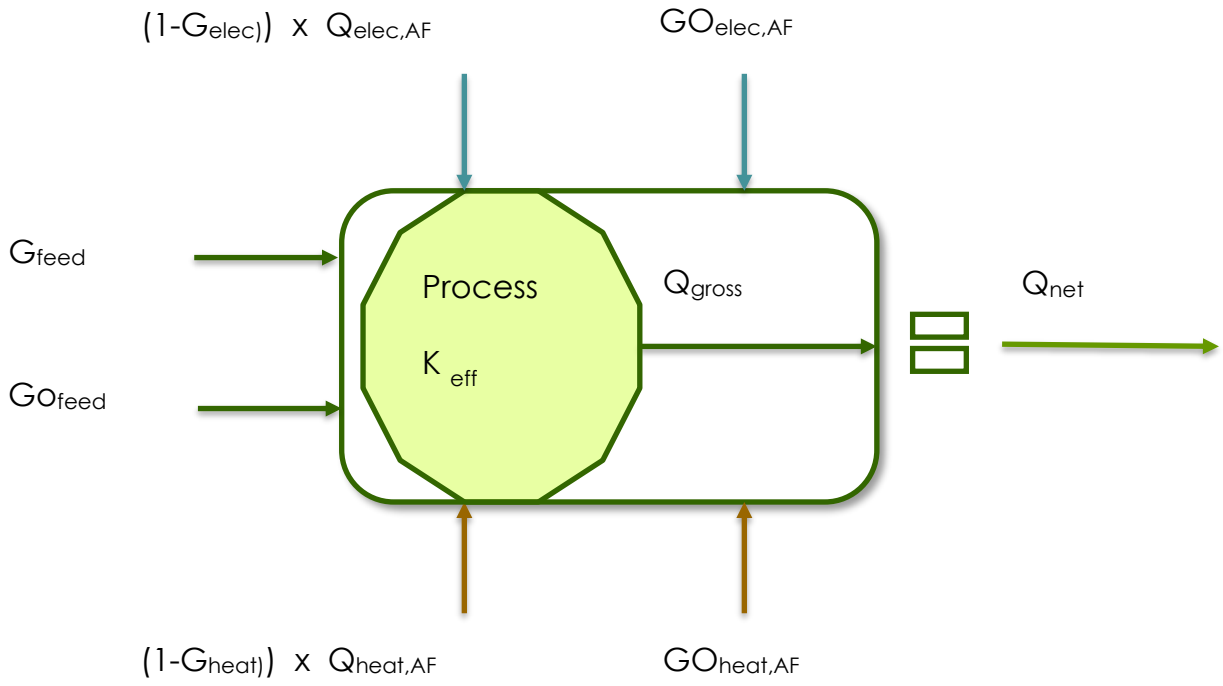
1 CALCULATION METHODOLOGY FOR GREEN-GAS PRODUCTION

The basis of the calculation methodology used to determine the quantity of green gas produced that is eligible for a guarantee of origin (GO) is laid down in the modified Flemish Government decree amending the Energy Decree of 19 November 2010 with regard to guarantees of origin for gas, heat and cold, which was published in the *Belgisch Staatsblad* (Belgian Official Gazette) on 7 August 2019 and came into force on 17 August 2019.

1.1 GENERAL REMARKS

The calculation methodology is intended to determine the volume of energy (Qnet in kWh) that can be allocated to the renewable share of the gas produced (green gas) on the basis of:

- the measured gas production;
- after deduction of non-renewable energy flows for own use which are relevant for the production of green gas (auxiliary flows);
- taking into account the green factor of the input flows (feedstock or primary fuel);
- plus the submitted guarantees of origin, taking into account the efficiency of the conversion in the processes, and provided that the submitted guarantees are valid at the time of production and are the right type.



$$Q_{net} = [Q_{gross} x G_{feed}] + [GO_{feed} x K_{eff}] - [(1-G_{heat,AF}) x Q_{heat,AF} x G_{feed}] + GO_{heat,AF} - [(1-G_{elec,AF}) x Q_{elec,AF} x G_{feed}] + GO_{elec,AF}$$

Legend:

- G_{feed} The green factor (%) of the input flow
- $G_{heat,AF}$ The green factor (%) of auxiliary flows of heat
- $G_{elec,AF}$ The green factor (%) of auxiliary flows of electricity
- Q_{net} The net volume (kWh) calculated for the issue of a number of GOs
- Q_{gross} The gross volume (kWh) of measured gas production
- $Q_{heat,AF}$ The volume (kWh) of auxiliary flows of heat required for the process
- $Q_{elec,AF}$ The volume (kWh) of auxiliary flows of electricity required for the process
- K_{eff} The efficiency factor (%) of the process
- UCV The upper calorific value (in kWh $^{(25°C)}/m^3(n)$) used for all kWh
- GO_{feed} The number of GOs for feedstock (in kWh $_{UCV}$)
- $GO_{heat,AF}$ The number of GOs for auxiliary flows of heat (in kWh $_{UCV}$)
- $GO_{elec,AF}$ The number of GOs for auxiliary flows of electricity (in kWh $_{UCV}$)

Auxiliary flows are the utility supplies solely used in the process of producing green gas. The utility supplies used to pre-treat the input flow (pre-treatment flows) are not considered auxiliary flows and are therefore not counted as deductions in the calculation of the net volume that qualifies for GOs.

K_{eff} is only relevant when using GOs that serve to 'green' the primary fuels used as an input flow (feedstock) for the production of renewable gas (e.g. production of green hydrogen from electricity by using GOs for green electricity).

The net volume of green gas is calculated on a monthly basis; this calculation always covers the entire month. Therefore, the underlying parameters are also the parameters for an entire month. The calculation procedure for month M is suspended until all parameters (including underlying parameters) have been validated. If a statistical parameter (such as a green factor) has not been approved by the production registrar, it is deemed not to have been validated.

The production registrar has the right to check, at its own initiative, the validity and assignment of the conditions and parameters described in this document.

1.2 DETERMINING THE GREEN FACTORS

The green factor for a specific energy carrier is determined by working out the ratio of the renewable share of a flow to the total flow, where:

- the renewable source of the energy carrier in question can be linked directly to the process, making it impossible for GOs to be claimed for any other purpose;

- GOs are not applied;
- the green factor can never exceed 100%, and only applies to the specific energy carrier.

The green factor of the input flows can be determined by default or based on the biomass ratio.

- For determination by default, a fixed percentage is assumed that is demonstrably from a renewable source (e.g. 47.78% for the combustion of household waste) and is substantiated by the auditor or by the legal basis.
- For determination based on the biomass ratio, reference is made to the OVAM [1] regulations on the determination of the green factor for input flows.
- Where a producer produces its own renewable energy (heat, electricity, gas) on its site but does not ask to be issued GOs for this energy, the producer may use this energy to increase the corresponding green factors for its auxiliary flows. However, this can only be done with respect to the equivalent energy carrier and must be demonstrable during the auditor's audit.

The validity of (period covered by) the green factor can range from one month to two years (the maximum validity of an inspection report). This depends on the extent to which the green factor can vary. The validity of each green factor is determined by the production registrar based on the opinion of the auditor responsible for the applicable inspection report or of OVAM (where applicable).

The producer and its auditor submit a proposal to the production registrar concerning the determination and validity of the green factors based on the specific characteristics of the facility. Insofar as possible, efforts are made to achieve fixed, safe values that will be valid for longer periods. The approved green factors may be amended by the production registrar or at the request of the producer during the validity period of the inspection.

In the event of a major change (impacting the green factors) in the biomass supplied, an auditor must recalculate the green factors. The calculation of net green energy is suspended until the green factors are approved.

Concerning the non-renewable share of an energy flow, the producer can submit valid GOs for the relevant energy carrier up to the maximum amount of the input flow. Thus, a GO for green power can only be used for electricity consumption.

1.3 DETERMINING THE MEASURED VOLUMES

All relevant and available measurements shall be calibrated in line with the applicable, required rules. The auditor reports on this in the inspection report.

1.3.1 DETERMINING THE GROSS MEASURED VOLUME OF GAS

[1] OVAM : Openbare Vlaamse Afvalstoffen Maatschappij (The Public Waste Agency of Flanders)

The Q_{gross} is measured on a monthly basis (monthly resolution) in kWh at the UCV. If they are measured remotely by the system operator (remote measurements), the operator will forward the data to the production registrar. If not, the producer must enter the data into the production registrar's system (manual measurements).

- With regard to remote measurements of production, the system operator sends the validated value in kWh, as known two months after the production month, to the production registrar, who will register the value for the production month. The measured monthly value cannot deviate by more than 10% from the producer's maximum production capacity, based on the facility's nominal capacity and the number of hours in the month.
- For manual measurements, the producer enters the data per production month. The measurement value entered in the system cannot deviate from the producer's maximum production capacity by more than 10%.

Remotely or manually measured values may not be entered more than six months after the production month. Any adjustments (upwards or downwards) for a production month can be applied to the last month that has not yet been processed. Processing is activated by the production registrar as soon as a final volume is entered and reported to the production coordinator (VREG[2]).

1.3.2 DETERMINING THE AUXILIARY FLOW VOLUMES

The determination of auxiliary energy flow volumes is split into heat and electricity. These can be determined in two ways:

- Using meters
- Using a default factor

Metering is recommended for large facilities that use considerable volumes of energy for the process, or where auxiliary flows of energy come from an energy-carrying grid. The producer can choose to enter these values on a monthly basis as volumes of auxiliary flows of electricity and/or heat.

Alternatively, the producer can use a default efficiency factor for auxiliary flows for electricity ($K_{elec,AF}$) and/or heat ($K_{heat,AF}$) if there is a sufficiently linear correlation between the consumption of auxiliary flows and the gross volume of gas produced (Q_{gross}). The default efficiency factor applies to $Q_{gross,GG}$ and is determined and verified by the auditor.

- For heat: $Q_{heat,AF} = K_{heat,AF} \times Q_{gross}$
- For electricity: $Q_{elec,AF} = K_{elec,AF} \times Q_{gross}$

This default factor method for auxiliary flows is definitely preferred if the green factor of the auxiliary flows in question is greater than 75%. A conservative approach is always adopted when determining the default factor. If the producer believes that it is entitled to a better factor, hecan request this by submitting demonstrable measurements.

[2] VREG: Vlaamse Regulator Elektriciteit en Gas (Energy Regulator in Flanders)

1.3.3 CALCULATING THE NET VOLUME OF GREEN GAS

The net volume of green gas in kWh is calculated using the basic formula once all the associated parameters have been validated.

The equivalent GO volume Q^{M}_{GG} in MWh for the month ^{M} is determined as follows:

$Q^{M}_{GG} = ((Q^{M}_{net} + Q^{M-1}_{rem} + Q^{M}_{adj})/1000)$

Where Q^{M}_{GG} is rounded down

Legend:

- Q^{M}_{GG} The volume in MWh eligible for green-gas GOs in month ^{M}
- Q^{M}_{adj} The adjustment in kWh applied in month ^{M}
- Q^{M-1}_{rem} The remainder (in kWh) from rounding to MWh in the previous month ($^{M-1}$)

Once this calculation is complete, the production registrar submits this Q^{M}_{GG} volume to the production coordinator, who allocates the calculated number of GOs.

1.4 APPLYING GARANTEES OF ORIGIN

GOs for a given energy carrier can only be applied if they have not expired.

1.4.1 FOR INPUT FLOWS

GOs for a given energy carrier can be used to increase the green factor of the input flows of said energy carrier, provided an efficiency factor K_{eff} is taken into account.

- A default efficiency factor of the renewable gas production process is determined by the production registrar based on information provided by the producer and its auditor – this factor remains valid while the corresponding inspection report is valid. A conservative approach is always adopted when determining the default factor. If the producer believes that it is entitled to a better factor, he can request this by submitting demonstrable measurements.
- Alternatively, the efficiency factor is determined on the basis of the primary fuel used as an input flow for gas production, as measured on a monthly basis.

When determining the maximum number of GOs that can be applied in order to fully green the input flows, the efficiency factor of the main process K_{eff} needs to be taken into account (e.g. when using electrolysis to convert electricity into green hydrogen, the average efficiency is 70%).

1.4.2 FOR AUXILIARY FLOWS

The efficiency factor is not taken into account in the application of GOs for auxiliary flows because smaller volumes are involved and also it is assumed that the best available technique was used in the construction.

The GOs for green heat (GO_{GH}) expressed in MWh $_{LCV}$ (LCV: lower calorific value) should be converted to MWh $_{UCV}$ (UCV: upper calorific value) by dividing the GO_{GH} by 0.903.

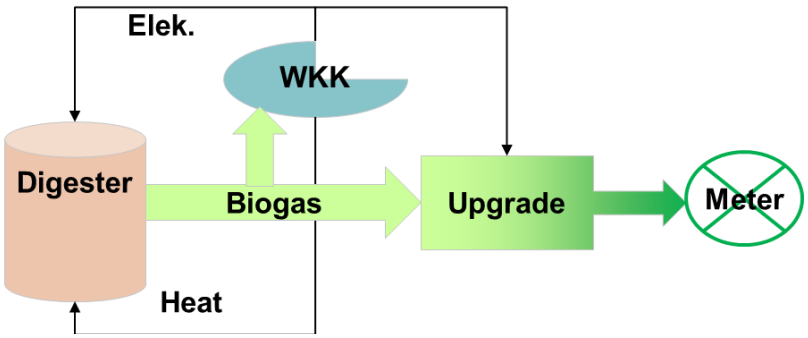
The number of GOs applied for a corresponding auxiliary flow must not exceed the total consumption of auxiliary flows.

2 ANNEX A: CASE STUDIES

These examples are not binding for the production registrar and each case will be assessed individually via the inspection report.

2.1 CASE STUDY 1: BIOMETHANE PRODUCTION WITH OWN BIOGAS-FUELLED CHP

As a rule, biomethane producers always ensure that their input flows are renewable under the OVAM protocol. Green factor for feedstock = 100%



Legend	
On the graph	**Translation**
Digester	Digester
Elek.	Elec.
WKK	CHP
Biogas	Biogas
Upgrade	Upgrade
Meter	Meter
Heat	Heat

- $G_{feed,}$ 100% (demonstrated based on OVAM report)
- $G_{heat,AF}$ 95% (chosen default factor)
- $G_{elec,AF}$ 90% (chosen default factor)
- Q_{gross} 1000 MWh
- $Q_{heat,AF}$ 3 MWh
- $Q_{elec,AF}$ 2 MWh
- $K_{heat,AF}$ 0.3%
- $K_{elec,AF}$ 0.2%

Q_{net} = (1000 MWh x 100%)
– (1-95%) x (0.3% x 1000 MWh) x 100%
– (1-90%) x (0.2% x 1000 MWh) x 100%

QM = 999.650 MWh

QM_{GG} = 999 MWh

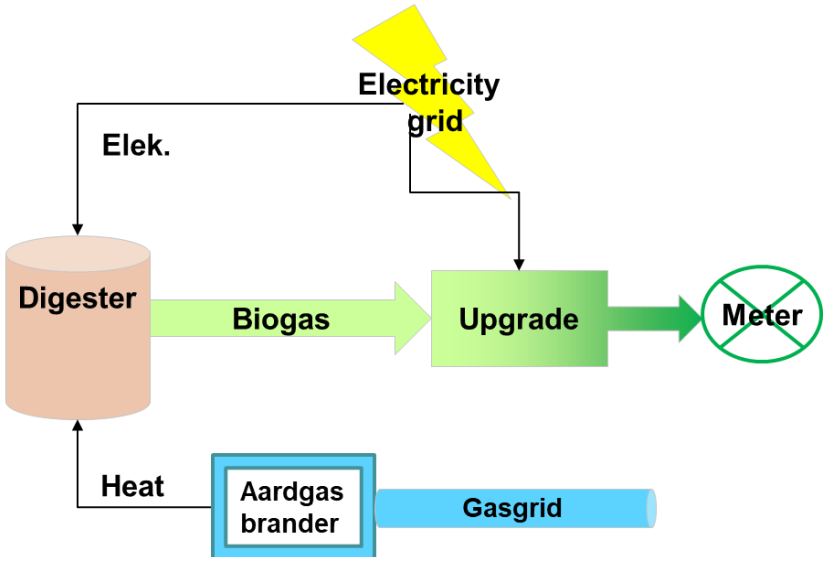
QM_{rem} = 0.650 MWh

The net and gross volumes are very close in such a case and could almost be identical if the green factors for auxiliary flows were even higher.

2.2 CASE STUDY 2: BIOMETHANE PRODUCTION WITHOUT BIOGAS-FUELLED CHP

As a rule, biomethane producers always ensure that their input flows are renewable under the OVAM protocol. Green factor for feedstock = 90%

2.2.1 CASE STUDY 2.1: WITHOUT GOS FOR OWN CONSUMPTION



Legend	
On the graph	**Translation**
Digester	Digester
Elek.	Elec.
WKK	CHP
Biogas	Biogas
Upgrade	Upgrade
Meter	Meter
Heat	Heat
Electricity grid	Electricity grid
Aardgas	Natural gas
brander	burner
Gasgrid	Gas grid

- $G_{feed,}$ 90% (demonstrated based on OVAM report)
- $G_{heat,AF}$ 0% (chosen default factor)
- $G_{elec,AF}$ 0% (chosen default factor)
- Q_{gross} 1000 MWh
- $Q_{heat,AF}$ 3 MWh
- $Q_{elec,AF}$ 2 MWh
- $K_{heat,AF}$ 0.3%
- $K_{elec,AF}$ 0.2%

Q_{net} = (1000 MWh x 90%)
– (1-0%) x (0.3% x 1000 MWh) x 90%
– (1-0%) x (0.2% x 1000 MWh) x 90%

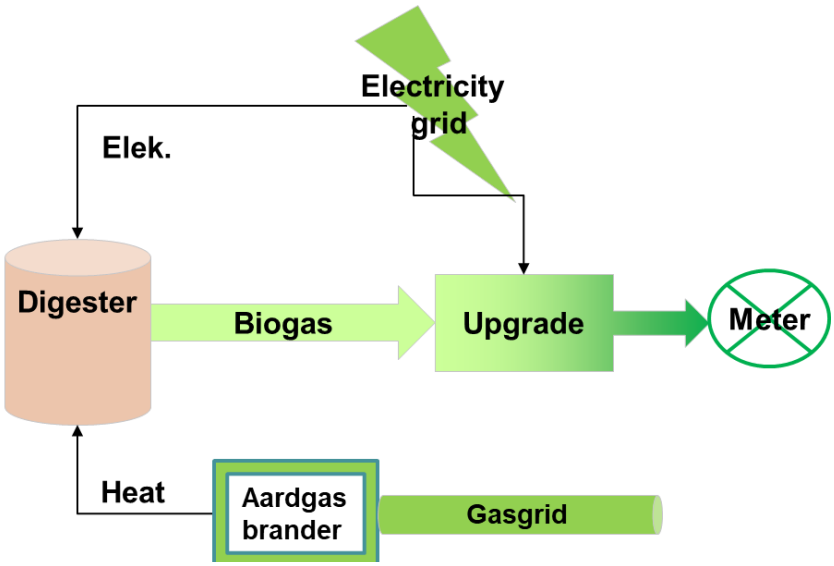
QM_{net} = 895.500 MWh

QM_{GG} = 895 MWh

QM_{rem} = 0.500 MWh

By not using green energy for the auxiliary flows, the producer loses 90% of the 5 MWh (auxiliary flow consumption) for the determination of its green gas volume eligible for GOs.

2.2.2 CASE STUDY 2.2: WITH GOS FOR OWN CONSUMPTION



Legend

On the graph	Translation
Digester	Digester
Elek.	Elec.
WKK	CHP
Biogas	Biogas
Upgrade	Upgrade
Meter	Meter
Heat	Heat
Electricity grid	Electricity grid
Aardgas	Natural gas
brander	burner
Gasgrid	Gas grid

- G_{feed} 90% (demonstrated based on OVAM report)
- $G_{heat,AF}$ 0% (chosen default factor)
- $G_{elec,AF}$ 0% (chosen default factor)
- $GO_{elec,AF}$ 1.8 MWh (elec GO applied for auxiliary flow)
- Q_{gross} 1000 MWh
- $Q_{heat,AF}$ 3 MWh
- $Q_{elec,AF}$ 2 MWh
- $K_{heat,AF}$ 0.3%
- $K_{elec,AF}$ 0.2%

Q_{net} = (1000 MWh x 90%)
– (1-0%) x (0.3% x 1000 MWh) x 90%
– (1-0%) x (0.2% x 1000 MWh) x 90% + 1.8 MWh

QM_{net} = 897.3 MWh

QM_{GO} = 897 MWh

QM_{rem} = 300 kWh

By using and demonstrating green energy for the auxiliary flow consumption, the producer loses virtually no green gas production.

3 ANNEX B: CALCULATION PARAMETER FORM

This form is only an example; the latest version is available on the production registrar's website.

Information form – Parameters of calculation methodology for green-gas production – Producer				
General information				
Item			**Value**	**Substantiation or comment**
Production site				
Address				
Person responsible for registration				Authorised for the company/site
Type of facility				
Type of green gas				Biomethane/hydrogen/other
Injection of gas into system (if relevant)				System name (if applicable)
Calculation parameters				
Item	**Code**	**Unit**	**Value**	**Substantiation or comment**
EAN number of production meter	EAN nr	#		
Feedstock green factor	G_{feed}	%		To be determined via proof of origin for biomass or OVAM report
Green factor for heat auxiliary flow	$G_{heat, AF}$	%		To be substantiated in auxiliary flow report
Green factor for electricity auxiliary flow	$G_{elec ;AF}$	%		To be substantiated in auxiliary flow report
Default factor for heat auxiliary flow	$K_{heat, AF}$	%		To be substantiated in auxiliary flow report
Default factor for electricity auxiliary flow	$K_{elec, AF}$	%		To be substantiated in auxiliary flow report
Efficiency factor for converting feedstock into produced gas	K_{eff}	%		In inspection report (only relevant if GOs are used for the feedstock)