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Biogas — Biogas production, conditioning, upgrading and utilization — Terms, definitions and classification scheme

Biogaz — Production, traitement, épuration et utilisation du biogaz — Termes, définitions et classification

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 255, *Biogas*.

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Introduction

The technical committee on biogas (ISO/TC 255) was established in 2011 in order to

— provide liberalization and facilitation for international trade of biogas installations,

— contribute to international cooperation on technical regulations, standards and assessment procedures,

— curb discriminatory technical requirements as the main form of trade protectionism, and

— reduce and eliminate the technical barriers for international trade of biogas installations.

This document about terms, definitions and classifications is applicable for biogas production by anaerobic digestion, gasification from biomass and power to gas from biomass sources, biogas conditioning, biogas upgrading and biogas utilization.

The availability of a set of agreed terms and definitions for biogas installations, as well as a classification scheme for the whole biogas chain, is necessary in order to

— moderate the communication between the different biogas parties through meaningful discussions,

— facilitate development of regional and national regulations and incentive programs to promote biogas production and application,

— contribute to the reinforcement of biogas installations' safety and business competitiveness with recognized terms and definitions that clarify the actors' expectations related to procurement, contracts and services as well as reporting on biogas related action plans and road maps, and

— contribute to the use of standards by facilitating their development and furthering the users' understanding and application of standards.

ISO/TC 255 intends to promote international technology exchange and to accelerate international application of biogas (products) and equipment by developing and maintaining globally harmonized standards.

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Biogas — Biogas production, conditioning, upgrading and utilization — Terms, definitions and classification scheme

1 Scope

This document defines terms and describes classifications related to biogas production by anaerobic digestion, gasification from biomass and power to gas from biomass sources, biogas conditioning, biogas upgrading and biogas utilization from a safety, environmental, performance and functionality perspective, during the design, manufacturing, installation, construction, testing, commissioning, acceptance, operation, regular inspection and maintenance phases.

Biogas installations are, among others, applied at industrial plants like food and beverage industries, waste water treatment plants, waste plants, landfill sites, small scale plants next to agricultural companies and small scale household installations.

The following topics are excluded from this document:

— boilers, burners, furnaces and lightening, in case these are not specifically applied for locally produced biogas;

— gas-fuelled engines for vehicles and ships;

— the public gas grid;

— specifications to determine biomethane quality;

— transportation of compressed or liquefied biogas;

— transportation of biomass or digestate;

— assessment and determination whether biomass is sourced sustainably or not.

This document describes the following for information purposes as well:

— the parameters to determine the size (e.g. small, medium-sized, or large scale);

— the parameters to determine the type of installation (e.g. domestic, industrial);

— the parameters to describe the type of technique;

— terms and processes in order to develop health, safety and environmental protection guidelines for biogas installations.

NOTE For an explanation of the Scope, see Annex A.

2 Normative references

There are no normative references in this document.

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3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
anaerobic digestion
biological conversion of biodegradable materials by micro-organisms in the absence of oxygen creating two main products: *biogas* (3.2) and *digestate* (3.19)

Note 1 to entry: An example of anaerobic digestion is the biological conversion of the biodegradable parts of *biomass* (3.9) sources, but also fossil biodegradable sources.

Note 2 to entry: Wet and dry anaerobic digestion systems are applied.

3.2
biogas
gas produced by anaerobic digestion of organic matter, *gasification* (3.25) of *biomass* (3.9) or power to gas from biomass sources and without further upgrading or purification

Note 1 to entry: Biogas comprises mainly methane and carbon dioxide and/or hydrogen and/or carbon monoxide and/or heavier hydrocarbons with two till six carbon atoms.

Note 2 to entry: *Bio-syngas* (3.15) is also a type of biogas.

3.3
biogas boiler
boiler which uses *biogas* (3.2) as fuel

3.4
biogas flare
installation to burn *biogas* (3.2), whether superfluous or not

Note 1 to entry: A flare is applied for biogas generated in *biogas installations* (3.5) or extracted from landfill sites, among others, to avoid methane and/or hazardous compounds to be emitted into the atmosphere. A biogas flare can be applied as safety, environmental and/or process device.

Note 2 to entry: A typical flare consists of, among others, an ignition system, flame and temperature detection system, windproof body and combustion chamber, biogas piping, valves, condensate drainage, electrical control cabinet, installation fixtures, burner head, heat insulation and pilot or ignition burner.

Note 3 to entry: A flare can be classified in three main categories: *open flare* (3.43), *enclosed flare* (3.23) and *enclosed high efficiency flare* (3.24).

3.5
biogas installation
installation including its pipelines, pipes and accessories for anaerobic digestion of *biomass* (3.9), *gasification* (3.25) of biomass and waste, upgrading of *biogas* (3.2), liquefaction of biogas, storage of biogas (in raw, gas or liquid form), storage of CO_2, storage of auxiliaries, storage of biomass and *digestate* (3.19)

Note 1 to entry: Upgrading of biogas includes cooling, compressing, heating, separation, reaction in order to purify or upgrade the biogas to a higher methane percentage.

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3.6
biogas pipeline
system of pipework for transportation of *biogas* (3.2) or *biomethane* (3.12) with all associated equipment and stations up to the point of delivery and outside the *biogas installation* (3.5)

Note 1 to entry: This pipework is mainly below ground, but includes also above-ground parts.

3.7
biogas storage
buffer, gas holder, tank, vessel, bag or similar to store *biogas* (3.2)

Note 1 to entry: The biogas storage can be part of the fermenter.

3.8
biogenic content
organic material from *biomass* (3.9)

3.9
biomass
material of biological origin excluding material embedded in geological formations and/or transformed to fossilized material

Note 1 to entry: Biomass is organic material that is plant-based or animal-based, including, but not limited to dedicated energy crops, agricultural crops and trees, food, feed and fibre crop residues, aquatic plants, alga, forestry and wood residues, organic agricultural, animal and processing by-products, agricultural, municipal and industrial organic waste and residues whether or not in landfills, sludge, waste water, and other non-fossil organic matter.

3.10
biomass pipeline
digestate pipeline
system of pipework for transportation of liquid *biomass* (3.9) or *digestate* (3.19) with all associated equipment and up to the point of delivery

3.11
biomass pretreatment
treatment of *biomass* (3.9) with chemical, physical, thermal and biological methods in order to increase methane production when the biomass is digested or gasified

3.12
biomethane
methane-rich gas with the properties similar to natural gas derived from *biogas* (3.2) produced by anaerobic digestion or *gasification* (3.25) or from power to gas by upgrading

Note 1 to entry: Requirements for chemical and physical properties of biomethane, such as heat content, flame characteristics, dew points, traces of chemical compounds, are part of standards for injection of biomethane in public grids and standards for vehicle fuels and are not in the scope of, and thus not described by, this document.

Note 2 to entry: In the business, the term “upgraded biogas” is also used instead of the term "biomethane”.

3.13
biomethane potential of biomass
potential of *biomethane* (3.12) production expressed in normal cubic metres per tonne dry matter of *biomass* (3.9)

3.14
biomethane storage
buffer, gas holder, tank, vessel, cylinder or similar to store *biomethane* (3.12)

Note 1 to entry: In case of liquefied biomethane, this often concerns vacuum insulated tanks.

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3.15
bio-syngas
type of *biogas* (3.2), comprising principally carbon monoxide and hydrogen, obtained from *gasification* (3.25) of *biomass* (3.9)

Note 1 to entry: Bio-syngas also contains traces of methane and carbon dioxide.

3.16
combined heat and power installation
CHP
gas engine, pilot spark ignition engine, gas turbine or fuel cell using gas to generate electrical power and useful heat at the same time

Note 1 to entry: This is also called co-generation.

3.17
compressed biomethane
CBM
biomethane (3.12) used as a fuel for vehicles or for other purposes, typically compressed up to 20 000 kPa in the gaseous state

3.18
compressed natural gas
CNG
natural gas (3.39) used as a fuel for vehicles or other purposes, typically compressed up to 20 000 kPa in the gaseous state

[SOURCE: ISO 14532:2014, 2.1.1.11, modified — the definition has been revised and Note 1 to entry has been deleted.]

3.19
digestate
remaining effluent from the anaerobic digestion process including solid fraction and liquid fraction

3.20
digester
anaerobic digestion installation including reactors, tanks and related equipment

3.21
dry matter
remaining part of *biomass* (3.9) or *digestate* (3.19) after the removal of water

3.22
emergency flare
biogas flare (3.4) which is meant to combust *biogas* (3.2) during exceptional situations when the biogas is not utilized

Note 1 to entry: Emergency flares can be of the type *enclosed flare* (3.23), *enclosed high efficiency flare* (3.24) or *open flare* (3.43).

3.23
enclosed flare
biogas flare (3.4) which consists of an enclosed combustion chamber, where the flame is invisible from the outside

Note 1 to entry: An enclosed flare is burning more efficiently with a relatively higher temperature than an *open flare* (3.43), and the burning temperature can be monitored.

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3.24
enclosed high efficiency flare
biogas flare (3.4) which consists of an enclosed combustion chamber, where the flame is invisible from the outside and the biogas is combusted at a monitored and automatically controlled temperature of 1 000 °C to 1 200 °C with a retention time of at least 0,3 s

3.25
gasification
process that converts biogenic or fossil-based materials into carbon monoxide and hydrogen

Note 1 to entry: This is achieved by exposing the material at high temperatures (>700 °C), without combustion, with a controlled amount of oxygen and/or steam.

Note 2 to entry: Normally, the gasification is followed by conversion into methane and carbon dioxide (methanation).

Note 3 to entry: The resulting gas mixture of carbon monoxide and hydrogen is called *syngas* (3.58). When the feedstock of gasification is *biomass* (3.9), the resulting gas mixture is called *bio-syngas* (3.15).

3.26
gas infrastructure
pipeline systems including pipework and their associated stations or plants for the *transmission* (3.59) and distribution of gas

3.27
gas pipeline
system of pipework for transportation of gas with all associated equipment and stations up to the point of delivery

Note 1 to entry: This pipework is mainly below ground but includes also above-ground parts.

3.28
hydraulic retention time
theoretical average period of time a soluble compound remains in the *digester* (3.20)

Note 1 to entry: The hydraulic retention time (HRT) is calculated as net digester volume (m^3)/daily feedstock input (m^3/day).

3.29
hydrocarbon dew temperature
temperature at a specified pressure at which hydrocarbon vapour condensation initiates

3.30
injectable biomethane
upgraded *biogas* (3.2) having *natural gas* (3.39) quality suitable to feed into the public grid and which fulfils the legal requirements for feeding into the public grid

3.31
installation owner
legal entity, a company or natural person owning the *biogas installation* (3.5)

3.32
liquefied biogas
biogas (3.2) which has been liquefied

EXAMPLE Liquefied biomethane.

3.33
liquefied biomethane
LBM
biomethane (3.12) which has been liquefied, after processing, for storage or transportation purposes

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3.34
liquefied natural gas
LNG
natural gas (3.39) that has been liquefied after processing for storage or transportation purposes

Note 1 to entry: Liquid natural gas is revaporized and introduced into pipelines for *transmission* (3.59) and distribution as natural gas.

3.35
lower heating value
amount of heat that would be released by the complete combustion with oxygen of a specified quantity of gas, in such a way that the pressure, *p*, at which the reaction takes place remains constant, and all the products of combustion are returned to the same specified temperature, *T*, as that of the reactants; all of these products being in the gaseous state

[SOURCE: ISO 14532:2014, 2.6.4.2, modified — "inferior calorific value" has been replaced.]

3.36
methane content
mol percentage of methane in *biogas* (3.2) or *biomethane* (3.12)

3.37
methane number
rating indicating the knocking characteristics of a fuel gas

Note 1 to entry: It is comparable to the octane number for petrol. One expression of the methane number is the volume percentage of methane in a methane-hydrogen mixture that in a test engine under standard conditions has the same tendency to knock as the fuel gas to be examined.

[SOURCE: ISO 14532:2014, 2.6.6.1]

3.38
mixer
agitator within a *digester* (3.20) homogenizing the *biomass* (3.9) in the digester

3.39
natural gas
complex gaseous mixture of hydrocarbons, primarily methane, but generally includes ethane, propane and higher hydrocarbons, and some non-combustible gases such as nitrogen and carbon dioxide

Note 1 to entry: Natural gas can also contain components or containments such as sulfur compounds and/or other chemical species.

[SOURCE: ISO 14532:2014, 2.1.1.1]

3.40
natural gas network
network which is either a *transmission* (3.59) network or a local distribution system

Note 1 to entry: Network and grid have the same meaning.

3.41
normal cubic metres of gas
volume of one cubic metre for real dry gas at ISO Standard Reference conditions of 15 °C and 101 325 kPa

Note 1 to entry: In the industry, 0 °C and 101 325 kPa are also often used; however, in this document, the ISO Standard Reference conditions are used.

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3.42
odorization
addition of odorants, normally intensively smelling organic sulphur compounds, to *natural gas* (3.39) to allow the recognition of gas leaks by smell at very low concentration (before a build up to a dangerous gas in air concentration can occur)

Note 1 to entry: Natural gas is normally odourless. It is necessary to add an odorant to the gas fed into the distribution system for safety reasons. It permits the detection of the gas by smell at very low concentrations.

[SOURCE: ISO 14532:2014, 2.8.2]

3.43
open flare
biogas flare (3.4) from which the burning flame is visible from the outside

Note 1 to entry: This is also called external combustion flame burner.

Note 2 to entry: The flame burner combustion is not optimal; the combustion temperature is relatively low.

3.44
organic dry matter
part of *biomass* (3.9) or *digestate* (3.19) which consists of dry matter containing carbon and originating from living materials

Note 1 to entry: Instead of organic dry matter, the term "total volatile solids" is also used.

3.45
organic loading rate digester
amount of volatile *organic dry matter* (3.44) entering the anaerobic *digester* (3.20) over time, measured in kilograms per cubic metre digester volume per day

Note 1 to entry: The organic load gives an indication on biological degradation of the *substrates* (3.56). It provides information on nutrient supply levels of the microorganisms involved, overload or undersupply of the system as well as resulting technical and process control measures to be taken. The organic load describes the efficiency of the anaerobic digester.

3.46
pipeline network
system of interconnected pipelines, both national and international, that serve to transmit and distribute *natural gas* (3.39)

[SOURCE: ISO 14532:2014, 2.1.2.1, modified — "grid" has been replaced by "network".]

3.47
power to gas
gas generated from electrical power from *biomass* (3.9) origin

3.48
raw biogas
biogas (3.2) directly from the *digester* (3.20) which is not conditioned, so it is not yet dried and cleaned

3.49
recovered gas
gases such as hydrogen, carbon dioxide, carbon monoxide and/or complex gaseous mixtures of hydrocarbons, primarily methane, but generally includes ethane, propane and higher hydrocarbons, and some non-combustible gases such as nitrogen and carbon dioxide which are recovered as a by-product or residual product of gases from, for example, industrial or thermochemical processes not being *biogas* (3.2) and not produced from *biomass* (3.9)

Note 1 to entry: Recovered gas can also contain components or containments such as sulfur compounds and/or other chemical species.

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Note 2 to entry: Usually, these gases have a fossil origin.

3.50
relative density
ratio of the mass of a gas contained within an arbitrary volume to the mass of dry air of standard composition that would be contained in the same volume at the same reference conditions

3.51
renewable non-biogenic gas
gas such as hydrogen, carbon dioxide, carbon monoxide and/or complex gaseous mixtures of hydrocarbons, primarily methane, but generally includes ethane, propane and higher hydrocarbons, and some non-combustible gases such as nitrogen and carbon dioxide which are produced from renewable sources not being *biogas* (3.2) and not produced from *biomass* (3.9)

Note 1 to entry: Examples are gases produced via *power to gas* (3.47) processes from renewable power from solar, wind, hydropower or geothermal sources, but not from biomass sources.

3.52
service provider
legal entity or a company operating on request of the biogas *installation owner* (3.31) and/or maintaining the *biogas installation* (3.5)

3.53
solid retention time
period of time expressed in days the *biomass* (3.9) is in the *digester* (3.20) for anaerobic digestion

Note 1 to entry: The solid retention time (SRT) is calculated as the net capacity for biomass content in the digester (kg)/daily feedstock input (kg/day).

3.54
specific biogas production
standard state volumetric *biogas* (3.2) production expressed in normal cubic metres per liquid volume in cubic metres of the digester per day

3.55
specific biogas yield
standard state volumetric biogas production expressed in normal cubic metres per kilogram *organic dry matter* (3.44) of the feedstock

3.56
substrate
part of the *biomass* (3.9) which is biodegradable and converted by microorganisms and/or enzymes as catalyst into *biogas* (3.2) and/or degradable by *gasification* (3.25)

3.57
supplier of the biogas installation
legal entity or a company which designs, manufactures or constructs and delivers the *biogas installation* (3.5) to the biogas *installation owner* (3.31)

3.58
syngas
gas, comprising principally of carbon monoxide and hydrogen, obtained from *gasification* (3.25) of fossil fuels

3.59
transmission
activity intended to convey gas from one place to another through pipelines in order to supply gas to distribution systems or to industrial consumers

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3.60
treated biogas
biogas (3.2) which is dried until a water dew point of at least 10 °C and conditioned by cleaning from contaminants like hydrogen sulphide and siloxanes, but from which the CO_2 and N_2 percentages have not been decreased yet

3.61
treated digestate
digestate (3.19) after partly removing the nutrients such as phosphates, nitrogen and/or water

Note 1 to entry: Treatment can be done by drying, pelletizing, and separating water and nutrients.

3.62
volatile fatty acid
fatty organic acid containing less than six carbon atoms

Note 1 to entry: These are intermediate products of the *biogas* (3.2) production process.

3.63
waste water treatment gas
biogas (3.2) produced by anaerobic waste water treatment installation or waste water treatment sludge digestion

Note 1 to entry: Waste water treatment gas is often mentioned as sewage gas.

3.64
water dew point
temperature at a specified pressure at which water vapour condensation initiates

Note 1 to entry: For any pressure lower than the specified pressure, there is no condensation of water vapours at this water dew point temperature.

[SOURCE: ISO 14532:2014, 2.6.5.1.1]

3.65
Wobbe index
calorific value on a volumetric basis at specified reference conditions, divided by the square root of the relative density at the same specified metering reference conditions

Note 1 to entry: The Wobbe index is specified as superior (denoted by the subscript "S") or inferior (denoted by the subscript "I"), depending on the calorific value.

[SOURCE: ISO 14532:2014, 2.6.4.3]

4 Abbreviated terms

CBM Compressed biomethane

CHP Combined heat and power plant

CNG Compressed natural gas

HRT Hydraulic retention time

LBM Liquefied bio methane

LNG Liquefied natural gas

SRT Solid retention time

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5 Classifications

Biogas installations can be classified in different types (e.g. domestic, farm, industrial) and different sizes (e.g. domestic scale, small scale, medium scale and large scale). Also, parts of the installations can be classified in different pressure classes. Classifications are descriptions and categorizations used for information and better understanding and do not contain technical requirements for standardization. For this reason, classifications are described in Annex B.

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Annex A
(informative)

Explanation to the scope

Biogas is produced by making use of one or more of the following types of installations:

— biomass storage and preparation (see Table A.1 for more detail);

— biomass to biogas processes (see Table A.1 for more detail):

  — anaerobic digestion;

  — gasification from biomass;

  — power to gas from biomass sources;

— biogas, biomethane and syngas storage and management (including flares);

— biogas treatment:

  — biogas dewatering and cleaning (e.g. hydrogen sulphide and siloxanes);

— biogas to biomethane process:

  — upgrading;

  — combined upgrading and liquefaction;

— biogas and biomethane applications:

  — raw material for chemical processes;

  — transportation fuel (liquefied or compressed);

  — biogas combustion processes, as far as it concerns applications which are directly and specifically used for biogas:

    — boilers used for locally produced biogas;

    — burners used for locally produced biogas;

    — furnaces used for locally produced biogas;

    — lightening by locally produced biogas;

    — flares;

    — combined heat and power (CHP) installations, such as:

      — micro gasturbines;

      — fuel cells;

      — gas engines;

— biogas and biomethane distribution:

  — compression and pressure control installations;

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  - injection into the pipeline:
    - public grid;
    - private grid (e.g. raw biogas and treated biogas);
  - liquefaction;
  - re-fuelling stations;
- process and safety control;
- digestate storage and digestate conversion (separation of minerals) including manure conversion and conversion of sludge.

The following topics are excluded from this document:

- boilers, burners, furnaces and lightening in case these are not specifically applied for locally produced biogas;
- gas-fuelled engines for vehicles and ships;
- the public gas grid;
- specifications to determine biomethane quality;
- transportation of compressed or liquefied biogas;
- transportation of biomass or digestate;
- assessment and determination whether biomass is sourced sustainably or not.

Table A.1 provides an overview of the categorization of the different processes.

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Table A.1 — Overview of different biogas production processes

Anaerobic digestion	Gasification from biomass	Power to gas from	Biomass sources
Biomass containing substrates for anaerobic digestion: — Manure — Sludge — Organic waste and residues: — Household waste — Agricultural residues — Industrial residues — Industrial effluent — Food residues — Landfill — Compost — Waste water — Energy crops	Biomass containing substrates for gasification: — Manure — Sludge — Organic waste and residues: — Household waste — Agricultural residues — Industrial residues — Industrial effluent — Food residues — Landfill — Compost — Ligno-cellulosic biomass (wood)	Power to gas from biomass sources: — Electricity from biomass sources — Water and — CO_2	—
Main components/gases: $CH_4 + CO_2$ (raw biogas)	Main components/gases: $CO + H_2$ (bio-syngas)	Main components/gases: H_2	—
Treatment	Methanation	Option 1 Methanation catalyst + CO_2 (e.g. from anaerobic digestion)	Option 2 Anaerobic digestion
Biogas	Biogas ($CH_4 + CO_2$)	Option 1 CH_4 (Methanation gas)	Option 2 Biogas
Upgrading	Upgrading	Upgrading	—
Biomethane[a]	Biomethane[a]	Biomethane[a]	—

[a] Biomethane can exist in the gaseous or (after liquefaction) in the liquid form both at different temperatures and pressures.

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This document describes for information purposes as well:

— the parameters to determine the size (e.g. small, medium-sized, or large scale);

— the parameters to determine the type of installation (e.g. domestic, industrial);

— the parameters to describe the type of technique;

— the terms and processes in order to develop health, safety and environmental protection guidelines for biogas installations.

Figures A.1 to A.3 show the scope of this document in schemes

Figure A.1 shows an example of the most simple biogas production process.

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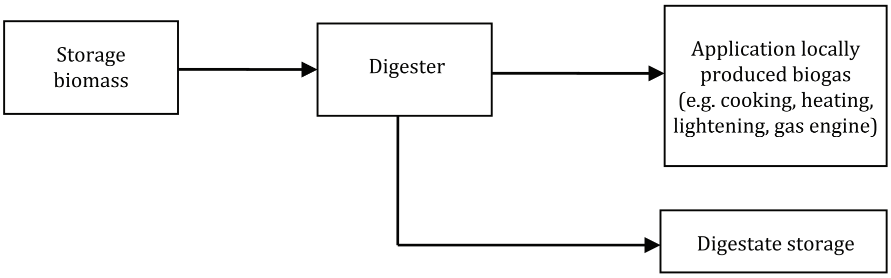
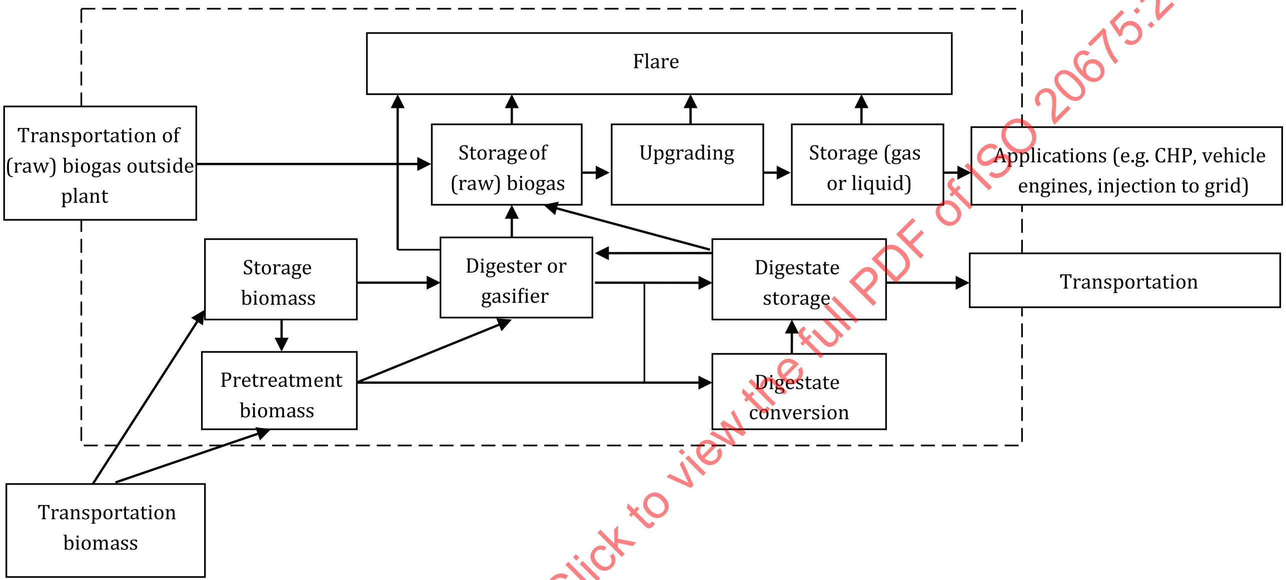


Figure A.1 — Scope of standard schematic overview: Simple biogas production process

Figure A.2 shows an example of a more complex biogas production process.



NOTE Not all process steps in this scheme are applicable, except for the process step “digester/gasifier”. All other boxes are possible pathways.

Figure A.2 — Scope of standard schematic overview: More complex biogas production process

Figure A.3 shows an example of the biogas production process based on power to gas from biomass.

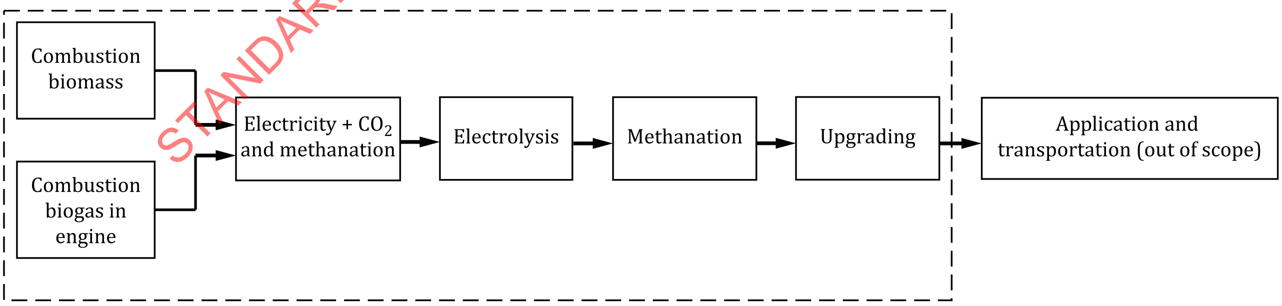


Figure A.3 — Scope of standard schematic overview: Power to gas from biomass source process

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Annex B
(informative)

Biogas characteristics, processes and classifications

B.1 Biogas characteristics

Biogas is produced by

— anaerobic digestion of biomass, or the conversion of a part of the organic materials in biomass making use of microorganisms without the presence of oxygen,

— conversion of the products of biomass gasification, or

— conversion of the products of power to gas from biomass processes.

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The processes are described below.

Biogas consists of a main part of methane, carbon dioxide, nitrogen, oxygen and, in case of gasification, hydrogen. Furthermore, contaminants like hydrogen sulphide, siloxanes, hydrocarbons and others are present. The percentages depend on the feedstock and the type of process. The caloric value of a normal cubic metre of methane is about 36 MJ per normal cubic metre.

Biogas properties can be described by

— energy parameters such as kWh/Nm^3 and/or Wobbe index,

— physical parameters like dew points, pressure, temperature,

— chemical parameters: chemical composition, and

— biological parameters: biogenic content, biological composition.

B.2 Description of the processes and the used technologies

B.2.1 General

For information purposes, a short description is included regarding the most used processes and technologies mentioned in Figure A.1.

B.2.2 Storage of biomass

Biomass is stored depending on its characteristics (solid or fluid, e.g. waste, sludge, manure) before it is led to the digester. Biomass can be stored in silos, storage tanks, and basins.

B.2.3 Treatment of biomass

Biomass can be pretreated with chemical, physical, thermal and/or biological methods in order to increase methane production when the biomass is digested. For example, it is possible to include hydrolysis as a pretreatment step in order to speed up the process. Sometimes, additives like enzymes or agents are added to the biomass (substrate) in order to improve the fermentation process.

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B.2.4 Fermentation

The purpose of the fermentation process is to convert a part of the organic materials in the biomass to biogas, making use of microorganisms. This process is anaerobic, without the presence of oxygen. The biomass can be solid or fluid and can be added batch-wise or continuous flow.

A distinction can be made between psychrophile (0 °C to 20 °C), mesophile (20 °C to 45 °C) and thermophile (45 °C to 75 °C) fermentation. At higher process temperatures, the fermentation process will run faster, by which reason more biogas is produced in a shorter time. In such cases, heat is added to keep the microorganism at the desired temperatures. Psychrophilic fermentation can occur at environmental temperatures spontaneously. Most of the usual fermentation installations are working in the mesophilic temperature area. Sometimes, a thermophilic process as a first step is combined with a mesophilic process as a second step. Wet and dry anaerobic digestion systems are applied (in general, “wet” means able to pump).

Biogas can also be produced during anaerobic waste water treatment processes. These processes can be batch flow or continuous flow. Examples are UASB (upflow anaerobic sludge bed) reactors and EGSB (expanded granular sludge bed) reactors. The chemical oxygen demand (COD) and/or biological oxygen demand (BOD) and/or total suspended solids (TSS) are important for the organic load of the waste water and for the biogas potential.

For a more detailed scientific explanation of the anaerobic digestion process, refer to the International Water Association (IWA) anaerobic digestion model number 1.

B.2.5 Digestate storage

Digestate is stored depending on its characteristics (solid or fluid, e.g. waste, sludge or manure) before it is removed from the biogas production site. Digestate can be stored in silos, storage tanks, and basins.

B.2.6 Digestate conversion

For treatment of the digestate, concentrating of the minerals and reducing the volumes are of importance. In case the minerals are eliminated, the treatment is called digestate conversion. Sometimes, this treatment is combined with the fermentation process.

Methods of digestate conversion are described below. Sometimes different techniques are combined with each other:

— physical separation of the solid part and the liquid part, which can also lead to reduce the mineral concentration in one of these phases. Examples are filter press, screw press, jack-screw press, sieve belt press, rotation filtration, brush filtration or decanter. For example, after a screw press, the liquid fraction can be led via a decanter. In the effluent of this decanter in the solid fraction, the phosphate is concentrated and in the liquid fraction the nitrogen is concentrated;

— hygienization of the digestate at increased temperatures for a certain period of time;

— precipitation of phosphates, like production of struvite (magnesium-ammonium-phosphate), in order to separate phosphates, and also nitrogen for an important part in granulars (addition of magnesium salts);

— separation of liquid nitrogen concentrate by stripping ammonium and after this, regenerating the ammonium;

— ultrafiltration, electrodialysis or reversed osmosis to concentrate the minerals and separate clean water, which can be disposed on the sewage or can be reused for cleaning or irrigation;

— aeration in order to stabilize active digestate after the fermentation;

— eutectic freezing of digestate (drying by freezing) in order to separate water.

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