

01

version

Commercial proposal

Biomethane plant: 20 million m³ of biomethane + 34,000 tonnes of food-grade liquid CO₂ per year



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Overview

Zorg Biogas offers an integrated solution for converting straw and maize crop residues into biogas and subsequently upgrading it to biomethane. The process combines feedstock preparation, two-stage digestion, biogas collection and membrane purification.

Fibrous feedstock requires pretreatment and a long retention time. The main digestion stage takes 35 days in four high-load reactors (HLR). The substrate then enters a separate post-digester for further breakdown of organic matter. A gasholder installed on this tank collects the biogas.

Straw preparation includes shredding and drying equipment. HLR technology is designed for straw, silage and similar plant materials, including operation without adding other substrate types. The design organic loading rate is 9.49 kg of organic dry matter per m³ of reactor volume per day. The plant comprises four main reactors of 4,170 m³ each.

The comparison in this proposal assumes a loading rate of 3-5 kg ODM/(m³·day) and 8-10 reactors for a conventional CSTR system. On this basis, HLR reactors are approximately three times more compact and less expensive, while capital expenditure for the proposed solution may be lower by a factor of 2-2.5. Fewer tanks also reduce the need for pumps and associated equipment.

Thermophilic operation reduces reactor cooling costs. The membrane upgrading unit produces biomethane with a methane content above 99% at low electricity consumption. Together, these solutions support efficient use of crop residues and lower operating costs.

Feedstock potential

Feedstock	Quantity (tonnes/ day)	Quantity (t/Year)	DM content (%)	ODM content (%)	DM quantity (tonnes/ day)	ODM quantity (tonnes/ day)	Biogas yield (m³/t ODM)	Biogas (m³/day)	Methane content (%)	Biomethane (m³/day)
Straw pellets	85,24	31 112	90	90	76,71	69,04	640	44 186	53	
Crop residue pellets	114,16	41 668	90	94	102,74	96,58	640	61 808	53	
Total	199,40	72 780						105 994	53	
For feedstock drying								-3600		
To biomethane unit								102 394	53	54 597

Biogas plant specifications

Specifications	Unit	Value
Total number of digesters	unit	5
Digesters 1,2,3,4 (HLR)	unit	4
Digester volume		
Working	m ³	3925
Total		4170
Digestion temperature	°C	52
Digester dimensions		
Diameter	m	25,0
Height		8,5
Organic load	kg ODM/ m ³	9,49
Retention time (gross/net)	days	35/33
Number of gasholders	unit	0
Digester 5 (post-digester)	unit	1
Post-digester volume		
Working	m ³	4988
Total		5300
Digestion temperature	°C	48
Digester dimensions		
Diameter	m	26,0
Height		10,0
Organic load	kg ODM/ m ³	3,32
Retention time (gross/net)	days	15/14
Number of gasholders	unit	1
Gasholder volume	m ³	3826
Gasholder dimensions		
Diameter	m	26,0
Height		13,0

Plant personnel

	Shift 1	Shift 2	Shift 3
Director	1	-	-
Chief Engineer	1	-	-
Manager	1	-	-
Accountant	1	-	-
Operator	1	1	1
Straw line operator	1	1	1
Driver (straw, crop residues)	1	1	1
Driver (digestate)	1	1	1
Electrician	1	-	-
Mechanic	1	-	-
Laboratory technician	1	-	-
Total	19		



Biogas production process

The organic fraction is converted by biochemical hydrolysis of high-molecular compounds into simple organic acids, salts and alcohols.

Organic compounds + H₂O -> C₅H₇N₀2 + HCO₃.

The dissolved compounds are then converted into CH₄ and CO₂:

C₅H₇N₀2 + HCO₃ + H₂O -> CH₄ + CO₂ + NH₄.

This staged biological conversion requires anaerobic conditions in a closed, oxygen-free bioreactor. In

the first stage, acid-forming bacteria hydrolyse the substrate. In the second stage, heteroacetogenic bacteria oxidise simple organic compounds, producing acetate, carbon dioxide and free hydrogen. Other organic compounds and acetate form C₁ compounds (simple organic acids).

These substances feed the methane-forming bacteria of the third stage. Two processes, A and B, involve different bacterial groups. They convert the products of the first two stages into methane CH₄, water H₂O and carbon dioxide CO₂.

Plant operating principle

Straw and crop residues are sent to the preparation unit and converted into pellets. This changes the feedstock properties, increases its contact area with microorganisms and improves digestibility. A belt conveyor distributes pellets to the feeder hoppers; screws then feed digesters 1,2,3,4. Conveying optimises loading and unloading, reduces fuel and personnel requirements and keeps the site cleaner. Wheel-loader feeding remains possible during conveyor maintenance or repair. Weighing systems automate the feeders and distribute feedstock evenly between digesters.

The substrate is mixed and maintained at a stable temperature using sensors and continuous monitoring of the heating/cooling system installed on the digester walls. Depending on substrate temperature, this system heats or cools it. Dry coolers provide cooling, maintaining stable thermophilic operating conditions. Vertical mixers periodically mix the HLR reactors; inclined mixers serve digester 5, the post-digester. Drives are mounted on frames outside the tanks and remain accessible for inspection and maintenance. Average retention time is 35 days in digesters 1-4 and 15 days in digester 5.

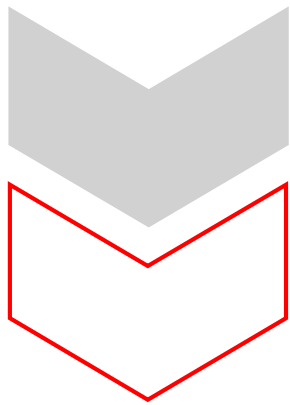
Pumps transfer digestate to separation, which produces solid and liquid organic fertilisers. Solids are discharged into a trailer and transported to fertiliser storage for subsequent use on site. The liquid filtrate enters its storage tank and is then pumped to the lagoon.

Biogas rises to the roofs of digesters 1-4 and flows to the gasholder on digester 5, where it mixes with gas generated in the post-digester. The double-membrane dome is mounted on the concrete walls of the post-digester as its roof. The outer membrane protects against weather and foreign objects. A safety valve opens at 5 mbar to release excess gas to atmosphere and prevent excessive pressure.

Collected and homogenised gas passes through biogas cooling and a blower, which raises pressure to 300-250 mbar for gas treatment. Desulphurisation takes place in several stages: iron hydroxide concentrate is added and activated carbon columns provide final cleaning to 0-5 ppm sulphur. Dried, cleaned biogas is supplied to the biomethane unit.

Automation monitors and controls all processes. The plant is visualised on the operator's computer. The control station provides central operation and switches individual units to local, manual or automatic control.

Main equipment





Crop residue drying line

After shredding and before pelletising, crop residues enter a modular drying unit that can readily be expanded. Twin distribution screws ensure optimum product distribution. A product mixer provides uniform final moisture, while energy-efficient ventilation improves drying performance.



Indirect drying uses tubular heat exchangers with hot water up to 130°C. Plate heat exchangers can be used for special heat-transfer media, including geothermal heat and thermal oil.



Direct drying uses hot air below 120°C or flue gas, depending on its composition and the application.

Technical specifications

Electrical power:	110kW
Thermal power:	210kW
Quantity:	1 set

Straw preparation unit



Shredding and pelletising line

The straw preparation line automatically shreds the feedstock to a consistent quality, a key factor in producing biogas from this material. The shredder continuously and uniformly processes bales and residues at 3-5 t/h.

Separate conveyors provide automatic straw loading, bale opening, strap removal, bale breaking, screw dosing, scraping and stone removal. Hammer mills and an extruder then reduce material from 5 mm to a 0-2 mm fraction and produce pellets. The mills have an air-gravity separator for continuous removal of foreign particles, twin-screw feeding and a bulk-material hopper.

Each line is designed to meet customer requirements, with low energy consumption and integrated control of feed devices according to shredder and mill-extruder current draw. The control unit is intuitive and operator-friendly.

Technical specifications

Power:

200 kW

Quantity:

1 set



Pellet feeder

A modular hopper feeder loads pellets onto the belt conveyor. Its main components are a buffer hopper, scraper-chain conveyors and a supporting structure. A frequency converter varies the drive speed and pellet feed rate. A weighing system monitors the quantity supplied.

Technical specifications

Height:	2,75 m
Length:	24,0 m
Width:	3,0 m
Total volume:	200m ³
Quantity:	1 unit



Biomass feeder (SF-01 ... SF-04)

A modular hopper feeder supplies feedstock to the digesters. Its moving floor and screw conveyors ensure uniform biomass dosing. A wheel loader fills the hopper. Main components include a 20 m³ buffer hopper, scraper-chain conveyors and a supporting structure for horizontal or inclined installation. Frequency converters regulate drive speed and substrate feed. The hopper includes weighing equipment and hammer crushers.

Technical specifications

Height:	2,0m
Length:	6,0m
Width:	2,3m
Total volume:	20m ³
Quantity:	4 unit



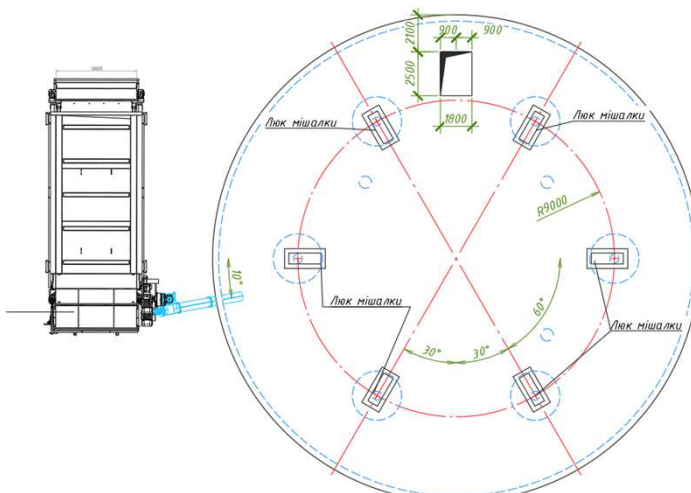
Digester (HLR) (R-01...R-04)

The digester is the central component of the plant: a circular reinforced-concrete tank on a concrete base. Its reinforced-concrete roof supports mixers, valves and biogas pipes. A central column with a capital supports the roof. The sloping bottom improves feeding and mixing; additional outlets allow complete emptying.

External extruded-polystyrene insulation limits heat loss. Below ground, walls and floor are waterproofed over the insulation using roll membranes. Protective sheeting shields insulation above and below ground from mechanical damage and rodents. A perforated drain pipe around the external wall on the concrete base monitors wall and floor tightness. Inspection chambers provide access to the drainage system.

Technical specifications

Height:	8,5 m
Diameter:	25,0 m
Total volume:	4170 m ³
Quantity:	4 unit



Digester roof layout with vertical mixer openings

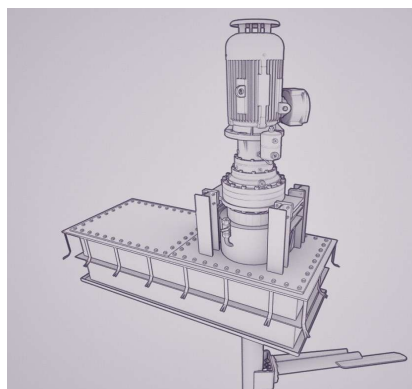
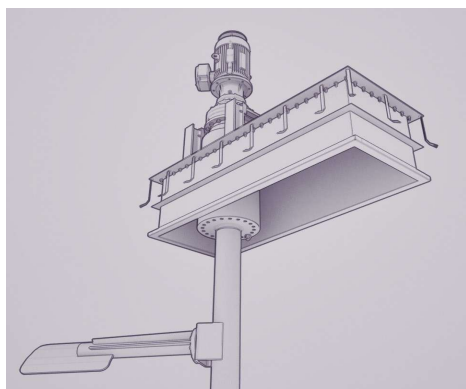


Vertical digester mixer - 1,2,3,4 (AG-01...AG-20)

The vertical mixer has blades along the full shaft length and handles substrates with 16-18% dry matter, including grass, silage and manure. Blade geometry and positioning thoroughly homogenise floating and settled layers. The shaft is adapted to digester height. Frequency converters control the drives under plant automation software. Major wear components are outside the tank for quick, convenient maintenance.

Technical specifications

Drive power:	15kW
Quantity per tank:	5 pcs
Total quantity:	20 pcs



Hatches and vertical mixer connections

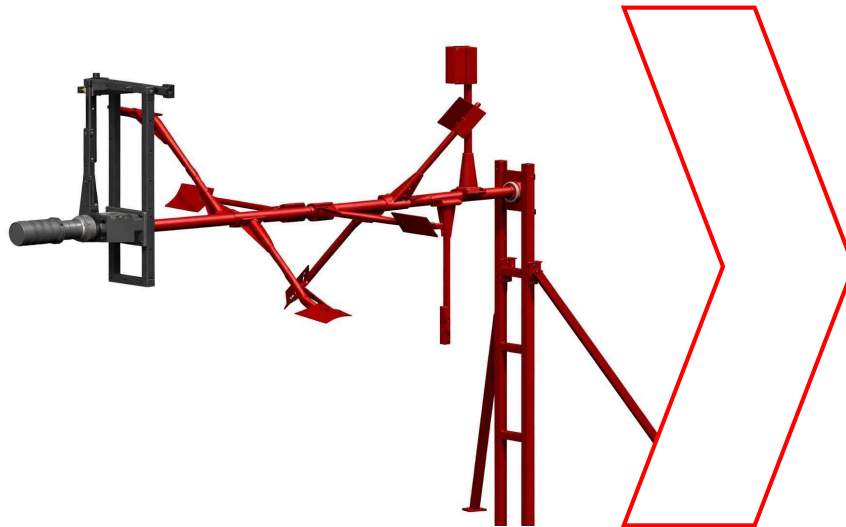


Post-digester (D-01)

The post-digester is a circular reinforced-concrete tank on a concrete base. A sloping floor improves feeding and mixing, while additional outlets allow complete discharge. External extruded-polystyrene boards retain heat and reduce losses. Below ground, rolled waterproofing covers the insulation on walls and floor. Protective sheeting shields all insulation from mechanical damage and rodents. A perforated drain pipe runs along the outside of the walls on the concrete base to monitor tank tightness. Drainage is checked through inspection chambers.

Technical specifications

Height:	10,0 m
Diameter:	26,0 m
Total volume:	5 300 m ³
Quantity:	1 unit



Post-digester paddle mixer (AG-21...25)

The inclined paddle high-power mixer Paddle-giant is designed and engineered for high efficiency with all types of raw materials (including highly viscous media). The operating mode is designed to maximize the preservation of bacterial populations (to achieve optimal gas output). The mixer bearing is made of special, extremely wear-resistant and rust-proof plastic. All components can be replaced without the need to drain the reactor or replace the mixer shaft. The operating principle is ideal for breaking up floating layers and supports the mixing of solidification layers. Degassing of the substrate is simplified. This type of mixer is suitable for minor fluctuations in filling levels. In the production of mixers, gearboxes and motors from well-known European manufacturers are used. This guarantees a long service life of our mixers. All motors and gearboxes are available with ATEX certificates. Mixers are installed at different levels in the tank.

Technical specifications

Drive power:	15kW
Quantity per tank:	5 pcs
Total quantity:	5 pcs



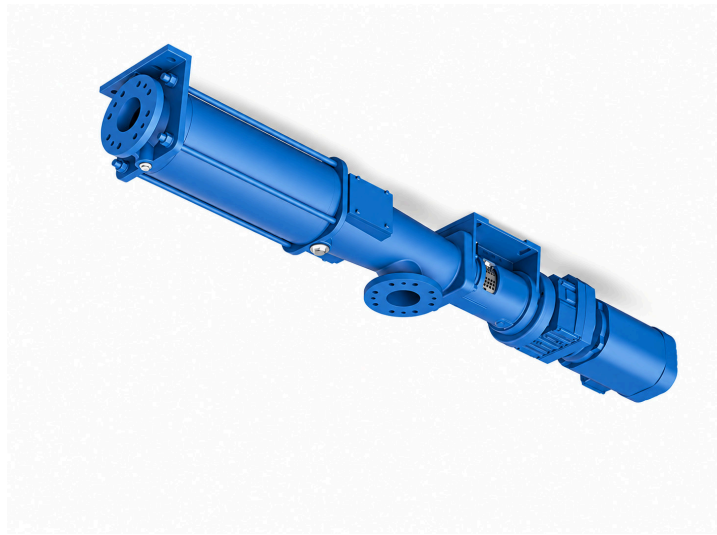
Inspection windows with spotlights (SG-01...SG-05)

Inspection windows allow visual monitoring inside the digesters. Explosion-proof spotlights have automatic disconnection. A wiper and washing system clean the windows.

Technical specifications

Inspection window: Ø300

Spotligh:
VISULUXUL50-G -H 230V, 50W, IP65



Pumping equipment (PU-01....PU-09)

Pumps move substrate between the plant units. Kinematic viscosity affects pump curves and therefore pump selection. As resistance to flow, viscosity and fluid thickness determine behaviour inside a pump. Suitable pump types are selected for each substrate. Screw pumps handle fluid sludge, mechanically thickened sludge and substrates containing up to 15% dry matter.

Technical specifications

Liquid substrate feed pump to digesters

Drive power:	11 kW
Flow rate:	40 m ³ /h
Quantity:	1 pcs

Substrate pump to post-digester

Drive power:	18 kW
Flow rate:	60 m ³ /h
Quantity:	4 pcs

Separator feed pump

Drive power:	18 kW
Flow rate:	60 m ³ /h
Quantity:	4 pcs

Filtrate supply pump

Drive power:	11 kW
Flow rate:	40 m ³ /h
Quantity:	1 pcs



Separator (SR-01 ... SR-04)

Separator separates water from solids. It operates continuously and automatically according to the press screw separator principle and separates thin and viscous compounds. Solid matter / liquid compound is pumped from the inlet chamber by the press screw into the horizontal screen. Some of the water flows due to the force of gravity through the screen. Press screw conveys the rest of the water with solid particles (also smallest particles) into the press zone in the last section of the screen. Here a permanent regenerative, compact solid matter is generated and is then pressed out through the outlet of the machine, which can be easily filled into containers. Separated fluid flows through outlet underneath the machine. On the grounds of narrow tolerance the inside of the screen is permanently kept clean.

Technical specifications

Drive power:	7,5 kW
Capacity:	8-30 m ³ /h
Quantity:	4 pcs



Reception and filtrate tanks (RT-01, FT-01)

The reception tank collects and stores liquid substrate, preheats and mixes it before transfer to the digesters. It is equipped with level and temperature sensors and a mixer. A pump supplies the liquid substrate. The filtrate tank collects liquid after separation and acts as a buffer for reuse in the process or discharge to the lagoon.

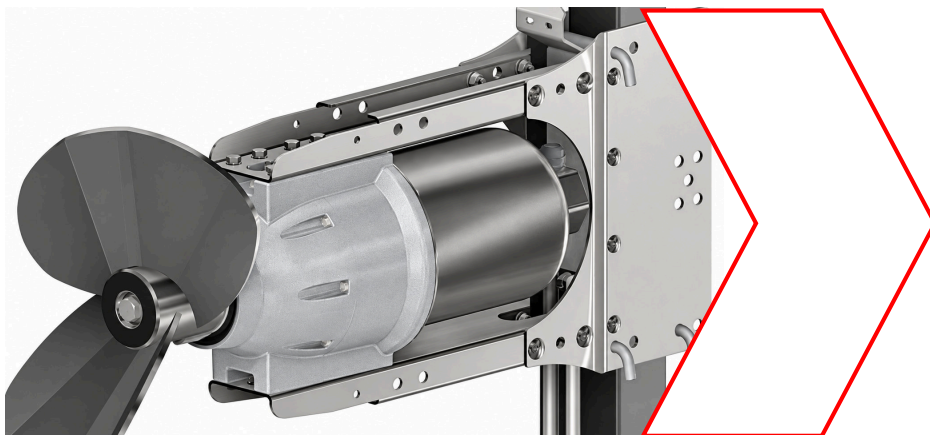
Technical specifications

Receiving tank (RT-01)

Height:	3,0 m
Diameter:	8,0 m
Total volume:	150 m ³
Quantity:	1 unit

Filtrate tank (FT-01)

Height:	3,0 m
Diameter:	8,0 m
Total volume:	150 m ³
Quantity:	1 unit



Submersible mixer (AG-21, AG-22)

The submersible mixer thoroughly mixes liquid substrates. Its watertight monoblock drives a three-blade propeller. The electric unit is designed for potentially explosive Zone 2 environments. The motor support fits most guide masts and permits height adjustment. The geared motor is painted spheroidal-graphite cast iron, the propeller is galvanised and the motor support is stainless steel.

Technical specifications

Drive power: 15 kW

Quantity per reception tank: 1 pcs

Total quantity: 1 pcs

Drive power: 5,5 kW

Quantity per filtrate tank: 1 pcs

Total quantity: 1 pcs



Gasholder (GH-01)

The gasholder collects and stores biogas and equalises pressure. It has a double-membrane construction. The outer film is PVC-coated and UV-protected on both sides, with strength of 3,000 N/5 cm. The biogas-resistant inner PEHD membrane has maximum methane permeability of 260 cm³/(m²·day·1 bar) and strength of 650 N/5 cm. The film resists cold down to -30°C.

Biogas pressure expands the inner membrane. Air supplied between the membranes presses on the inner membrane; gas pressure is 2-5 mbar. CNC cutting and high-frequency welding improve quality compared with manual fabrication and thermal welding.

A pneumatic clamping system provides a strong, gas-tight connection to the tank wall. It includes a trapezoidal profile, fixings, a pressure compressor and a hose that secures the membrane in the profile. A relief valve protects against pressure damage.

Technical specifications

Height:	13,0 m
Diameter:	26,0 m
Total volume:	3826 m³
Quantity:	1 unit



Biogas cooling and drying system (CHL-01..04)

Specialised chilling equipment dries and cools the biogas. The system includes low-pressure heat exchangers and a range of water chillers and dry coolers. The gas cooler is a single-pass shell-and-tube exchanger: biogas flows inside the tubes and coolant around them in the shell. All parts contacting biogas are stainless steel 316Ti or 316L.

Technical specifications

Biogas flow:	2200 m³/h
Inlet temperature:	+48°C
Outlet temperature:	+25°C
Electric power:	56 kW
Quantity:	4 pcs



Biogas blower (BC-01..04)

The biogas blower transfers gas and increases its pressure through a rotating impeller. A frequency converter allows operation at 30-100% of capacity.

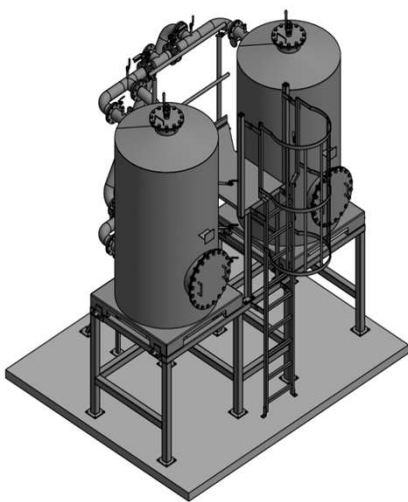
Technical specifications

Biogas flow:	4500 m ³ /h
Pressure:	300 mbar
Electric power:	55 kW
Quantity:	2 pcs



Activated carbon filter

Fine purification uses activated carbon impregnated with potassium iodide and developed specifically for biogas. Hydrogen sulphide is adsorbed in the carbon pores. The housing, base, grids and piping are stainless steel, ensuring corrosion resistance even at high H₂S concentrations. The filter can be installed indoors or outdoors on a foundation or frame. This method reduces sulphur to 0-10 ppm and also removes halogen compounds and siloxanes.

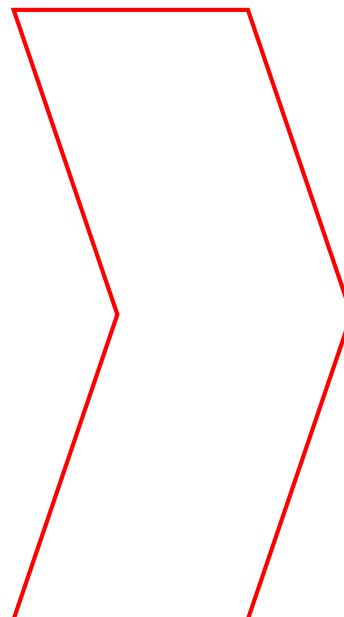


For convenient adsorbent replacement, columns should be installed on an elevated support frame. A vehicle can drive underneath so spent carbon is quickly discharged into a trailer.

Technical specifications

Carbon filling:
Quantity:

500 kg
2 pcs



Oxygen generator

The oxygen generator serves the first stage of biogas purification. Air contains approximately 21% oxygen, an odourless, colourless and tasteless gas at atmospheric conditions. Oxygen can be produced by pressure swing adsorption (PSA) or cryogenic fractional distillation of liquefied air.

In PSA, compressed air first passes through filters and an activated carbon column to remove dust, oil and water. It then enters one of two vessels containing molecular sieve (MS). CO₂ and residual moisture are adsorbed at the bed inlet. At high pressure, the sieve selectively adsorbs nitrogen while oxygen passes through at the required purity.

While one vessel produces oxygen under pressure, the other is depressurised to release adsorbed nitrogen to atmosphere. Automatic switching between adsorption and desorption ensures continuous production. Sizing the compressor and sieve vessels provides a wide range of flow and purity combinations. PSA can economically produce oxygen from less than 1 m³/h to several hundred m³/h at 90-95% purity.

Technical specifications

Capacity:	80 l/min
Power :	5,5kW
Quantity:	1 set

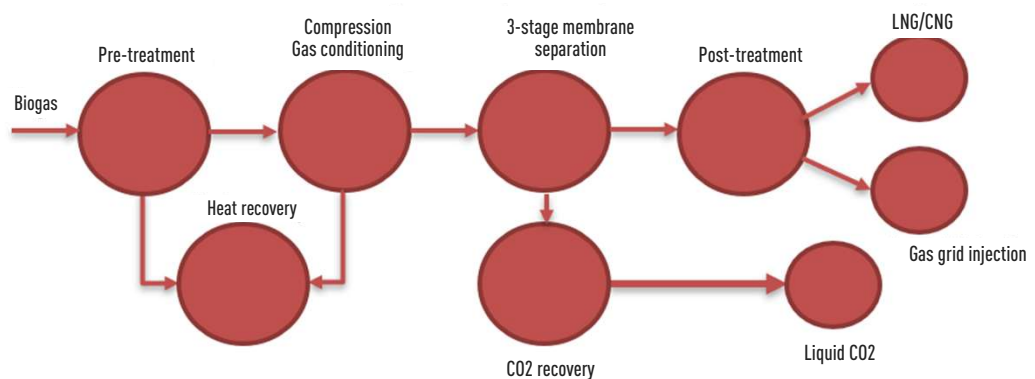


Biogas upgrading unit

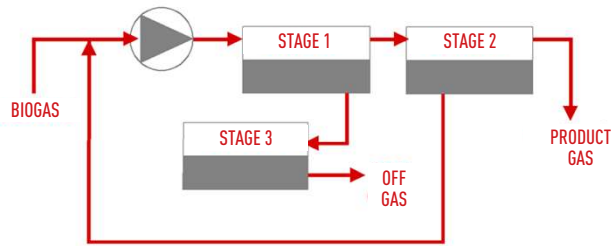
Biogas is upgraded to biomethane by membrane separation driven by a pressure difference. CO₂ and other impurities are separated from methane, producing CH₄-rich biomethane suitable for grid injection or vehicle fuel. Before entering the membranes, raw biogas is pretreated to remove water, H₂S and other contaminants using the plant's cooling and filtration systems.

The cleaned gas is compressed to the pressure required for separation, typically 12-16 bar depending on the required product specifications.

Highly selective membranes allow CO₂ to permeate much faster than methane. Permeate from the different stages is recycled to the process. Two streams are produced: biomethane at the specified methane content and CO₂-rich gas. Biomethane leaving the membranes is practically ready for grid injection. Standard quality monitoring includes a biomethane analyser, dew-point sensor and temperature sensor.



Highly selective three-stage membranes are advanced German technology developed specifically for efficient biogas upgrading to biomethane.



A membrane cartridge contains several thousand hollow fibres made from high-performance polymers inside a stainless-steel casing. The fibre ends are fixed in resin. The cartridge fits into a steel pressure housing; together they form a membrane module. Several modules can be interconnected by piping to process pressurised gas mixtures, creating a compact and easy-to-operate gas purification system. Stainless-steel housings are manufactured to national regulations, allowing plant builders to meet local requirements. Housings rated for up to 20 bar and 25 bar are available.



The membranes separate gases through thousands of hollow polymer fibres. Gas permeability depends on solubility in the membrane material and diffusion rate. More soluble gases with smaller molecules permeate faster than larger, less soluble gases. The ratio of the transport rates of two gases is called selectivity; higher selectivity improves the energy efficiency of separation.

For CO₂/CH₄ separation, CO₂ permeates the membrane much faster, while methane is retained. A partial-pressure gradient provides the driving force. This upgrades biogas to natural-gas quality with methane purity above 99%.

Benefits

- Lower energy use with 30-40% recirculation.
- Resistance to H₂S concentrations up to 3%.
- No auxiliary water or sorbents required.
- No environmental emissions.
- Separation at ambient temperature.
- Compact footprint.
- Continuous separation.
- Simple modular layout.
- Flexible and easily expandable.
- Very high selectivity and product purity.
- Methane recovery above 99%.



Biomethane unit specifications

	Biogas	Biomethane	CO ₂ rich gas
Maximum gas flow (Nm ³ /h)	4500	2400	1995
Actual flow (Nm ³ /h)	4266	2275	1891
CH ₄ (%)	53	99	2,74
CO ₂ (%)	42,17	1,8	94,6
H ₂ O (%)	0,8	dew point < -65°C	2
N ₂ (%)	0,8	1,16	0,3
O ₂ (%)	0,2	0,1	0,35
H ₂ S (ppm)	<3	-	-
Temperature (°C)	20	25	40
Pressure (bar)	0,09	3,1	0,05

Energy consumption

Biomethane upgrading unit

0,26 kW/Nm³ biogas



Biomethane compression station 50 bar (CS-01)

The compact compression station is easy to install. It is designed for biomethane with inlet pressure from 0 to 50 bar and provides reliable operation at 3,000-54,600 Nm³/day.

Main components:

- Reciprocating compressor with oil-free cylinders.
- One or two stages, outlet pressure 4-50 bar.
- Advanced plungers and seals exceeding industry standards.
- Direct motor-compressor coupling.
- PLC with display.
- Integrated remote control.
- Inlet scrubber with automatic drain.

Technical specifications

Biomethane flow:	2275 m³/h
Electric power:	400 kW
Quantity:	2 pcs

Recommended quantity: 2 units, to maintain biomethane plant operation during compressor repairs and servicing.



Gas chromatograph

The chromatograph precisely measures biogas and biomethane composition. It continuously or periodically monitors gas quality before grid injection or delivery to another consumer. It collects and analyses data, performs calibration and calculates physical properties under ISO 6976, including lower and higher heating values, density and Wobbe index, from component composition. The chromatogram identifies each component concentration, providing the operator with real-time composition or a report.

Technical specifications

Explosion-protected for Zones 1 and 2. Stainless-steel housing with protected door, IP66. Industrial front-panel PC. LAN remote control of the chromatograph and stream selector. Industrial interface with database software. Modbus and Profibus communication via Ethernet/RS232/RS485.

Quantity:

1 pcs



Odorisation station

The odorisation station adds an odorant, usually based on mercaptans or sulphur compounds, giving biomethane a characteristic smell so leaks can be detected by smell. Odorisation is required for injection into gas distribution networks. The station comprises an odorant tank, precise metering pump, dosing control, pressure and flow sensors, control unit, protective enclosure and cabinet, and leak protection.

Technical specifications

Maximum operating pressure:	100 bar
Operating temperature: (heated versions for cold weather)	17°C-60°C
Gas flow input signal:	pulse
Quantity:	1 pcs



CO2 liquefaction unit

Upgrading produces two streams: biomethane with the specified methane content and CO2-rich gas. Adding CO2 recovery allows gaseous CO2 from purification to be liquefied. A compressor raises its pressure in two stages. Activated carbon then removes residual odours and other impurities, followed by an automatic molecular-sieve dryer that removes moisture.

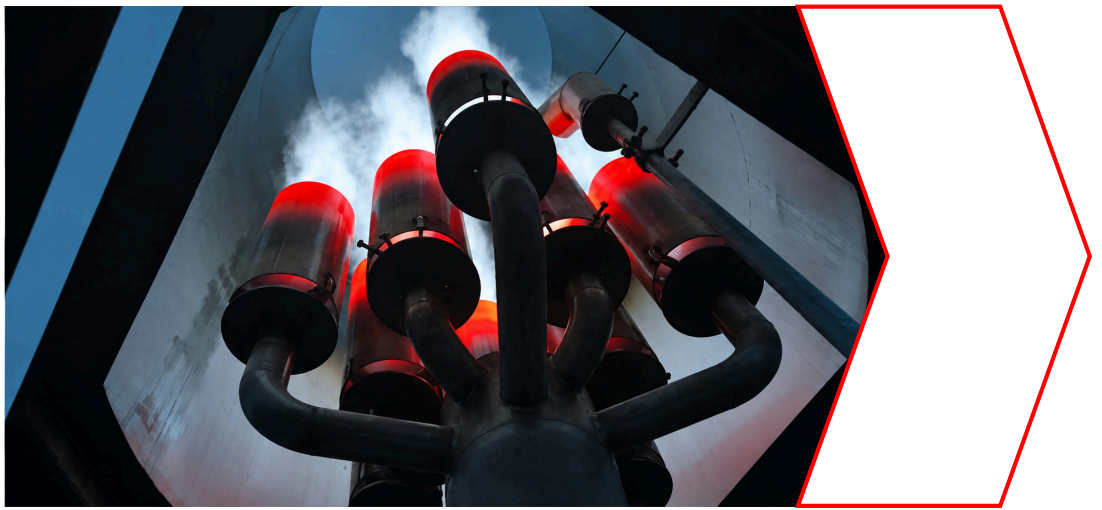
The purified gas enters the liquefier: CO2 condenses while non-condensable gases remain gaseous. Oxygen, methane and nitrogen are removed in a stripping column. Pure liquid CO2 flows to an insulated storage tank. Food-grade liquid CO2 can be used in food and carbonated beverages, refrigeration and greenhouses. CO2 recovery can provide an additional revenue stream for biomethane projects.

CO2 filling

Liquid CO2 enters a booster pump that establishes the pressure required for cylinders, tankers or industrial vessels. During filling, the cylinder cools rapidly and gains weight. The system monitors weight to 0.01 kg, pressure, flow and liquid temperature. At nominal fill mass, for example 6, 10, 20 or 30 kg, the pump changes to slow topping-up to keep CO2 liquid. Excess gas leaves through the evaporation line, mass stabilises and cylinder temperature equalises. Cylinders must be filled to 67-75% to leave room for thermal expansion.

Technical specifications

CO2 flow:	1940 m ³ /h
Liquefaction capacity:	3880 kg CO2/h
CO2 purity:	99%
Quantity:	1 pcs



Biogas flare (BF-01, BF-02)

Flare is designed for the temporary or periodical complete combustion of the biogas produced by biogas plants without the possibility of its use as an energy source. The burn system consists of a burner and additional equipment. The burner is designed on the principle of injection and consists of a combustion nozzle with an injector with an air supply control system, flame protection tube, fitting and burner control system. The biogas combustion system is made of stainless steel. The supporting structure holds the burner and vertically mounted socket. The burn control system is installed in a case, which is mounted on the supporting structure of the combustion system and contains all the elements for monitoring and controlling ignition and flame.

Technical specifications

Biogas flow:

2500 m³/h

Pressure:

**min. 10 mbar-
max. 60 mbar**

Quantity:

2 pcs

Water supply and drainage



Water systems supply the plant for domestic, process and fire-fighting needs. Self-priming single-stage centrifugal pumps are used. Wastewater pumps discharge process and domestic wastewater and, where needed, rainwater. Booster systems increase network pressure using two or three pumps connected in parallel.

Technical specifications

Water supply pump station

Drive power:	7,5 kW
Flow rate:	40 m ³ /h
Pressure:	20 m

Fire water pumping station

Drive power:	7,5 kW
Flow rate:	38 m ³ /h
Pressure:	25 m

Drainage pump

Drive power:	1,5 kW
Flow rate:	10 m ³ /h
Pressure:	15 m

Air supply system

The air supply system secures the gasholder's protective dome through a pneumatic clamp maintained at the required pressure.

Technical specifications

Air consumption:	200 l/min
Maximum pressure:	8 bar
Receiver capacity:	9,5 l



Heating system

Heating equipment compensates heat losses and maintains a constant digester temperature. It includes circulation pumps, piping and heating tubes. Heat is supplied by CHP units or another external source. The heat-transfer fluid is an aqueous propylene glycol solution. An electric boiler is used for heating.

Technical specifications

Circulation pump

Drive power:	3,5 kW
Flow rate:	28 m ³ /h
Pressure:	1 bar

Circulation pump

Drive power:	2,0 kW
Flow rate:	12 m ³ /h
Pressure:	1 bar

Propylene glycol pump station

Drive power:	0,77 kW
Flow rate:	1,0 m ³ /h
Pressure:	4 bar

Electric boiler

Installed power, kW:	As calculated
Quantity:	1 set



Dry cooler (substrate cooling) (DC-01 ... DC-04)

Active digestion and thermophilic operation can cause self-heating around +48 to +50°C. Digester cooling prevents an uncontrolled rise above the operating range. The same spiral heat exchanger used for heating provides cooling: the heat-transfer circuit is switched from heating to the dry cooler.

Technical specifications

Heat power:	100 kW
Electric power:	4 kW
Quantity:	5 pcs



Automation

Process automation monitors and regulates plant operation and limits damage. In an emergency, such as power failure, the plant automatically enters a safe mode. Real-time monitoring detects and corrects deviations promptly, optimises operation and reduces costs. Parameters are continuously recorded in an electronic log.

The system consists of a control cabinet, process sensors and actuators. The modular cabinet contains a power supply, central and buffer processors at the top, Simatic ET200S distributed I/O below, and interface relays and terminals for actuators at the bottom. One operator controls the whole plant.

Technical specifications

Distribution boards VRU-1, 2, 3

Controller: Siemens CPU315-DP2

Peripherals: Simatic ET200S

OP277 touch panel

Communication: PROFIBUS and MPI

Interface: RS-485

Control system: Simatic Step7



Sensors, set

Sensors measure physical quantities, including temperature, pressure, level and moisture, and transmit readings and signals to the operator's display.



Sensor types

Conductivity sensor
Pressure / level sensor
Ultrasonic sensor
Gas pressure sensor



Diesel generator

The diesel generator provides standby or primary power. Its powerful engine meets international quality and environmental standards and has both mechanical and electronic speed governors. The robust alternator withstands 300% short-circuit current for 20 seconds without interrupting operation, improving emergency resilience. An all-weather sound-insulated enclosure and temperature control support starting in any weather.

Benefits include reliability, low noise, enhanced safety and three-stage fuel cleaning. Options include LiveLink remote monitoring, improved sound attenuation, additional mobility and different fuel-tank capacities. Pre-start heating enables rapid starting in freezing conditions. Automatic voltage regulation (AVR) protects against overload and voltage surges.

Technical specifications

Rated power:	1000 kW
Rated voltage:	230/400kW
Engine displacement:	35,8 l
Fuel consumption (75% load):	172l/h
Dimensions (H x L x W)	2600x 6060x 2440mm
Quantity:	1 pcs



Laboratory

Monitoring and control of parameters of raw materials and fermentation processes is important for the efficient operation of a biogas plant. The laboratory allows you to assess the content of dry matter in the input raw materials, fermented mass, determine the ratio of volatile organic acids to total inorganic carbon (FOS/TAC parameter), determine the degree of substrate fermentation in fermenters, the level of biogas output, and evaluate the efficiency of separator. -

Equipment

Analytical balance
Moisture analyser
Automatic titrator
Laboratory pH meter
Centrifuge
Flask set

Equipment specification



No.	Name equipment Equipment	Technical specification	Quantity
1	Biomass feeder -1,2,3,4	V=20 m ³	4
1.1	Feeder hopper		4
1.2	Screw set.	set	4
2	Pellet feeder for conveyor	V=200 m ³	1
1.1	Feeder hopper		1
1.2	Screw set.	set	1
3	Submersible mixer for reception and filtrate tanks	N=15 kW	1
3.1	Airtight motor gearbox		1
3.2	Propeller (wear-resistant steel)		1
3.3	Mixer adjustment mechanism		1
3.4	Electric motor mounting		1
3.5	Fixings		1
4	Vertical digester mixer-1,2,3,4	N=15 kW	20
4.1	Sealed geared motor		20
4.2	Propeller (wear-resistant steel)		20
4.3	Shaft (adapted to digester height)		20
4.4	Blades		20
4.5	Frequency converter		20
4.6	Lower mixer bracket mounting		20
5	Post-digester paddle mixer	N=15 kW	5
6	Overpressure/vacuum safety valve		5
7	Inspection windows with spotlights	set	5
7.1	RD300 inspection window (fixings and sealant)	Ø300	10
7.2	Spotlight (mounting included) VISULUX UL50-G-H	230V, 50W, IP65	5
8	Liquid substrate pump	30-40 m ³ /h N=11.0 kW	1

No.	Equipment	Specifications	Quantity
9	Substrate pump to post-digester	60 m ³ /h N=18.0 kW	4
10	Separator feed pump	60 m ³ /h N=18.0 kW	4
11	Separator	N=7.5 kW	4
11.1	Body		4
11.2	4-inch substrate connection		4
11.3	Motor and gearbox	N=7,5 kW	4
11.4	Frame		4
11.5	Screw		4
11.6	Filter screen		4
12	Filtrate supply pump	40 m ³ /h N=11 kW	1
13	PVC gasholder H/D = 1/2	3826 m ³	1
13.1	Protective dome	Ø26 m	1
13.2	Inner PELD membrane		1
13.3	Air blower	16A, 0,5kW	1
13.4	Fixings		1
13.5	Overpressure/vacuum safety valve		1
13.6	Fill indicator		1
13.7	Accessories		1
13.8	Safety valve		1
14	Biogas cooling system	2200 m ³ /day	4
14.1	Chiller		4
14.2	Heat exchanger		4
14.3	Propylene glycol tank		4

No.	Equipment	Specifications	Quantity
15	Desulphurisation system		1
15.1	Oxygen generator, set	80 l/min	1
15.2	Carbon filter	500kg	2
16	Biogas blower	Q=4500m ³ /h, H=250mbar, N=55kW	2
17	Electromagnetic biogas meter		2
18	Biogas flare	2500 m ³ /h	2
19	Gas equipment	set	1
19.1	Drain pump with float	DN=50, Q=1m ³ /h, H=13 m	2
20	Heating system	set	1
20.1	Expansion vessel	V=1000 l,P=6Bar T=120°C	1
20.2	Heat-transfer fluid circulation pump	Q=30 m ³ /h, H=1 bar	1
20.3	Propylene glycol supply unit	Q=1,0 m ³ /h, H=4 bar	1
20.4	Digester heating circulation pump	Q=18 m ³ /h, H=1.1 bar	5
20.5	Electric boiler	set	1
21	Water supply and drainage	set	1
22	Automation and electrical equipment	set	1
22.1	Incoming distribution board VRU-1		1
22.2	Incoming distribution board VRU-2		1
23	Sensors (set)		1
23.1	Pressure sensor (gas pressure) 0,025 bar		5
23.2	Pressure sensor (gas pressure)0,4 bar		5

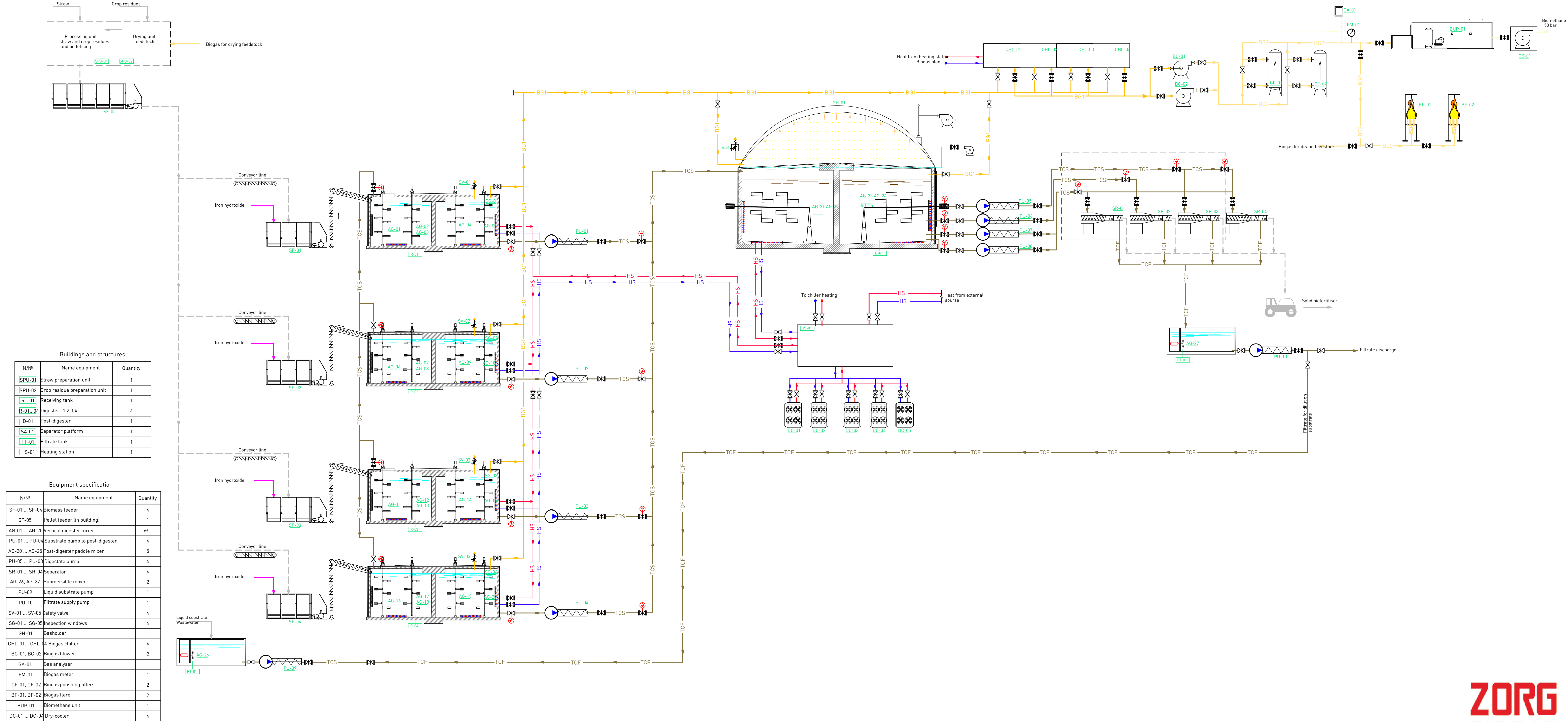
No.	Equipment	Specifications	Quantity
23.3	Pressure sensor (substrate pressure) 1,0 bar		5
23.4	Pressure sensor (substrate pressure) 2,5 bar		5
23.5	Thermal converter		5
23.6	Thermowells		5
23.7	Heating circuit temperature sensor		5
23.8	Pressure sensor (substrate pressure)		6
23.9	Pressure sensor (substrate pressure)		6
23.10	Pressure sensor (coolant pressure)		6
23.11	Submersible pressure sensor		1
23.12	Gas humidity and temperature sensor	SEN 3276 B065 G1/2 6Bar	5
23.13	Thermal converter	ESFTF-I	5
24	Dry-cooler 100kW Thermal power		5
25	Biomethane unit	set	1
26	Biomethane compression station	set	2
27	Laboratory	set	1
28	Diesel generator 1 MW	set	1

Appendices

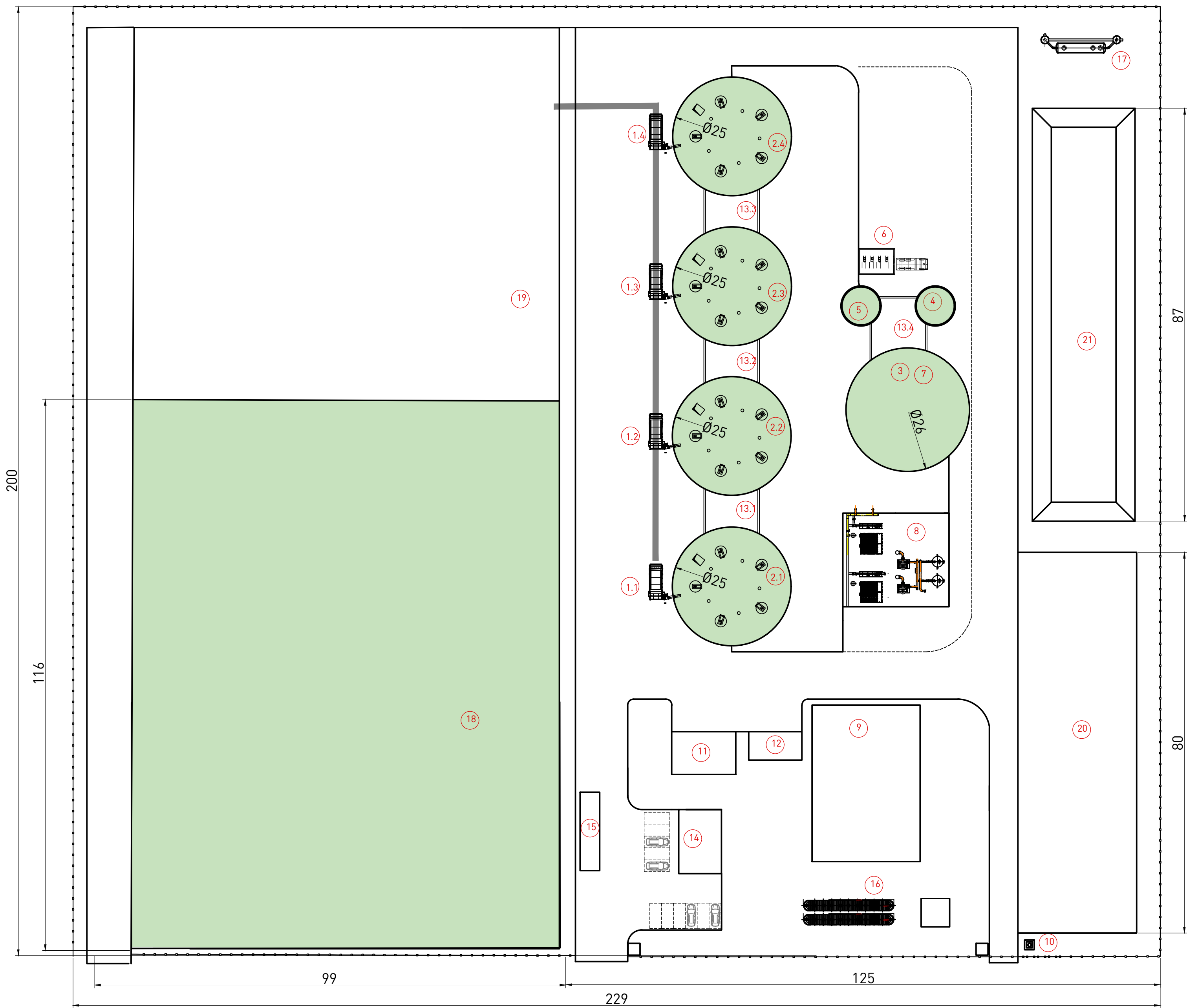




Process diagram



Plant layout



Explcation		
N/Nº	Name equipment	Note
1.X	Biomass feeder-1,2,3,4	
2.X	Digester-1,2,3,4	
3	Post-digester	
4	Receiving tank	
5	Filtrate tank	
6	Separator platform	
7	Gasholder	
8	Biogas equipment area	
9	Biomethane unit	
10	Biogas flare	
11	Administration building	
12	Transformer station	
13.X	Equipment building	
14	Spare parts store	
15	Weighbridge	
16	Fire water tank	
17	Local stormwater treatment	
18	Straw storage area	
19	Straw and residue processing unit	
20	Solid fertiliser storage area	
21	Lagoon	

Appendix 4

Biogas plant					
Equipment	Power (kW)	Qty. units	Total power (kW)	Operating hours per day	Electricity consumed (kWh/day)
Feedstock preparation unit	200,0	1	200,0	16,0	3200,0
Crop residue drying line	110,0	1	110,0	16,0	1760,0
Pellet feeder 200 m³	47,0	1	47,0	6,0	282,0
Feedstock conveyor line	44,0	1	44,0	6,0	264,0
Biomass feeder-1,2,3,4 V=20 m3	18,0	4	72,0	6,0	432,0
Screw set.	23,0	4	92,0	6,0	552,0
Vertical digester mixer - 1,2,3,4	15,0	20	300,0	16,0	4800,0
Post-digester paddle mixer	15,0	5	75,0	16,0	1200,0
Reception tank submersible mixer	15,0	1	15,0	8,0	120,0
Filtrate tank submersible mixer	5,5	1	5,5	8,0	44,0
Biogas cooling system	56,0	4	224,0	24,0	5376,0
Biogas blower	55,0	2	110,0	12,0	1320,0
Oxygen generator	5,5	1	5,5	8,0	44,0
Liquid substrate pump	11,0	1	11,0	0,5	5,5
Substrate pump to post-digester	18,0	4	72,0	4,0	288,0
Digestate pump	18,0	4	72,0	6,0	432,0
Separator 1,2, 3,4	7,5	4	30,0	6,0	180,0
Filtrate supply pump	18,0	1	18,0	3,0	54,0
Gasholder pneumatic clamp compressor	1,5	2	3,0	1,0	3,0
Gasholder membrane air blower	1,0	2	2,0	24,0	48,0
Dry-cooler	4,0	4	16,0	24,0	384,0
Circulation pump of heat carrier systems cooling	0,8	4	3,0	24,0	72,0
Circulation pump of heat carrier systems cooling	2,0	4	8,0	24,0	192,0
Circulation pump of heat carrier systems cooling	0,1	1	0,1	24,0	1,9
Propylene glycol pumping station	0,8	1	0,8	0,5	0,4
Drainage pump	1,0	2	2,0	0,5	1,0
Territory lighting Biogas plant	1,2	1	1,2	8,0	9,6
Digester inspection light	0,1	4	0,3	0,5	0,2
Distribution board lighting	0,1	1	0,1	0,5	0,1
Total installed power, kW			1138		
Total electricity consumption, kWh/day					21066
Total consumed power, kW					878

Biomethane complex					
Equipment	Power (kW)	Qty. units	Total power (kW)	Operating hours per day	Electricity consumed (kWh/day)
Biomethane unit	1148,3	1	1148,3	24,0	27558,6
Biomethane compression station 50 bar	400,3	1	400,3	24,0	9608,0
Total installed power, kW			1548,6		
Total electricity consumption, kWh/day					37167
Total consumed power, kW					1549

Total power consumption, kW					2426
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Prices: straw biomethane plant, 20 million m³/year

Pos	Name equipment	Qty.	Unit price, EUR	Price sub- EUR	
1	Design documentation	1	118.300	118.300	
2	Construction supervision	1	60.000	60.000	
3	Startup and training	1	60.000	60.000	
4	Accommodation and travel expenses	1	40.000	40.000	
5	Delivery of the equipment (trucks)	25	8.000	200.000	
6	Belt conveyor	1	245.000	245.000	
7	Biomass feeder-1,2,3,4 (V=20m³)	4	95.000	380.000	
8	Screw set.	4	115.000	460.000	
9	Biomass feeder-4 (V=200m³)	1	235.000	235.000	
10	Screw set.	1	125.000	125.000	
11	Vertical digester mixer-1,2,3,4 15 kW	20	44.800	896.000	
12	Frame for vertical digester mixer, item 12	20	4.900	98.000	
13	Post-digester paddle mixer 15 kW	5	44.800	224.000	
14	Digester mixer frame, item 14	5	4.900	24.500	
15	Liquid substrate pump 11kW	1	20.300	20.300	
16	Substrate pump to post-digester 18 kW	4	25.200	100.800	
17	Digestate pump 18 kW	4	25.200	100.800	
18	Separator 7.5 kW	4	40.600	162.400	
19	Filtrate supply pump 11kW	1	20.300	20.300	
20	Overpressure/vacuum safety valve	4	5.600	22.400	
21	Inspection windows with spotlights	4	4.900	19.600	
22	Water supply and drainage	1	63.910	63.910	
23	Heating system	1	67.900	67.900	
24	Dry cooler (substrate cooling)	5	25.900	129.500	
25	Automation and electrical cabinet	1	590.000	590.000	
26	Motorised valves	22	6.300	138.600	
27	Sensors (set)	7	25.000	175.000	
28	Gasholder D26m 1/2D	2	81.000	162.000	
29	Gas piping set (valves, gates and fittings)	1	101.500	101.500	
30	Chiller (Biogas cooling system) 2200 m³/h	4	87.500	350.000	
31	Biogas blower 4500m³/h	2	38.500	77.000	
32	Activated carbon filter 500 kg	2	27.300	54.600	
33	Biogas flare 2500 m³/h	2	127.400	254.800	
34	Gas analyser	2	18.900	37.800	
35	Biomethane unit	1	3.710.000	3.710.000	
36	Biomethane compression station 50 bar	2	350.000	700.000	
37	Laboratory	1	19.600	19.600	
38	Civil works and installation of equipment and utilities	1	3.700.000	3.700.000	client
	Total ZORG scope, EUR			10.244.610	
Total Zorg + Client, EUR				13.944.610	

Project schedule and payments

Year														
Month	01	02	03	04	05	06	07	08	09	10	11	12		
Initial data collection														
Design		50%			50%									
Approvals and permits														
Equipment						30%	20%	20%		30%				
Delivery Equipment														
Biomethane unit			30%							70%				
Module delivery														
Construction														
Construction supervision					50%					50%				
Start-up and commissioning												50%		50%

Contracts

The project is implemented under several parallel contracts.

- Design documentation
- Equipment supply
- Construction supervision
- Start-up and commissioning

Exclusions from the biogas plant scope

- 1) Topographical and geological surveys: EUR 3,000-7,000.
- 2) Transformer and external power line for start-up and construction, and 2,500 kW for normal operation.
- 3) External roads.
- 4) Temporary water supply during construction and hydraulic testing of digesters: 5,300 m³. Non-saline process water from a river, lake or well may be used.
- 5) Start-up inoculum: substrate from another biogas plant, liquid manure or sewage-treatment sludge. The client supplies it once over 1-2 weeks to fill 15-20% of digester volume (800 m³). The remaining volume is filled with the water above.
- 6) Machinery to transport manure and straw to/from storage areas, preparation unit and feeder: wheel loader and tractor.
- 7) Activated carbon: 1.0 tonne per two years x EUR 4,800/t = EUR 4,800.
- 8) FeO(OH) concentrate: 132 t/year x EUR 800/t = EUR 105,600.
- 9) Trace elements: 3,760 l/year x EUR 25/l = EUR 94,000.
- 10) Demineralised water for heating: 5 tonnes.
- 11) Spare parts for two years: EUR 280,000.